Boundaries and Bridges: adults learning mathematics in a fractured world

Mathematics conference incorporating NANAMIC 2018

UCL Institute of Education, London UK

9th – 12th July, 2018

ALM25 Conference Proceedings

Proceedings of the 25th International Conference of Adults Learning Maths – A Research Forum (ALM)

Hosted by University College London, Institute of Education

Edited by **Diane Dalby, David Kaye, Beth Kelly& Jenny Stacey**

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Hosted by UCL: Institute of Education

July 9th – July 12th, 2018

Edited by:

Beth Kelly, Diane Dalby, David Kaye, & Jenny Stacey

Local Organisers:

Beth Kelly, David Kaye, Graham Griffiths, Diane Dalby, Jeff Evans, Jenny Stacey

Conference Convenor

ALM

Local Conference host

UCL Institute of Education

Centre for Post-14 Education and Work

Conference co-host

National Association for Numeracy and Mathematics in Colleges (na)²MIC

Financial contributor

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About ALM

Adults Learning Mathematics – A Research Forum (ALM) was formally established in July 1994 as an international research forum with the following aim:

> *To promote the learning of mathematics by adults through an international forum that brings together those engaged and interested in research and development in the field of mathematics learning and teaching.*

Charitable Status

ALM is a Registered Charity (1079462) and a Company Limited by Guarantee (Company Number: 3901346). The company address is: 26 Tennyson Road, London NW6 7SA, UK.

Aims of ALM

ALM's aims are to promote the advancement of education by supporting the establishment and development of an international research forum for adult mathematics and numeracy by:

> *Encouraging research into adults learning mathematics at all levels and disseminating the results of this research for the public benefit.*
>
> *Promoting and sharing knowledge, awareness and understanding of adults learning mathematics at all levels, to encourage the development of the teaching of mathematics to adults at all levels for the public benefit.*

ALM's vision is to be a catalyst for the development and dissemination of theory, research and best practices in the learning of mathematics by adults, and to provide an international identity for the profession through an international conference that helps to promote and share knowledge of adults' mathematics teaching and learning for the public benefit.

ALM Activities

ALM members work in a variety of educational settings, as practitioners and researchers, to improve the teaching and learning of mathematics at all levels. The ALM annual conference provides an international network, which reflects on practice and research, fosters links between teachers, and encourages good practice in curriculum design and delivery using teaching and learning strategies from all over the world. ALM does not foster one particular theoretical framework, but encourages discussion on research methods and findings from multiple frameworks.

ALM holds an international conference each year at which members and delegates share their work, meet each other, and network. ALM produces and disseminates Conference Proceedings and a multi-series online Adults Learning Mathematics – International Journal (ALM - IJ).

ALM website

On the ALM website http://www.alm-online.net, you will also find pages of interest for teachers, experienced researchers, new researchers and graduate students, and policy makers.

Teachers: The work of members includes many ideas for the development and advancement of practice, which is documented in the Proceedings of ALM conferences and in other ALM publications.

Experienced Researchers: The organization brings together international academics, who promote the sharing of ideas, publications, and dissemination of knowledge via the conference and academic refereed journal.

New Researchers and Ph.D. Students: ALM annual conferences and other events allow a friendly and interactive environment of exchange between practitioners and researchers to examine ideas, develop work, and advance the field of mathematics teaching and learning.

Policymakers: The work of the individuals in the organization helps to shape policies in various countries around the world.

ALM Members

ALM Members live and work all over the world. See the ALM members' page at www.almonline.net for more information on regional activities and representatives, and for information on contacting your regional representative. How to become a member: Anyone who is interested in joining ALM should contact the membership secretary. Contact details are on the ALM website: www.alm-online.net.

Membership fees for 2018

	Sterling	Euro	US Dollar
Individual	20	24	32
Institution	40	48	64
Student/unwaged	4	6	7
Low waged	Contribute between full and unwaged		

Board of Trustees

ALM is managed by a Board of Trustees elected by the members at the Annual General Meeting (AGM), which is held at the annual international conference.

Open access publication

ALM 25Proceedings Editors: Beth Kelly, Diane Dalby, David Kaye, & Jenny Stacey

ALM 25LocalOrganisers:Beth Kelly, David Kaye, Graham Griffiths, Diane Dalby, Jenny Stacey

These proceedings publish long abstracts from the presenters at the conference. Where longer papers on similar topics have also been submitted for reveiw to the Adults Learning Mathematics – International Journal (ALM - IJ) an asterisk (*) is placed next to the title in the table of contents...

Photos front and back cover: …………

Cite as:

Kelly, B., Kaye, D., Griffiths, D., Dalby, D., Stacey, J. (Eds.). (2019). Boundaries and Bridges: Adults learning mathematics in a fractured world. Proceedings of the 25th International Conference of Adults Learning Mathematics: A Research Forum (ALM). London, UK: UCL Institute of Education

ISBN: 978-1-9161278-1- 4

Acknowledgement

Conference administrative secretariat

UCL Institute of Education

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Preface: About ALM 25

The 25thinternational conference of Adults Learning Mathematics – A Research Forum (ALM 25) was held in London, England.

The conference was organized by UCL Institute of Education, and was funded by UCL Institute of Education and The Education and Training Foundation. The conference was spread over three days with the first day incorporating National Association for Numeracy and Mathematics in Colleges (NANAMIC), a sister organization that provides professional development for numeracy and mathematics teachers and is a voice for the post-16 learning and skills sector in the UK. The conference was attended by over 80 researchers, practitioners and policymakers, from 15 countries (Australia, Canada, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Senegal, Spain, Sweden, Switzerland, the United Kingdom and the United States of America).

The main theme of the conference was 'Boundaries and Bridges: adults learning mathematics in a fractured world.' The conference involved a range of creative and inspirational speakers such as Rob Easterway (Director of Maths Inspiration), Professor Chris Budd (University of Bath and Gresham College) and Bobby Seagull (Teacher, author and Ambassador for Mathematics) who discussed ways to build bridges and engage various learners from parents to prisoners, through the inspiring use of mathematics, while overcoming such barriers as maths anxiety. Dr Gail FitzSimons (University of Melbourne (Emerita) addressed the need to build capacity to keep mathematics and numeracy practitioners and researchers professionally informed to improve quality, while Professor Candia Morgan (UCL Institute of Education) offered an analysis of examinations that researchers and practitioners can use to support the learning of mathematics skills. David Walker(Journalist) argued, the creativity, inspiration and quality is lost if we do not support the adult sector with the much-needed resources. He argued given the studies that suggest a link between skills and economic performance, "why is adult numeracy not actively propagated?"

ALM has held the 9th, 16th and 25th conferences in London – the areas of the squares of the Pythagorean 3, 4, 5 triangle.

Note: Papers for these Proceedings are based on the long abstracts prepared by presenters for the Conference. They have been up-dated and edited and in some cases longer versions have been submitted. The Trustees of ALM decided to use revised versions of the long abstracts, which are lightly edited, but not peer reviewed, as papers for the proceedings. Conference presenters are still invited to submit longer articles for peer review based on conference presentations to the ALM International Journal editors editor-ij@alm-online.net.,

Conference host

UCL Institute of Education

UCL Institute of Education (IOE) is a world-leading centre for research and teaching in education and social science.
Ranked number one for education worldwide in the 2014, 2015, 2016, 2017 and 2018 QS World University Rankings, the IOE was awarded the 2015 Queen's Anniversary Prize. In 2014, the Institute secured 'outstanding' grades from Ofsted on every criterion for its initial teacher training, across primary, secondary and further education programmes. In the most recent Research Excellence Framework assessment of university research, the IOE was top for 'research power' (GPA multiplied by the size of the entry) in education. Founded in 1902, the Institute currently has more than 8,000 students and 800 staff. In December 2014 it became a single-faculty school of UCL, called the UCL Institute of Education (IOE).

Conference Co - hosts

The National Association for Numeracy and Mathematics in Colleges (NANAMIC) provides professional development for numeracy and mathematics teachers and is a voice for the post-16 learning and skills sector in the UK.

UCL, Centre for Post-14 Education and Work

The centre seeks to research current and future-oriented perspectives on post-14 education and its role within society.
We will explore broad issues, such as globalisation, changing employment patterns, the ageing society, the effects of new technology, migration, dimensions of inequality, London as a global city, citizenship, and examine the role of lifelong and life-wide learning in helping people and organisations face these challenges and opportunities.

Theme of the conference

The overall theme of ALM 25was:

Boundaries and Bridges: Adults learning mathematics in a fractured world

The Conference themes included:

Inspiring and getting adults engaged in mathematics
Changing cultural attitudes to mathematics
Transcending boundaries and barriers in an uncertain world
The evolution of discourse in high stakes assessment
Perspectives on the economics and politics of adults learning mathematics

Plenary speakers - Presentations

In order of appearance.

Rob Eastaway

Director of Maths Inspiration and winner of the Zeeman medal for excellence in the promotion of maths.

Rob's site.

Getting adults engaged in mathematics

How do you get an adult engaged in maths? And what is the best way to turn them off the subject? Since he last spoke at an ALM conference – over 20 years ago – Rob Eastaway has enjoyed an exciting career in communicating maths to audiences of every age group, on the radio, in schools and pubs, at the Edinburgh Fringe, and even in a prison. In this plenary session he will talk about some of his experiences, from dealing with the maths anxieties of parents, to discovering the maths topic that got a group of prisoners at Pentonville most excited.

Professor Chris Budd

University of Bath and Gresham College.

See the latest series of lectures here.

Inspiring mathematics

One of the main barriers to adults learning mathematics is a lack of appreciation of what mathematics really is, what it can do, its relevance to our lives and, above all, its creative nature. This lack of appreciation can lead to a feeling that mathematics is a dull and boring subject which is not worth learning and can never be understood or appreciated. In this talk, I will show that this view of mathematics could not be further from the truth. To do this I will draw on a number of examples that I have found very effective in inspiring adult learners of mathematics. These will include a show case of some of the ways that mathematicians have changed the world in which we live, some mathematical magic, some mathematical art, and some 'mathematical experiments that you can try at home'. Be warned, audience participation will be expected.

Bobby Seagull

University Challenge star, teacher and ambassador for mathematics,

https://twitter.com/Bobby_Seagull?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor

Changing cultural attitudes to mathematics

Bobby is enthusiastic about numbers, whether working with adults in his role as an ambassador for the National Numeracy charity that seeks to improve adult numeracy or as a school maths teacher with young students. However, he appreciates that once learners leave school, many people's negative classroom experiences scar their adult relationships with maths and numeracy. Bobby's doctoral research at Cambridge University is about maths anxiety and phobia. He will share his understanding of why there is such antipathy towards maths, that one wouldn't find with other subjects such as English. To change cultural attitudes towards maths takes time, but is important to start now.

Dr. Gail FitzSimons

Editorial Board,

Adults Learning Mathematics – An International Journal

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*Adults Learning Mathematics: Transcending boundaries and barriers in an uncertain world **

In this plenary I will address briefly the possible interests that adults might have in learning mathematics in a fractured and fragmented world with constantly changing horizons in terms of politics, economics, technology, the environment, and so on. I will draw on Bernstein's theories to stress the importance of understanding the big ideas of mathematics, and hence its underlying structures and relationships, in order to support numeracy in this era of change. In addition I emphasise the importance of keeping adult mathematics and numeracy practitioners and researchers professionally informed through having access to high quality research related to their interests, such as ALM's own journal. As a member of the founding editorial team, I will recall salient aspects of the formative process that was also an important learning experience for the three of us at the time.

A full paper is in preparationandwillbesubmittedto the Adults Learning Mathematics – International Journal (ALM - IJ).

Professor Candia Morgan

UCL Institute of Education

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The evolution of discourse in high stakes assessment

High-stakes assessments such as the General Certificate of Secondary Education (GCSE) in the UK have a strong influence on the actions and orientations of teachers and students. Examinations define the kinds of mathematics that students are expected to engage with, not only by overt specifications but also by the ways in which questions are posed and the types of answers demanded. In a recent project in collaboration with Anna Sfard, we developed a scheme for analysing the discourse of examination questions and applied this to an extensive set of examination questions in order to investigate how expectations about student engagement in mathematics may have changed over time.

Following a brief introduction to the theoretical and methodological orientation of the project, two key issues will be discussed. Firstly, the role of contextualisation of mathematics: how has this changed over time and what difference may it make to students' mathematical activity? Secondly, mathematical and linguistic complexity: changes over time and dilemmas for examiners and teachers. Finally, I will consider how the findings, and the analytical tools of the project, can be used by teachers preparing students for examinations, including consideration of recent changes in the GCSE examination.

David Walker

Journalist

Chair, governing board Understanding Society

https://www.theguardian.com/profile/davidwalker

A perspective on the economics and politics of adult numeracy

Wanting to (re)learn maths skills, an adult peruses the Learndirect website, which offers qualifications and courses. (UK adult quantitative skills are relatively weak.) With some difficulty, she finds out that Learndirect is owned by a private equity division of one of the banks that precipitated the financial crash of 2008 and after further diligence discovers that Learndirect has been the subject of highly critical reports by a government inspector but has received preferential financial support from the same government.
The tale introduces twin themes. (1) In England (and much of the rest of the UK) post school learning – outside of higher education – is occluded if not actually ignored. Adult education

is, largely, a policy oxymoron. Programmes – such as the new apprenticeship scheme — are disjointed. Quantitative capacity is lacking – but we need to explain why, despite the evidence for commercial and individual benefit, this capacity shows no sign of improving substantially. If, simply put, numbers make money, why is adult numeracy is not actively propagated?

(2) Numbers are unavoidably political. Becoming more adept at statistics can't be separated from acquiring better understanding of how numbers are generated and for what purpose. Sometimes, the view is taken that statistical literacy is about technique. Of course it is but it must also embrace awareness of who is generating numbers, for what purpose.

Conclusion. In Britain this is a dark decade. We can't naively say that numeracy (statistical enlightenment) is a precondition of progress. But better skills are needed. We're seeing a backlash against the 'tyranny of metrics', fuelled from both right and left. That's healthy, provided it doesn't reinforce a culture in which basic technique is still limited and too many have to resort to the poor second chance offer of such companies as Learndirect.

All powerpoints accompanying the speeches can be found at

http://www.alm-online.net/alm25_conference/

Parallel sessions

We have included long abstracts and articles from the presenters at the ALM 25 Conference in alphabetical order.

Managing Money: using an app to help adults develop Financial Literacy

Tanja Aas

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

There were eight partners from seven different countries participating: ESPC Europe (Germany), Skills Norway (Norway), CVO Antwerpen (Belgium), Roc-Brabant (the Netherlands), LjudskaUniverzaVelenje (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".

Initially the focus of the Managing Money project was to carry out a needs analysis reportin each country, reporting on the existing material in financial literacy aimed at adults. Since there was few, if any, resources available geared specifically at adults, each partner focused on its own country, looking at existing resources and financial literacy in the school systems, as well interviewing different stakeholders to identify needs. The different stakeholders included teachers, financial institutions, schools and government agencies. The project found different partner countries showed large differences in how financial literacy is already included in the schools curriculum. During the process, resources focused on children to see if they could be adapted to make them useful for adults. This is all included in the needs analysis report.[1]

Next came the development of the curriculum[2]. This was partially based on the Competence goals for numeracy (Skills Norway, 2012) and The Basic skills profile for financial literacy (Skills Norway, 2016). 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.

The app is an avatar game based on the curriculum and the needs analysis report. 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 the goal with one avatar, you can either try again for a better result, or switch avatar.

Alongside the app, the project also aimed to provide learners and teachers with a learning guide containing 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

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[1] Can be found at managing-money.eu

[2] Can be found at managing-money.eu

app can be used together or by themselves.The app aims at a wider audience anyone can access it on smart phones and tablets and use it at any time. The app is available at Google Play and App Store.

During the research project participants in the Netherlands and Slovenia piloted the different activities and resources and a multiplying and dissemination event was held in Belgium for all the countries, to try out the app.

Most, if not all the material is available in English, Slovenian, German, Dutch and Norwegian.

The 40-minute session at the ALM conference had two parts. The first 15 minutes consisted of a presentation on the project itself, with a summary of the needs analysis report, curriculum content and examples from the teacher resources. During the rest of the session it was intended to launch the app to the public, demonstrating the content and how to use it, as well as giving the participants the opportunity to use the app.

Further information about the project is available at managing-money.eu

The Managing Money app is available at Google Play or App Store(these links will take you directly to the app).

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

Charlotte Arkenback

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Introduction

For a long time, mathematics has been considered the foundation for societal development and economic prosperity and it has held a strong position in formal education. However, it is still the case that many students fail in school mathematics, giving rise to a longstanding discussion on how best to educate for the mathematical skills needed for vocational training and working life. The increasing adoption of digital mobile devices, information technologies and robotic technologies at work is transforming the organisation of work, thus leading to new vocations being established and existing vocations and skills dramatically being transformed if not disappearing. Also, the automatization of work and work functions is leading to mathematics becoming increasingly invisible in work, hidden in complex technologies(Wedege, 2010; Williams & Wake, 2007). In Australia the computerisation and automation of container terminals have altered significantly the previous tools of the trade and the skills required of port terminal workers: "They increasingly require digital touchscreen skills, data entry and retrieval skills, basic digital data interpretation skills, as well as the ability to understand how what they do contributes to, and influences, the highly integrated and synchronised information and data flow" (Gekara & Thanh Nguyen, 2018).Digitalisation in retail, another industry deeply affected by digitalisation, entails different aspects: resources for automatization or equivalent to e-commerce, as well new technology leading to automatization and e-commerce (Radon et al., 2016)transforming how, where and when products are sold and purchased. However, digitalisation also transforms the organisation of physical stores and salesperson's work when implementing digitalised business models, omnichannel sales, mobile Point of Sale systems (mPOS) and cloud-based management systems. Point of sale is the time and place where a retail transaction is completed.

Aim and research questions

Sales assistant work, like the port terminal work, has long been regarded as a low skilled occupation, that is they do not require any specific educational qualifications or previous experience (Newton, Miller, Bates, Page, & Akroyd, 2006). This work in progress aims to explore and enlighten how digitalisation has changed and continues to change sales assistants use of mathematics at the mobile checkout. The theory of practice architectures (Mahon, Francisco, & Kemmis, 2017) is used as a theoretical lens and analysing tool. Methodologically, I have combined qualitative methods from ethnographic research(O´Reilly, 2004)andonline video research (Legewie & Nassauer, 2018) to answer the following questions:

- *Is a sales assistant role in a digitalised physical store still to be regarded as an unskilled work?*
- *What numeracy may be identifiedin the mobile digitalised checkout?*

Technology and information systems in retail

In 1878 the saloon owner and former mechanic, James Ritty invented the mechanical cash register, a simple adding machine combined with a safety box. An article in the Scientific American from February 1878 presented the "Cash Recording Machine" invention as:

> *... a new machine for making people honest – a consummation to which (if ever it can be attained by machinery) no small amount of inventive genius is just now being brought to bear/.../ We are not prepared to assert that the present machine will at once be a system*

in which it is impossible to swindle/.../but the new "cash recorder" certainly offers a simple mode of keeping accurate records. (Crandall, 1997)

A few years later John Patterson at the National Cash Register Corporation (NCR) improved the CR, and it became a combination of a security system, accounting machine and a management information system. This "mechanical point of sale system" revolutionised the retail industry, and since then commerce has been augmented by machines. Besides being a tool and system for control and business management, the CR was designed to assist the sales assistants at the checkout (Spellman, 2009). An advertisement from 1886 described the CR as (Crandall, 1997):

An automatic cashier which records mechanically every sale made in a store. It never tires. It never does one things while thinking about another, and never makes a mistake. It is a mathematical prodigy in brass and steel, all of whose computations are infallibly correct. It is a machine which will save the money you make and thus pay for itself over and over again. (The American Store Keeper of Chicago, August 1886)

From a mathematical perspective, the sales assistants' work at the checkout was considerably simplified as they now only had to calculate the change and discounts. However, all employees did not embrace the implementation of CRs. Those that were honest felt their integrity was being questioned when every sale was recorded, and dishonest employees disliked the CR for making it difficult to steal money and receipts (Crandall, 1997).Installing a CR was the first step towards automating retail transactions, and it opened the door to an era of "mechanical commerce" (Spellman, 2009), followed by an era of "computerised commerce" in the 1970s. The digitisation of the CR began in the 1960s when retailers switched to electronic CRs. The real digitalisation in retail, however, started in the 1970s when barcodes, barcode scanner, POS terminal for credit cards and POS systems were introduced. The first POS systems were comprised of an electronic computerised CR (ECCR), a card terminal, a barcode scanner and POS software connected to a local computer system. Retailers used the technology to codify information and routinise activities to increase the power of economic and information. As software technology developed, the focus changed on organising and analysing the stream of sales data produced(Basker, 2016; Watson, 2011). At the end of the 1990s, more than a 100 years after the invention of the CR the door to the era of "digitalised commerce" opened. E-commerce, omnichannel sales, mobile POS systems (Henceforth, mPOS), self-checkouts and mobile sales assistants run on smartphones and iPads are becoming increasingly ubiquitous in the 2010s retail industry. This development is transforming the checkout in physical stores and the activities associated with the point of purchase (Spreer & Rauschnabel, 2016).

Methodology

This working paper is based on empirical data from three different studies (see Tab. 1).In study A, I have scrutinized educational videos for salespersons at retail checkouts published on YouTube. In study B, I have observed and interviewed sales assistant´s work with mPOS in retail stores. In study C, I have made a new analysis of data material retrieved in a previous study of mathematics-containing activities in adult sales assistant apprenticeships(Arkenback-Sundström, 2017).

Table 1 Empirical data

Method	Empiric material	Country
Study A: Work-based sales assistant training and learning during a century (1917 – 2017)		
Analyse of 20 educational videos of sales assistant training retrieved from YouTube	Video transcripts, snapshots, viewer comments	USA, UK, NZ, SWE
Study B: Work at digitalized retail checkouts (2017 – 2018)		
12 Observations + interviews with sales assistant, store manager	Field notes, photo, video	SWE, UK

Study C: Adult Retail Apprenticeship – The checkout (2014 – 2015)		
6 observations of learning practices at checkout, interview apprentice + supervisor	Logbook, photo, video field notes, interview, transcripts, field notes, logbook notes, photo, video	SWE

Preliminary results

The 1920s – 1960s	CR 'doings'	Salesperson´s & Learner´s 'doings'
1917/25: NCR mechanical Point of Sale system, M-POS (CR+ cashier counter + accountant drawer + stamp + paper + pen)	**Math -** add-up customers purchases **Administrate -** record sales transactions; store money, invoices	**Memorise -** prices; products and their placement in the store; the keys on CR interface. **Calculate -** fractions, exchange and discounts, estimation, count checkout **Automatise -** manual input of ring-up sales (price, department, payment form); handling money, receipts, different payment forms correct; handling situations, customers, merchandise
The 1970s	**ECCR 'doings'**	**Salesperson´s & Learner´s 'doings'**
1974: Electronic Computerized Cash Registers (ECCR); Barcodes; Barcode scanner **1979:** Point of sale (POS) terminal for credit cards; POS System (ECCR + card terminal + barcode scanner + POS software)	**Math -** add-up customers purchases and calculate exchange based on automatic input and, when needed, manual input **Administrate -** record sales transactions; handle different payment forms; store money	**Memorise -** barcodes; products and their placement in store; the keys on CR interface **Math -** calculate discounts, estimations, count checkout **Automatise -** scanning customers purchase, manual input of single articles and payment forms; handling money, receipts & different payment forms correctly; handling situations, customers, merchandise
The 1980s – 1990s	**PC POS 'doings'**	**Salesperson´s & Learner´s 'doings'**
1980: PC POS system **1982:** CCD scanner **1986:** Computer-based and local POS systems (PC cashier + keyboard + screen + mouse + scanner + card reader + receipt printer + POS software); Colorgraphic Touchscreen POS Computer **1994:** Barcode software for mobile computing **1999**: QR Codes **The 1990s:** Development of the Internet and e-commerce	**Math -** add-up customers purchases based on automatic (and when needed manual input) calculate exchange, refunds and discounts **Administrate -** handle different payment forms automatically; store money **Educate -** ECCR and POS system vendors provide instruction films and documents for users	**Memorise -** barcodes, keys/buttons and functions of the PC register interface **Math -** estimations, count checkout. **Automatise -** scanning of customers purchase and manual input of single articles; handling money, receipts & different payment forms correctly; handling situations, customers, merchandise
The 2000s - 2010s	**mPOS 'doings'**	**Salesperson´s & Learner´s 'doings'**
The 2000s: Development of mobile POS (mPOS) - Retail management solutions run in the cloud from one platform; Automatic software solutions that can integrate to retailers other IT systems; Self-scanning checkouts **The 2010s:** Increased availability and proliferation of the Internet and mobile technology; Mobile POS (mPOS) become ubiquitous; Mobile checkouts; Omni channel;	**Math -** add-up customers purchases based on automatic (and when needed manual input) calculate exchange, refunds and discounts **Administrate -** automatically record sales transactions via barcodes, handle different payment forms, returns, complaints, customer data and self-serving POS; looking up customers; applying promotions; store money; intertwine e-store & physical store **Educate -** mPOS - an instructor for s self-learning; POS vendors provide checkout and mPOS education and training online (documents, blogs, webinars, videos, virtual mPOS games)	**Memorise -** barcodes, keys/buttons and functions of the mPOS interface (several functions of each key); product knowledge **Math -** estimations, problem-solving, count checkout **Automatise -** scanning, manual input of single articles for developing speed and accuracy; interacting with different digital systems (e.g. POS, Members club, Reporting, Stock, Self-regulation); handling money, receipts & different payment forms correct; handling situations, customers, merchandise

When reading the table, it is important to point out that it takes a long time for new technology to permeate an industry. In the retail industry, this implies that depending on the size of the store, today everything from electronic computerised cash registers to digital mobile POS systems is put to use.

The results show that CRs and POS systems have continued to have the same basic features; handle and account money, receipts, and payment forms; conduct calculations and control salespersons´ work at the checkout. Another result is that M-POS goes from being a 'Tool' (before the 1970s) to being an interactive 'Assistant' to the salespersons working at the checkout. The interaction with mPOS, however, demands new skills of the salespersons suggesting that it is no longer to be regarded an unskilled work (Cf. Gekara & Thanh Nguyen, 2018).

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The usefulness of “Maths Histories” as (part of) a holistic assessment tool

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Abstract

A key issue in any educational context is diagnostic assessment, as this is often used to inform placement in and planning of specific classes. When it comes to adults with low educational achievements, the issue of assessing students is even more pertinent, since many of them have had negative educational experiences and are averse to formal tests. In this contribution we present first experiences with a qualitative assessment tool called maths histories, a concept that is based on the idea that individuals draw their personal maths history as a line graph. We shared insights learned from pilot interviews which we conducted with young and more experienced adults as well as a teacher and discuss next steps in developing this assessment tool.

Key words: mathematics, adult learners, assessment

Introduction

A key issue in any educational context is diagnostic assessment, as this is often used to inform planning of and placement in specific classes. When it comes to adult learners with low educational achievements, the issue of assessing students is even more pertinent, since many of them have had negative educational experiences and are averse to formal tests. In a pilot project we therefore explored the usefulness of an informal, qualitative assessment tool called maths histories. The following paragraphs will outline the specificities of this tool, describe how we have used it in six pilot interviews, what our insights from these are and we conclude with some reflections on how this tool could be further developed. The focus of this contribution is a practical one and theoretical references will be limited.[3]

Context

Adult learners of numeracy and mathematics comprise a very heterogeneous group (Safford-Ramus, Misra, & Maguire, 2016). While standardised achievements and related consecutive further education is the norm for many at the tertiary level, planning classes and delivering tailored content can be a challenge at the other end of the scale, namely for individuals with low educational achievements in general (or in mathematics specifically) who return to school. Cumming and Gal (2000) have identified various purposes of numeracy assessment, amongst them initial diagnosis to inform

[3] In line with the practical focus of this contribution, specific terms will not be discussed extensively. Particularly the terms numeracy, mathematics and maths will be used synonymously even though we acknowledge that they denote different concepts – as has often been discussed in the ALM community.

placement and planning of educational classes. They found that for this purpose either locally developed forms of assessment have been developed (not least of all due to teachers' resistance to standardised forms of assessment), or that standardised tests are implemented (mainly because that is required by funding agencies). The former used to be mainly the case in Australia and the UK, the latter in the USA (ibid., p. 309), however the UK, at least, now follows the USA model. With regard to other countries, a qualitative assessment tool called "The Supermarket Strategy" has been developed and used to different extents in the Netherlands (van Groenestijn, 2000). More recently, Kittel (2016) found that no standardised test to assess adults' basic mathematical skills is available in German and concludes that informal tests generally are adequate.

On the basis of this experience, namely that both standardised and informal assessment tools are in use and serve specific purposes, we have decided to pilot an assessment procedure that combines these approaches and takes into consideration the specificities of adult basic education, particularly negative previous learning experiences when learning mathematics (Evans, 2000). In the following paragraphs we first describe the three elements comprising an initial assessment for adult numeracy classes and then focus on describing the experiences we made with one element, namely maths histories.

Threefold assessment

As Cumming and Gal (2000) have noted, one type of assessment is not sufficient to inform all requirements of adult numeracy. In addition to the traditional criteria of validity, reliability and objectivity which describe the quality of standardised instruments, there are other assessment requirements specific to adult numeracy education. These include the fact that adult learners may perform at different levels in oral and written tasks respectively in different contexts such as work or school. With regard to specific content, tests ideally cover various competences such as reasoning processes, conceptual knowledge, but also other abilities and skills such as interpreting embedded statistical information or computation. In order to take these diverse requirements of adult numeracy assessment into consideration, we have decided to include three elements into our proposed assessment. However, in practice limited resources in both time and knowledge of those implementing the assessments constitute restrictions and we are aware that implementing a threefold assessment is demanding and it will not always be possible to use all three elements in a given situation. While we briefly describe all three proposed elements in the following paragraphs in order to present the envisaged ideal picture of an adult numeracy assessment, we will focus on the concept of maths histories. With regard to the other two, existing information and specific procedures are available in other publications and places[4].

Maths histories

The concept of using a line graph to chart one's experience with mathematics has been described by different people – we came across it for the first time in Archer and Newman's publication *Communication and Power* (Archer & Newman 2003). The overarching goal of this activity is for people to reflect on their personal experiences with mathematics and identify both positive and negative aspects. After individuals have had some time to think about and draw their graph, the

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[4] See for example the very comprehensive Mathematics Assessment Project website which focuses on formative and summative assessment in school (http://map.mathshell.org/, accessed November 15th, 2018) or also the websites of specific test instruments such as the Tests for Adult Basic Education, TABE (https://tabetest.com/, accessed November 15th, 2018).

illustration should be used as basis for a personal interview and questions such as the following can be asked: What happened in specific moments? What mathematical content was involved? In what situations was mathematics meaningful for you? Furthermore, if for example only experiences relating to school are represented, questions about doing mathematics in other contexts such as work or sports can be asked. If necessary the graph can be completed during this talk. *Figure* ***1*** shows a completed math history by one of our participants, where all marks in green were originally drawn by the participant and notes in red were completed during the interview following the drawing of the graph.

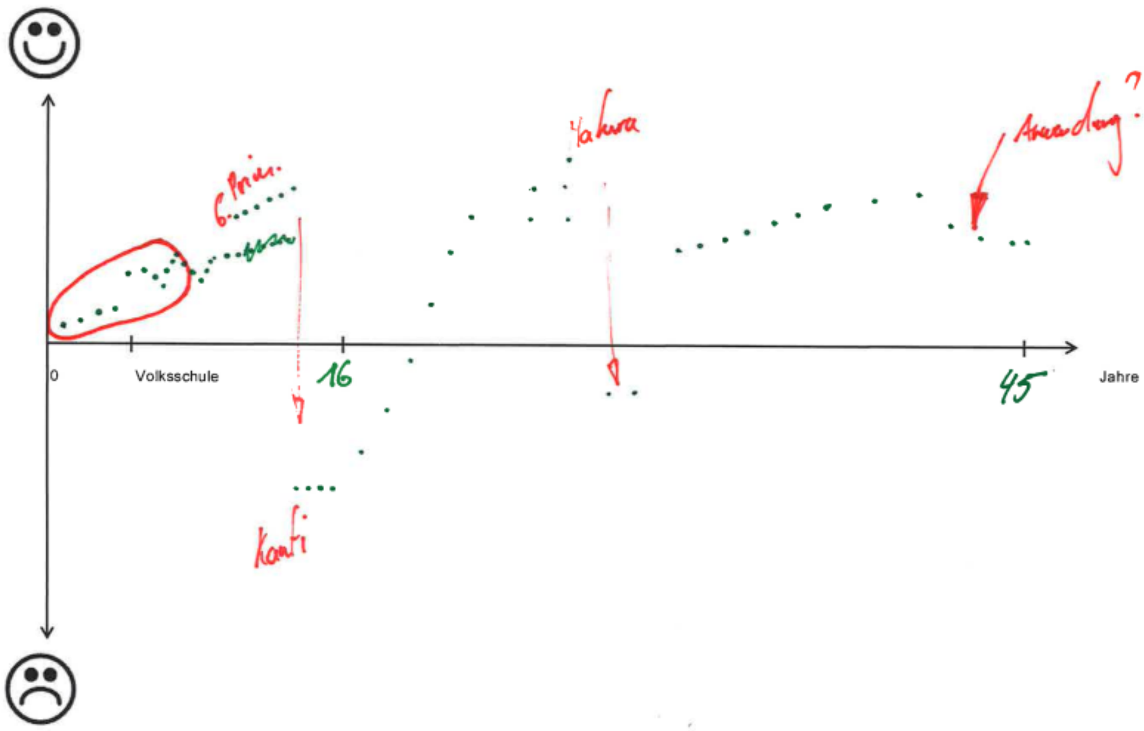

*Figure 1.*A completed math history.

We consider this oral and personal assessment relevant for a number of reasons: It addresses emotional aspects of learning mathematics – an issue which is key in adult basic education and is to our knowledge not addressed systematically in other forms of assessment. Furthermore, it provides teachers with the opportunity to learn something about their students, particularly why they might have difficulties learning mathematics. While this might often be linked to emotional aspects, it could also include other personal experiences, which are usually not addressed in classes and can therefore not be dealt with systematically. Finally, from the perspective of the participants, it gives them the opportunity to learn something about themselves and therefore provides a basis to actively guide their further learning.

Problem solving combined with self-assessment

As a second element we propose to present some specific tasks to be solved on paper by the participant and with the teacher present. The overall goal of this part is to identify the area and levels of specific skills, as it is for example done with the mathematics section of the Tests of Adult Basic Education (TABE). This part of the assessment is considered key to inform the planning of the classes with regard to specific areas of content. The content presented should of course be aligned to the course for which the assessment is conducted. This part focuses on procedural knowledge and taps into any routines generally acquired in formal settings. In addition we propose that the participant rates each task according to its perceived difficulty to provide further information.

Talking about mathematics

The third and last element focuses on conceptual knowledge and we propose to assess this by providing tasks which rely on reasoning and argumentation and support the process of talking about mathematics, or rather mathematical concepts. Tasks can range from presenting concrete material such as a graph from a newspaper and talking about it to asking conceptual questions such as “Why can 20% stand for different numbers?” When participants have to talk about mathematics, it enables the teacher to identify the depth of understanding of concepts, especially specific misconceptions, which are often the roots for further learning of mathematics.

We have put together an assessment which includes all three elements and piloted it with different participants. Since the focus is on maths histories, the following section presenting our experience will focus on this task only.

Pilot interviews

In spring of 2017 both authors have conducted some assessments which all included the element of maths histories, but not always the other two elements. We have tested the material with three teenagers (16 years each), two immigrants (28 and 33 years old) and one secondary school teacher (46 years old). One teenager was female, all other participants were male. Furthermore, all teenagers have completed the threefold assessment, while the three older adults only completed their maths histories. The part of the assessment covering the personal maths history lasted between 7 and 40 minutes. Our six pilot interviews were conducted in Swiss and standard German and recorded on video with the camera focusing on the paper leaving out the participants’ faces. *Figure 2* presents a still from one of the videos documenting the assessment with an immigrant.

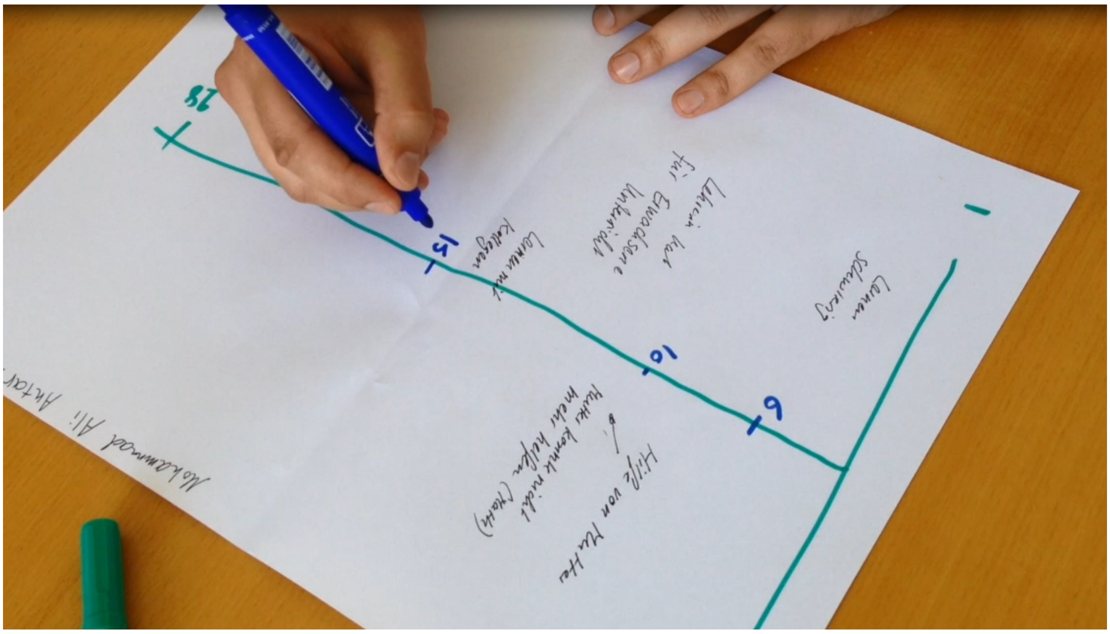

Figure 2. A personal math history in the making.

For the preliminary analysis the videos were not transcribed, but systematic notes were taken when watching them repeatedly. We then compared the individually collected notes systematically. In the following paragraph, first insights we collected in the interview and analytic process will be described.

First insights

It comes as no surprise that the three younger participants had less to talk about with regard to their personal maths history than the three older participants. Interestingly enough one of them also said that she preferred paper and pencil tests, arguing that “talking might be better for older people, for example my father would like that.” While the extent of personal experience certainly is an important aspect to consider, this finding might also point to the fact that a certain reflectivity is needed in order to be able to step back to make sense of this task. The three teenagers’ narratives also remained very close to their school knowledge and they did not mention mathematical activities outside of their school lives. However, in all cases specific mathematical content was addressed by the students, which we interpret as indication that maths histories go beyond affective issues and can serve as a door opener to more formal tests.

Another important point is how the task is presented, particularly how soon the interviewer intervenes after posing the task. Intervening too early presents the danger of interrupting the participant’s thinking processes, putting him/her in a question-answer mode rather than giving him/her the stage to talk about his/her personal experiences in a specific manner. More generally, conducting the assessment is demanding for the interviewer. S/he needs both sensitivity to cope with potentially difficult personal moments which are talked about – for example failed exams which limited a participant’s career choices – as well as specific knowledge in order to ask targeted questions. More often than not important aspects are not talked about at all and a sensitive assessment needs to not only follow up on what is said, but more importantly identify aspects which are not talked about and address them adequately.

Last, but by no means least when it comes to practical aspects, maths histories present another language based assessment. While mathematical content does not stand at the forefront, therefore not requiring specific language skills, the two interviews with immigrants have shown that talking about certain issues poses a challenge, depending on the individual’s language skills. As numeracy classes are often held for immigrants with limited knowledge of the target language, this factor needs to be considered in the further development of this instrument.

Looking at the task from a methodological perspective, it is interesting to note that completing such a graph is a mathematical activity in itself, requiring basic understanding of its concept. As can be seen in figure 2, the student and teacher both worked physically on the graph, orienting it partially in other directions than initially intended. However, such observations go beyond the immediate purpose of the assessment, even though they would provide interesting instances to explore other concepts such as co-construction or situated numeracy (Yasakuwa et al. 2018).

Conclusions

On the basis of the six interviews conducted, we come to a preliminary positive assessment of using maths histories in an assessment situation. From our perspective the concept has the following strengths: It addresses different dimensions of learning, specifically the affective dimension; it enables identifying knowledge outside the curriculum, not least of all learning barriers; and it provides a basis for a positive teacher-student relationship. All of these aspects seem crucial in the adult numeracy classroom.

However, the instrument also comes with some limitations, namely its dependency on language skills and its demand in resources on behalf of the teachers/interviewers. One possibility to address the latter would be, to implement the maths history activity in the classroom, where it would not only provide some insights into individual experiences, but also allow for potentially interesting class discussions, for example when identifying similarities and differences in the students' personal histories. For both, the use of maths histories as an individual or group assessment tool, it is essential, however, that it is developed systematically and particularly the required tasks of the teacher are further elaborated and specified. Therefore, further development of the tool should try to provide answers to the following questions:

- What is the ideal way to present the task and then move from the individual work drawing the graph to the discussion part?
- What are key questions eliciting informative answers that need to be included in all interviews?
- How are interviews results best documented and, if necessary, shared?
- How can interviews be conducted with individuals possessing limited skills in the target language?
- What training is needed for teachers/interviewers to implement the interview productively?

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

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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.

A full paper is in preparation and will be submittedto the Adults Learning Mathematics – International Journal (ALM - IJ).

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

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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). There was much agreement with the report's findings as it highlighted how 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 was 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 explored who these students are and what issues they present, from poor literacy to social, emotional and mental health needs. We discussed how these issues were manifest in the classroom and the knock on effect on provision, teaching and other students. We used a framework to help explore what we can do to change results from an individual, departmental and institutional level. Finally, there was space to reflect on why this is so important for young people beyond their understanding of maths.

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The challenges of teaching mathematics in England's Further Education colleges

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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 cribically 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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Building bridges by mathematical gaming

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In this session, I discussed the experiences of myself and another teacher working in The Netherlands, with people from other countries who are 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 adults were divided into three sub-groups. There was one large group consisting of only women and the other two smaller groups contained only men. After two months, we were able to ascertain that the groups had made considerable progress in their overall proficiency in standards of Dutch, in mathematics, but also in their respect and tolerance towards other group members. For example, we observed that not everyone succeeded in starting up the digital mathematical game on their own computers. The people who did succeed, 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. During the interviews, they explained how they had even started to share the game with other people, including their children, we interpreted this as 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 the ALM session, we explained 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 initially the women in the female only 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. During the ALM session their was also further discussion on the development of social skills such as respect and tolerance, as well as the improvements in the adults' standards of Dutch and mathematics.

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

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The focus of this session was on building bridges between learning, gaming and socialising. I reported on a study carried out with 55 (mixed) young people between the ages 16-20 over a period of two months, split into three similar peer-groups, all of whom took part in the research.

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. The game involves practice in calculating with arithmetic, using numbers and a range of mathematical functions, including add, subtract, multiply and divide to achieve a particular target. 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 then started training the other two groups with a game especially designed for the third test. At the end of June we compared results.

In this session I gave a demonstration of the games involved, explaining about the different ways the games can be used. Then I explained more about the research we did with these peer groups and showed the remarkable results achieved by the students. We then decided to add another game and additional peer groups to the research, the results from these groups were presented in the session and our findings were discussed.

The game Cijferstorm can be accessed at https://www.cijferstormspelen.nl.

Dichotomies and paradoxes in the learning space of the present time

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By bridging mathematics and numeracy with geopolitics, science and humanities, the workshop aimed at indicating new avenues to widen the adult learners' views on the contemporary world, providing inputs toward renewed classroom discussions and ensuring that lifelong education supports citizens effectively in the contemporary world.

Most of the talks and activities proposed were inspired by my recent teaching experience in adult numeracy in Tower Hamlets and brought to ALM 25 for to share with practitioners and researchers from different countries.

Tower Hamlets in London, also known as the East End, is the second borough for population density and the first for income inequality, unemployment, poverty and child poverty rate. Its population has always been a mixture of ethnic minorities that settled after different migrations over the centuries. Nowadays, it is home to a large community of British Bangladeshi – making over 30% of the borough population - and hosts a growing Somali group. Adult classes in the borough reflect this demography.

Over time I have acknowledged that learners, parents and carers of Tower Hamlets come to attend educational opportunities in search of a safe space for dialogue, to find out more about the deep differences in cultural habits that they perceive in the everyday life of the borough and to try understand how to possibly mitigate the existing tension between the older and younger generations. I believe in the adult numeracy class' potential to offer a safe environment for talks and open-minded discussions on a solid, consistent ground: discerning to make well-informed choices.

The ALM 25 workshop opened with an informal activity, which saw the participants individually engaged in populating a blank time-line with events and dates that they would consider 'pivotal' in world history. A long strip of paper soon became a vibrant representation of the history of mankind, embracing as many points of view from across the planet: the end product of the collective task reflected the very varied backgrounds of the participants, showing a multitude of notes, dates and facts, from socio-political changes to technological inventions and artistic revolutions, since time begun to the present day. Overall, the participants enriched each other's contributions with their personal system of meaning: the lenses to look through the past and the present were multiplied by the presence of multiple eyes, like looking into a kaleidoscope *versus* looking through a keyhole.

The idea of starting with a group time-line led to a critical debate around promoting plenty of diversified views in the adult classroom: the 'year zero' as the birth of Jesus, for instance, is in itself quite a stance and other ways of counting time should show up on a time-line to represent the world truthfully.

A main section of the workshop was inspired by the works of M. Yunus (2003,2012), J. Stiglitz (2012) and H. Rosling (2018) on social business, inequality and population growth in the globalised world, and involved participants in a teamwork activity aimed at comparing different ways in which poverty is or may be tackled. By evaluating the effectiveness of possible solutions and their potential impact on individuals and communities in the long term, this task exposed inherent difficulties, conflicts and hidden frictions in the contemporary world; it also revealed opportunities worth exploring, experiments worth trying or ideas worth formulating with adult learners from different backgrounds.

My learners were fascinated by the concept of micro-credit and how it had worked for Bangladeshi women as a social business start-up (Yunus, 2007), with small saving gradually re-invested into realistic goals. Researching about the Grameen Bank led learners to consider the reasons why traditional bank loans and UK credit systems are dangerous and unfruitful.

Stiglitz' work on inequality, proved enlightening for adult learners when trying to explain how, for example, the 1% of the US people takes nearly a quarter of the nation's income (Stieglitz, 2012). A famous interview with Joseph Stiglitz, published in the magazine Vanity Fair in 2011,led my learners into deeper research around this remaining 99%. They were curious to find out how these inequalities end up 'balancing' themselves in reality and how they are kept alive via the economic system. Ultimately, the issue of the great divide (Stieglitz, 2015) can be understood more concretely when numeracy is used in support of certain arguments and it naturally brings the discourse on social justice to the classroom.

Lastly, as I shared with the participants to this workshop, my adult learners were amazed by the unforgettable genius of Hans Riesling and were especially engaged by his reconstruction of the crucial link between poverty and fertility rate. In numeracy session about population data I showed Hans Roesling giving a demonstration of these connections in a video taken from his *Gapminder*project. The experience had a huge impact on the group as each learner re-framed their personal background in the wider picture of world social studies. Learners opened up about their life outside the UK, and had an opportunity to re-interpret their journeys with a renewed awareness of the boundaries (the divides) and the bridges (the connections) that interest them.

The next part of the workshop focused on technological advancement in terms of information technology and reliability of data. Although some of the dangers ingrained in the development of computer science - from privacy breaches to the detriment of social interaction - were predictably announced and easily understood by most of us, many aspects of our life and culture have been drawn into the automated spin by an apparently uncontrollable force that can lead to social and political earthquakes (Gaggi, 2018).

To experience some of the implications in the everyday reality, adult numeracy learners can be guided into analysing how some of the formulas or 'algorithms' work and are used to address, transform or mould society. The risk is that the technological apparatus becomes more autonomous while becoming more powerful, with the human being moved to a subordinate position (Mezza, 2018).This theme implied discussion around politics, democracy and the threats from social media. In my adult classrooms, analysing and interpreting the fast-growing power of social networks had driven learners to debate deeply around the importance of transparent and unconditional voting systems as a strong foundation toward building a policy of equal opportunities in developing countries.

The final section of the workshop targeted the core of the environmental issue: saving the planet is not anymore said to be a realisable task. In everyday life, making choices that are sustainable is harder than ever. Examples of unexpectedly unsustainable lifestyle choices were suggested, with diagrams and pictures gathered from learner research in the numeracy classroom. The aim was to shed some light on the enormous disproportions between perceived benefits to the individuals and profound damages to the planet, and to reveal some hidden misconceptions or unexpected truths. The final part of this session helped participants reflect on the element of water as well, as one of the most contended and crucial political platforms in the world nowadays.

This workshop took place at the very end of the four-day conference. After days of intense debates and energetic presentations I liked to conclude with a calming, although thought-provoking piece of work to share and to listen to together. I chose *Elegy for the Artic*, a composition written by LudovicoEinaudi and performed on a floating iceberg. Greenpeace recorded it in Svalbard as part of their campaign to save the North Pole; Einaudi plays it as glaciers crumble around his piano in June 2016, meanwhile Norway, Denmark and Iceland reject an international measure aimed at protecting 10% of the Artic Ocean.

Overall, this workshop aimed at providing opportunities to experiment with a different approach to numeracy, based on a pluralistic, critical and open-minded learning process, which involves both the rational and the affective domains of the adult learner as a conscientious citizen and an inhabitant of the planet.

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

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

[Current & Previous Chief Editors]

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Adults Learning Mathematics: An International Journal is the only academic journal covering the field of adults who learn mathematics. This journal was created in 2005. In this session Gail FitzSimons, the first editor of the journal, Javier Díez-Palomar, the current editor, and Kathy Safford-Ramus, a former editor of the journal, will explain to the audience the origin of the journal: Where does it come from and why is it important to have a journal specific to ALM? ALMIJ is more than a journal, it is a way to support networking and to share knowledge, traditional or innovative theoretical approaches and evidence-based research, in order to improve our understanding of adults learning mathematics, and to increase the impact of our work.

ALMIJ is becoming consolidated as a journal in the field of adult mathematics education. It has been included in quality journal rankings such as ERIC. At the same time, ALMIJ faces new challenges in a world dominated by discussions about open access, metrics, journal impact factors, etc. ALMIJ is about to launch a new structure, with new tools, and a new online platform. But we would also like to hear from you, the audience about your challenges and other issues of importance to you, and how ALMIJ can address these, in order to keep being a journal of relevance for all of us!

This presentation was in two parts. In the first part, we briefly outlined the benefits to authors of having their work published here; also plans for a new structure. Feedback was sought from participants to ensure continuing relevance.

In the second part, we focused on the preparation of manuscripts for publication in this journal: the writing process. We outlined 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.

PART ONE

Why is it important to have a journal specific to ALM?

- ALMIJ is more than a journal; it is a way to support networking and to share knowledge, traditional or innovative theoretical approaches and evidence-based research, in order to improve our understanding of adults learning mathematics, and to increase the impact of our work.
- We stressed the importance of having an international, freely available, online journal.

The future of ALMIJ:

- ALMIJ has been included in quality journal rankings such as ERIC. At the same time, ALMIJ faces new challenges in a world dominated by discussions about open access, metrics, journal impact factors, etc.

- Looking to the future, ALMIJ is about to launch a new structure, with new tools, and a new online platform. But we would also like to hear from you, the audience about your challenges and other issues of importance to you, and how ALMIJ can address these, in order to keep being a journal of relevance for all of us!

There are benefits in writing for ALMIJ for:

- PhD students
- Early career as well as experienced researchers
- Practitioners

The call for papers states:

Adults Learning Mathematics – An International Journal is an international refereed journal that provides a forum for the online publication of high quality research on the teaching and learning, knowledge and uses of numeracy/mathematics to adults at all levels in a variety of educational sectors. Submitted papers should normally be of interest to an international readership.

We invite contributions in the following areas:

- Research and theoretical perspectives in the area of adults learning mathematics/numeracy
- Debate on special issues in the area of adults learning mathematics/numeracy
- Practice: critical analysis of course materials and tasks, policy developments in curriculum and assessment, or data from large-scale tests, nationally and internationally
- Both full-length articles and shorter reports may be submitted. No preference is given to any particular research methodology.

PART TWO

Preparing to write for ALMIJ

Gail FitzSimons

University of Melbourne

What is the purpose of writing?

- To share insights and experience that you have gained from your own and others' experiences set in the context of up-to-date relevant literature
- To inform your own research. Writing is a good form of professional development because it enables teachers & researchers to reflect on their experience & why it is worth sharing
- Writing is a valuable preparation for post-graduate study, with honest & supportive feedback on the writing, the structure, the reference style, etc.
- Read through several issues of this & other journals to get a feel for the language, the length, the style, etc.

It is also helpful to read proceedings of ALM, related ICME studies [e.g., relevant topic/study groups since ICME 8, 1996; *Contemporary Research in Adult and Lifelong Learning of Mathematics – International Perspectives* (in press)]

Choosing and refining your topic

The kinds of articles suitable for a research-based journal such as this include:

- A study of your own teaching of adults based on observations of experience [e.g.,] over a period of time or of a recent innovation, often called 'participatory' or 'action research', accompanied by a theoretical framework of this particular kind of teaching-learning situation and a short literature review of similar or related studies already published.

- A specialised literature review around a given theme related to adults learning mathematics, framed by your particular purpose or research question. This could encompass studies using different theoretical frameworks or methodologies.
- A reflective article or position paper on a particular issue, which pertains to, your particular interest in adult mathematics education, or the kinds of adult learners involved, or the implications of policy decisions in your country.
- a report of a pilot study or on-going research
- a report of completed research

Possible areas of interest

- Curriculum and assessment frameworks for mathematics or numeracy
- Teachers & teaching
- Learners & learning
- Textbooks and/or online tools for learning
- Teacher education & professional development
- Comparing theories of adult education, mathematics education, use of technology, etc.
- Developing a new framework to study a problem in Adults Learning Mathematics.
- A critical appraisal of education paradigms [held by teachers, government, etc.]:
  - Transmission-based, with students as passive receivers
  - Behaviourist — i.e., individual or programmed learning
  - Student centred, meeting individual needs, but within a social context, emphasising reflection and action
  - More egalitarian, encouraging co-operation & collaboration, problem posing & dialogue, with a focus on collective outcomes.

Theoretical perspectives

Psychological:

- cognitive domain [how a person learns],
- affective domain [the effects of a person's beliefs, attitudes, emotions]

Sociocultural:

- the effects of people's different social and cultural backgrounds
- (e.g., adults from socio-economically disadvantaged backgrounds as children, indigenous people, recently arrived immigrants, ...)

Research methods [Quantitative, Qualitative, or Mixed Methods]

- traditional hypothesis testing: control & experimental groups
- ethnographic: participant observation and interview
- action research: in-class teacher innovation and reflection
- theoretical studies, synthesising research and developing new frameworks
- longitudinal and comparative studies

Searching for references

- From past issues of ALMIJ & ALM conference proceedings, or from the reference lists of any articles that you find relevant & interesting
- University library catalogues & data bases
- Electronic journals

- ERIC Clearinghouse
- Google [& Google Scholar]
- WorldCat [https://www.worldcat.org/]

Collecting and recording references

- Record possibly useful abstracts and exact reference details as you find them [or have them sent to End Note or Refworks, etc.]
- Organise downloaded articles systematically — e.g., save as: Jones ALMIJ 2015
- Observe the preferred reference style of the journal

Getting started

- Start with a working title, and maybe improve on this as you go along.
- The stimulus might be a critical incident in class, where you noticed something surprising which had an important effect of changing your thoughts about, or the direction of the class at that point.
- It might be a dilemma that you have — or have not — been able to resolve.
- Developing and refining your own conference papers
- Working with another colleague [or supervisor] to share ideas etc. [where permitted by your university]

Guidelines for writing a journal article

- **Introduction & background**
    - Purpose —Why is this important? What is the significance of the problem that frames the research?
    - What is the context of the setting or situation?
    - What are you hoping to achieve in this article?
- **Literature review**
    - Does the literature review/theoretical framework inform the reader of the current state of the field relevant to your identified research problem?
    - Is this made clear via reference to scholarly work [refereed publications where possible] or through connection to educational policy settings?
- **Theoretical framework**
    - What is/are the important theory/theories that inform your article?
    - Explain your framework as clearly as possible to readers.
- **Methodology & Data Collection**
    - Make sure that the **methodological approach** and **data collection** are appropriately described, justified, & applied
- **Findings**
    - What are the interesting aspects from your perspective?
    - How will you organise the 'story line' in a logical manner?
- **Discussion**
    - Major themes, similarities, differences, interesting or unexpected outcomes
    - Are your claims from the research supported by evidence?
- **Implications**
    - What do/could these findings mean for this specific area of adult mathematics education? [e.g.; "the evidence suggests ..."]
- **Conclusion**
    - A brief summary of findings, possible questions for further research.
- **References**

    - Use a consistent reference system, as specified by the journal.
- **Word limit**
    - It is essential to keep within the limit set. Some journals refuse to accept articles that are too long.

Reviewers will ask:

- Does the manuscript contribute to new knowledge?
- What value is added to the field by the manuscript?
- Is the manuscript coherent and consistent with the ALMIJ guidelines?
    - correct use of APA style; spelling and grammar is of a high standard

We encourage all ALM members to share insights from their research and practice through this journal.

‘Seeing the World as It Really Is’ (in at least 5 dimensions): the work of Hans Rosling and Associates

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Abstract

This paper aims to illustrate the increasing wealth of data made available by government and other agencies, which has the potential to generate discussion, and to encourage the development of better understanding of data. Hans Rosling and his associates have made available a range of statistics on countries of the world, as dynamic interactive graphics. These are presented in an accessible form that allows teachers and learners to challenge (often mistaken) preconceptions about the world. This work can enable the development of data-reading skills, demonstrate the use of statistics for knowledge development, and promote insightful and collective ways of finding humane solutions for some of the world’s geo-political problems.

Introduction

In Evans (2018), I discuss a ‘crisis in statistics’, which threatens their acceptance by the public and thus seems to threaten public discussion and policy-making (e.g. Davies, 2017, 2018). 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 gap minder 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 pedagogic strategy 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’, such data is more and more often in forms that are convenient, and accessible, to generate discussion. Examples include: the Gap minder project (https://gapminder.org), developed for some time now by Hans Rosling and his associates (Rosling et al, 2018); and the Our World in Data project, (https://ourworldindata.org/), developed by Max Roser. Both of these focus on comparing countries with other countries in their region and throughout the world. With a more local focus, within a single country, see the Constituency Explorer project that focuses on parliamentary constituencies within the UK (http://www.constituencyexplorer.org.uk/), produced by Jim Ridgway and colleagues, along with the UK House of Commons Library. Other countries may have similar projects.

Finally, the National Statistical Offices of many countries are committed to making relevant data more accessible. In the UK, government statistics can be found at https://www.gov.uk/government/statistics.

Focusing on the Work of Hans Rosling and Associates

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.

Here, as an introduction to the work of Rosling and Associates, I indicate several of the ten misleading 'instincts' that Rosling et al (2018) 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). Readers may recognise the prominence of these 'instincts' in some of today's political discourse.

Below, I refer to an example of these extraordinary statistical tools, with full URL. A visit to these webpages will show how the graphics combine comparative and dynamic historical features – in particular, how they manage to show how five different dimensions can be portrayed on a two-dimensional surface, by the clever use of graphics.

My experience is that this work enables the development of data-reading skills, even if the website is used on one's own. It provides an even more fertile basis for the development of numeracy skills, in a classroom context.

Conclusion

Throughout his work Rosling was at pains to assure us that 'things are better than you think' (e.g. Rosling et al, 2018). 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 Webpage

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

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

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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 identify 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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Presentation by the Dutch prize winners!

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This session gave the opportunity to showcase the work of the three winners of a national competition for teachers that has been held in the Netherlands for the last three years, with the aim of generating good ideas and good practices from Dutch practitioners for Adults Learning Mathematics. The three prize winners each presented their ideas:

NoriKreetz, 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 crowd funding 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.

DimitriVerzijl, 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 provided a great opportunity to view and discuss some innovative approaches to use when teaching mathematics to adults.

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

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

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 manipulatives for all sorts of activities. This makes teaching numeracy motivating and easier to remember for the students. In this workshop we demonstrated several specific manipulatives which are very easy to collect. Participants were inspired to make their own manipulatives and consider how to integrate them into their lessons. Manipulative were used to perform calculations amongst other activities.

Participants were introduced 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 practice and we showed how this leads to lessons that are attractive to students in vocational education.

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

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Abstract

In Senegal, a pilot programme for teaching numeracy to women, as part of an already existing literacy programme in three local languages has shown promising results. The programme built on traditional numeracy practices and introduced new ones, with a focus on financial management. I will present some findings of my research into traditional numeracy practices of a people group in the south of Senegal, followed by a description of the numeracy programme and some results at the end of the two-year intervention (2015-2017). I argue that bridging from traditional to new numeracy practices and using a language the teachers and learners know well are essential factors in teaching adults in the global South.

Key words: numeracy; language; ethno-mathematics; Africa

Introduction – Setting the scene

In Senegal, traditional and 'Western' lifestyles, values and practices meet. For example, many rural women work in their rice fields and have very little cash on hand, while a business woman or employee in town might earn several hundred thousand francs CFA (about 350 US$) or more per month. Another example is the fact that there are over 30 languages, but the language of instruction in schools is mainly French, a colonial language. The female adult literacy rate was 33% in 2013 (UNESCO, 2018). In terms of numeracy practices, there are traditional practices and knowledge as well as international numeracy practices.

I coordinated literacy classes in local languages in the south of Senegal over many years. Many of the women who attended these classes asked for a numeracy component. These women live in a context where traditional practices come face to face with strong influences from the outside. Whilst the traditional systems remain valuable in many situations, economic and other changes in society require new numeracy skills. Money plays an ever-increasing role in daily lives; for example, children's school fees or electricity bills need to be paid. Many women are responsible for the family finances and also run small businesses, for example selling vegetables at the local market, or buying sacks of charcoal and selling it in small piles.

The expressed need of the women led me to do some research into traditional numeracy practices of the Gusilay, a people group in southern Senegal.

Traditional numeracy practices – Some findings

Gusilay was the language used in all numeracy "events" (Heath 1983) that I observed. Number words were used in Gusilay, French and sometimes Wolof.
Here is a selection of Gusilay number words (Yashina, 2011):

Numbers (in digits)	Numbers (in letters)
1	yanur
2	síruba
3	sífaajir
4	sibaagir
5	futok
6 (5+1)	futokn'yanur
7 (5+2)	futokn'síruba
8 (5+3)	futokn'sífaajir
9 (5+4)	futokn'sibaagir
10	guñen (lit. 'hands')
15	guñen (lit. 'hands foot')
20	gafaakan (lit. 'the end [of a] person')
70 (20x3+10)	gafangúfaajirn'guñen
100	eceme
1,000	éwuli

In Gusilay, there are distinct number words for the numbers 1 to 5, 10, 15, 20, 100 and 1,000. All other numbers are mathematical calculations. The words for 10, 15 and 20 relate to the human body and probably indicate how counting used to happen using fingers and then toes (Zaslavsky, 1999; Kané, 1987). As numbers get higher, the number words get longer and cumbersome. 100 and 1,000 are loan words from a more dominant language in the area.

Numbers in the context of money pose a challenge in francophone Africa: There is a different arithmetic system, using the same number words but with a different value. The currency in French is the franc CFA, but the denominator in Gusilay (and the other local languages) is based on the 5 francs coin, with 5 francs equalling 1 ékori. 'Síkorifutok' – literally: ékori (plural) 5 - equals 25 F CFA. Calculating with money creates confusion for many Senegalese, especially with higher numbers.

Other findings of my research included mental calculation techniques practised by market vendors as well as traditional measurements of length, volume and capacity. Measurements of length were mostly based on body parts. Weight was measured using traditional baskets, or nowadays an empty Nescafé tin. Many women's groups organise a 'tontine', a savings scheme, with each participating woman paying a specific amount regularly into the group's cashbox. With some tontines, each woman in turn gets to take the whole amount of the month. Others continue saving until a specific event, for example a feast, when the money is divided equally among the participating women.

Developing a numeracy programme based on traditional practices

Based on these findings, I developed a numeracy programme for women as part of the existing local language literacy classes in rural areas in the south of Senegal. From 2015-2017, we piloted it in three languages, with two classes per language. We collaborated with our local literacy partner organisations, the associations 'PëpántarManjáku' (Manjaku language), 'AMOJ' (Jola-Fonyi language) and 'SempeKaloon' (Karon language). The classes in numeracy followed two years of classes in basic literacy. Most of the women who attended the classes had some schooling, but their level of French was minimal, as French is not used much in everyday life in rural areas. The goal of the pilot project was to encourage women to practise their reading and writing skills and to improve their abilities in numeracy in order to be better equipped to manage their income-generating activities and family finances. Our partner organisations developed a list of mathematical terminology in their language. We developed a curriculum and a detailed scripted teacher's guide in French as well as a learner's manual, both of which were translated into the three languages.

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 (D'Ambrosio, 2001). Therefore, the numeracy programme built on strengths, for example the traditional numeracy practices, cohesion and collaboration between women, and the women's ability to speak, read and write in their language. The more experienced women were encouraged to share and explain their strategies to the others, and new strategies were taught to the whole group. Problem solving and reasoning skills were practised in the classroom.

At the same time, the programme was designed to bridge to new numeracy practices. The conversion challenge of numbers in the context of money was explained and practised in exercises and role plays using plastic money. The curriculum included international measurements of length, weight and volume, written calculations, using a calculator, writing income-expenditure lists and calculating profit. Each class was encouraged to organise a tontine, with one person entrusted with keeping a cashbox and written records for it.

Results

126 women started the course, and 110 completed it. The women attended on average 86% of the sessions, which suggests high motivation. We tested the women at the beginning of the programme and after the end of the first and second year. The results of the evaluations were skewed because the testers were not able to prevent the women from helping each other. Nevertheless, the results showed a marked improvement.

Many said that they now made fewer mistakes when giving change, and that they couldn't be tricked anymore. A fish vendor commented how the calculator made it easy for her. Even when there were many clients, she was now able to calculate correctly. One woman said that she now understood the difference between profit and the money she needed to put aside each day in order to buy new produce to sell. Many of the women agreed, but stated that poverty did not allow them to put money aside. They borrow money continually in order to restart their business. Some women commented that they could help their children better with maths homework now. This shows that the programme impacted the women's families positively.

Arguments for bridging from traditional to new numeracy practices

I would like to emphasize the fact that bridging from traditional to new numeracy practices is an essential element for teaching adults in the global South. Beginning where the learners are and building onto prior knowledge are andragogical principles that enhance learning for adults (Knowles, Holton & Swanson, 2015). Doing so is also a way of showing respect for people's culture and roots (D'Ambrosio, 2001; Vella, 2002). It is important to use a language that both teachers and learners know well so that the learners can understand the lessons taught, contribute to discussions and then practice their newly acquired skills in everyday life. Practicing problem solving and other higher thinking skills in the classroom gives the women a basis for continuing to practice and develop these skills.

The women now have more strategies to choose from. For example, they are now able to solve a calculation mentally, using objects, a calculator or with a written calculation. They should be able to increase their income, since they now make fewer mistakes and are aware of many issues that can help them prosper. The programme strengthened existing structures, for example women's associations or tontine groups, by giving them more tools to effectively manage and control their finances.

Next steps

My plan is to visit some of these women again to hear their stories of how having attended the numeracy classes has impacted their lives in the long run.

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Teaching maths for 'mastery' in post-16 education

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In this session, we considered 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 (ETF) 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 examined the projects in detail and considered some of the early feedback to discuss how teachers can be supported in their teaching and learners can be supported to achieve by introducing a Teaching for Mastery approach. With the recent 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 for future teacher development in post-16 English mathematics education.

Towards a Common European Numeracy Framework for Adults

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We are well into the 21st century now and the urgency for lifelong 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 referred to as "21st century skills" (Voogt & ParejaRoblin, 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 Wöbmann, 2012; Grotlüschen, et al. 2016).

With respect to numeracy (and/or mathematics) education, we explore 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. Consequently many citizens are overlooked for certain jobs and have problems in their daily life, dealing with the abundance of number-related circumstances.

The results of the last PIAAC survey (OECD, 2012, 2013, 2016b; PIAAC Numeracy Expert Group, 2009; Tout e.a., 2017) 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.

The workshop at the ALM25 conference was concerned with a possible future Erasmus+ project in 2019-2021 which is planned to 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, BerufsforderungsinstitutOberösterreich (BFI-OÖE) in Austria, University of Barcelona in Spain, and University of Limerick in Ireland.

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

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Towards the 2nd cycle of PIAAC

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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. Furthermore, the survey 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. Preparations have started by the Numeracy Expert Group in 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 Review of the PIAAC Numeracy Assessment Framework (Tout et al., 2017). The final report formulates the following argument:

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:

- thedisposition 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 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 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 updated the participants on the latest developments and discussed the intricacies in assessing adult numeracy behavior, illustrating these by examples of possible future items.

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

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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.

A full paper is in preparationandwillbesubmittedto the Adults Learning Mathematics – International Journal (ALM - IJ).

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

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Adults Learning Mathematics

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In this workshop we asked how and when do we use 'common sense', how does common sense relate to mathematics education and 'Bildung' and are contradictions introduced when valuing common sense explanations in the adult numeracy classroom.

The inspiration for this topic evolved out of a synthesis of many strands of research of both authors 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).

Consideration of these works led the authors to reconsider 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 ofCoben 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-Sundströmwith 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)

We found it useful to 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.

By its very nature 'Common Sense' is a popular, and at times a populist concept. With the prevalence of social media and access to many sources of information, in many forms we decided to use an immersive approach to this topic. The presentation was multi media and therefore cannot be represented on this plain page of text. The source materials for the workshop are stored on a dedicated Padletsite and a summary of the content available at the time of writing (February 2019)follows.

The Padlet can be accessed from https://padlet.com/arkenback/alm25

The site is constructed with five columns.

Workshop ALM 25 – David and Charlotte

Common Sense – Literature and Media

Mathematics, ALM and Common Sense

Common Sense in Education

Common Sense – TEDx Talks

The Workshop column includes all the materials that supported the workshop the authors ran at the ALM conference in July 2018 including some videos on giving change and the very popular and entertaining ‘We’re Choosing Wisely’ song.

Literature and media includes two filmed interviews with Sophia Rosenfeld the author of *Common Sense – a political history* (published in 2011) One recorded at the time of publication and another more recent one entitled *Sophia Rosenfeld – Populism, Conspiracy and Common Sense from Thomas Paine to Donald Trump.* It also includes a number of quite recent YouTube presentations about common sense from various political and ideological perspectives.

The ALM column gathers together copies of ALM publications that contain articles written about common sense. This includes an article from the ALM International Journal Volume 2 (2) published in 2007 *Adult Mathematics Education and Commonsense* by Noel Colleran& John O‟Donoghue.

The Education column gives a broader view of how common sense is used in other education contexts and the TEDx talks give some contemporary views on the wider understanding of this complex and ever-changing concept.

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The Role of Emotions and Confidence in Motivation to Learn Mathematics

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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 in wider research (Bandura, 2004; Debellis and Goldin, 2006; Hannula, 2012) and this 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', since research indicates that previous experiences influence people's motivation to learn (Covington, 1984; Hannula, 2012). 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, 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.

The research (Kelly, 2018) 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 reengage 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'tEynde 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 what I term an *Affective Mathematical Journey*, where their change in feelings influence their motivation 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 and their role in learning mathematics when teaching adults, including 16-19-year-old learners, who have had poor previous learning experiences but still find reasons to reengage with the subject.

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Proportional reasoning of adult students in aSecond Chance School *

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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.

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

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.

A full paper is in preparation and will be submittedto the Adults Learning Mathematics – International Journal (ALM - IJ).

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Building bridges in vocational education

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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.”(NRC, 2014).

In 2018, Monique Vogelzang from the educational inspection said, in response to a new educational report, 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." (Jong de Nienke, 2018).

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 in Zwolle (Netherlands) 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 international excursions 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 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 distinctive features to be experienced in this workshop.

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

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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 has emerged into a set of practices that have the power to buildwhat he terms 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 in my first early attempts at 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).

Over the past few years, I havehadfirst-hand experience of the profound shifts in classroom culture, engagement, and mathematical affect that the thinking classroom practices evokefrom the privilege of working and collaborating with Dr.Liljedahl as my graduate supervisor. I have attended many of his workshops on thinking classrooms, visited a variety of school environments where thinking classroom approaches are implemented, and have adopted the tools from this framework into my own practice as an adult mathematics educator. A such, the workshop at ALM 25 provided an opportunity to reveal some of mylearningsfrom these experiences. For example, I shared about how I have noticed that using visibly random groups in every class improves classroom dynamics and builds a positive social environment in which students of various social, economic, and racial backgrounds feel comfortable openly discussing mathematical ideas with each other. I also noted that particularly when the key practices of good problems, visibly random groups, and vertical non-permanent surfaces are used daily, the classroom culture transforms and offers the potential for a plethora of learning opportunities mostly because students are willing to engage.

In the workshop, participants had the opportunity toexperience elements of a thinking classroom. That is, I brought everyone together and told a story orally about a tax collector, which turned into a deceivingly interesting problem. Participants then choserandom playing cards that indicated the vertical whiteboard station they could find their team mates at. As everyone worked in threes at the boards, I circulated the room with various prompts and questions. Finally, we came together to consolidate and further explore the problem as a group. Experiencing such a setting within the workshopbecame a platform for reflection. Participants noted how engaged they were, how they appreciated being able to look around the room to see others' work, and how they didn't feel in competition with anyone even though they were out of their seats. We concluded that giventhat 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 and is worthy of pursuit.

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

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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 examined 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 included 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 cut-scores at the 75th and 90th percentiles) did better in Canada than in Korea, and low-performing adults (as represented by the cut-scores 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 argued 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.

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

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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 centred approach through open discussion and the removal of misconceptions in both the GCSE and Functional Skills classroom. 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, using those that can inculcate meaningful, positive, pragmatic learning attitude. As mentioned by Swan (2005, p4) these "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.

His views include the need to challenge learners through effective, probing questions and manage discussion in the classroom that can help learners to make connections between their ideas. 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?

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

This presentation gave 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 also reported 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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Using Lego to understand Algebra

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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 made a table and chairs out of Lego (but don't worry – we provided the Lego)! Some might want to make the tables with square blocks and the chairs with rectangle blocks. Or they may want to use all square bricks for the tables but different colours. In the workshop, we demonstrated 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

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

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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 (Richardson &Suinn, 1972) 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) (Hunt, Clark-Carter & Sheffield, 2011), 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.

A full paper is in preparationandwillbesubmittedto the Adults Learning Mathematics – International Journal (ALM - IJ).

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

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The United States Department of Education project, *Power in Numbers: Advancing Math for Adult Learners* (https://lincs.ed.gov/state-resources/federal-initiatives/power-in-numbers), 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*(https://lincs.ed.gov/publications/pdf/Advancing_Math_Market_Scan_1.pdf), 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* (https://lincs.ed.gov/publications/pdf/advancing_math_market_scan_2_4-13-2018.pdf), 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.

A full paper is in preparationandwillbesubmittedto the Adults Learning Mathematics – International Journal (ALM - IJ).

First Language Interference: a guide for teachers of mathematics

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Introduction

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 England, and in the last few years about 25% of my students have been English language learners (ELL), half in discrete Functional Skills Mathematics classes for ESOL (English for Speakers of Other Languages), where exam questions are structured around applications of mathematics in 'real life' situations. The other half are in GCSE (General Certificate in Secondary Education) Mathematics provision. These mathematics qualifications are generally taken by 16-18 year olds, and are used as requirements 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 language content and structure on students' ability to engage with the material in mathematics classes and exams is surprisingly high, and can reduce students' mathematics demonstrations of competencies significantly.

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 adult students may experience.

Sources of Information

Initially my research was of a purely observational nature. I became aware of the impact that the English language was having in terms of a negative effect on pass rates for low level English speaking students. For instance, a student might come out at one level on a maths initial assessment containing few word problems, but struggle to complete a lower level diagnostic assessment, where more word problems were included, and need to go even lower if their language skills were considerably below those contained in the maths questions. This observation is confirmed by other practitioners in mathematics classrooms (Kersaint, Thompson, & Petkova, 2013).

This led to a growing realisation of the importance of language levels in the maths questions, and a more language focussed teaching style. I then realised, and I am not alone in this, that the resources I was producing for the ESOL learners were appreciated by the English speaking learners, especially those with lower levels of competency (Adler, 2001).

Research work centred on this area led me to a publication by a number of writers with another first language, but high English competencies, about the differences between their first languages and English. This book was edited by Swan and Smith (Swan & Smith, 2001), and is a comprehensive guide covering over 20 specific languages, including Arabic, Chinese, Polish and Spanish, and some language clusters, such as Dravidian (includes Kannada, Malayalam, Tamil and

Telugu), Scandinavian (Danish, Norwegian and Swedish), and West African languages (including Hausa, Ibo and Mende).

There are other works written about the English language that have also proved useful in extending this knowledge (Swan, 1995) (Crystal, 1995). It is unfortunate that, although we have more than a quarter of a million words in the English language, and more words are being added all the time, we seem to have no body that oversees the quality of the content, as exists in Germany and France. This seems to have led to the proliferation of single words that have more than one meaning, only one of which is mathematical, such as product, factor, modal and chord. There are also specific mathematical terms which students have to learn, such as integer, factorise and indices.

The importance of thought and discussion as aids to learning mathematics has been explored by a number of academics and practitioners, which has led to the view that restricted thought or talk can lead to restricted learning (Sfard, 2008) (Barwell, 2009) (Woolley, 2013). This has implications for my students: do I encourage thought or talk in their first language, and then translation into English (Adler, 2001) (Kersaint, Thompson, & Petkova, 2013), or do I insist on discussion in English? If the former, how much does this exclude those learners who do not have anyone who speaks their first language (Newmarch, 2005)?

This led me to view mathematics learning as a triad: Procedural competence, conceptual understanding and language learning. I have applied this thinking to all my classes now, even if they are 100% English language speakers, because I believe that the language can often be a barrier to comprehension and progress for adult learners.

I owe a debt of gratitude to my colleagues and students for additional information and knowledge. Any errors are, of course, my own.

Where individual languages have been referred to in this paper, I have placed them in alphabetical order.

First Language Interference: Impact on Learners

Two case studies illustrate the actual impact of language differences:

The first example is of a learner where the mathematical ability was far greater than was shown by his maths work in English. This was a student with a Master's degree in mathematics in Poland, a Level 7 qualification, who just passed an Entry 3 qualification in the UK, which is below Level 1. This shows the impact of the language on achievement, as this adult learner was compromised eight levels of mathematics by his English language skills, which were around ESOL Entry 1.

The second case is a Chinese student's experience of moving to the UK to continue his studies in Mechanical Engineering at a university in England. He dropped his degree course in at the end of the first year because he failed the maths exam. In China they do not use Greek letters for formulae, and he was unable to change from the Chinese to the European system using Greek letters, such as mu (μ), in time.

This led to a realisation that it is not just the English language, but also the mathematical language or symbolism itself which may impact on how successful learners are when studying mathematics in English (Kersaint, Thompson, & Petkova, 2013) (Woolley, 2013).

As a teacher, I also need to be aware of the cognitive load on students, and how asking students to multitask in the classroom can impair learning (Ashcraft, 2002). English speaking students are likely to be drawing on a substantial knowledge about the construction, content and meaning of the phrases and questions they are given. Those without first language English may be focussed initially more on the translation, and an understanding of what is required, before they reach a stage where they can process the mathematical content. At the very least these students may need more time to cover the same amount of work (Swan & Smith, 2001).

Findings of Potential First Language Interference

In this section we will look at some of the many differences between English and other languages, in terms of sentence structure, words and sounds before progressing to evaluating mathematical symbolic, procedural and terminological differences (Crystal, 1995) (Swan, 1995) (Swan & Smith, 2001).

Sentence Structure

Sentence structure is very different between languages, Written language may not be from left to right, as it is in English, but can be from top to bottom, as it is in Chinese and Japanese, or from right to left, as it is in Arabic and Urdu.

Punctuation is not present in all languages, for instance in Arabic, Korean and Thai a gap is often left instead. Punctuation use can differ between languages, for instance there is no possessive apostrophe in French, and so in French we can only say 'the learner's work' by using the whole phrase, which would translate as 'the work of the learner'. In German and Scandinavian languages a comma is often placed after the verb in a sentence, but in Turkic languages it is placed after the subject of the sentence; in English it is used to separate phrases. In Hindi a full stop is a vertical line.

In English we use upper case letters at the start of sentences, and for proper names, such as Dublin, Monday and September. In German all nouns are written with an uppercase letter, so that would include car (das Auto) and house (das Haus); in French and Spanish days of the week and months start with letters in lower case, so 'lundi', or 'lunes'. In Italian the days of the week start with a capital letter, but the months do not.

Many languages have no upper and lower case format, including Arabic, Chinese or the Sanskrit languages, such as Bengali, Farsi, Hindi, Punjabi and Urdu.

English seems to be unusual, in that the nouns do not have a gender, as is the case with most of the languages mentioned above. Nouns in many languages can be masculine, feminine or neutral, which affects both the spelling and pronunciation of words such 'the' and 'my', and how adjectives attached to the noun will look.

In many non-English languages when nouns are used as objects in a sentence they take their gender with them. Hence you may find that learners will translate 'She has lost her bag', as 'She has lost his bag', if 'bag' in their first language is a masculine noun.

The order of words within sentences is also a challenge for many learners moving from their first language into English, as it is often different from their first language. When Yoda in 'Star Wars' says to Luke Skywalker "Found someone, you have", he is translating from his first language, rather than using his knowledge of English language word order. Different word order, where sentences are start with a verb, is also present in Arabic, but in Sanskrit languages, Tamil and Turkic languages, the verb comes last.

Words

Continuing the verbs theme, the verb ‘to be’ does not exist in Arabic, Thai, or Turkish. In some languages the use of ‘to be’ and ‘to have’ are switched, so learners may say, and expect to see, that they ’have thirty years old, rather than they ‘are thirty years old’; this includes French, German, Italian and Polish.

The verb ‘to do’ does not exist in languages as disparate as the East African languages, French, German, Hindi, Italian, Punjabi or Urdu. This is a very common verb in English appearing in many ways in questions and instructions.

Languages differ in their use, and even the presence of articles, such as ‘the’ and ‘a’; for instance ‘the’ does not exist in Japanese, Russian, Turkish or Urdu, whilst ‘a’ does not exist in Arabic, Hindi, Malay or Urdu. Other languages, such as French, German, and the Scandinavian languages can use articles differently, so will say ‘The human beings are strange’ rather than ‘Human beings are strange.

There can be less or different use of prepositions in sentences, such as in, on, under, at, for, of and so on, in most languages, including those in northern Europe, Turkey, and the Arabic speaking world. Describing the location or position of an object comes in at the lowest level of mathematics assessment in the UK, namely, Entry 1.

Countable and uncountable nouns, and their quantifiers, can also be different in many languages, including those of Africa, France and Scandinavia. In English words such as news, trousers, pyjamas and scissors are always plural, but information, advice, expenditure, time, money and hundred are always singular. This is not the case in other languages, so you may hear ‘two hundreds’ rather than ‘two hundred’, and learners may be confused by the lack of a plural if they see 200 written in words.

We seem to have a proliferation of words in English where elsewhere perhaps only one word will be used, including hear and listen, find and look, lend and borrow, which and what, some and any, much and many. This can add to the complexity of translation for lower level English speakers.

Comparatives and superlatives are another area of difference, as not all languages, such as Turkish, differentiate between them, for instance between taller and tallest, of older and oldest, but this is very common in English, and is an expected skill at Entry Level 1 mathematics.

The use of questions containing negatives should be used with great caution in class, as different languages have the opposite response to what we might expect in English.

Some words genuinely occur in more than one language, for instance ‘oval’ is the same word in Bulgarian, Romanian and English, but other words are classified as false friends: they may look and sound like a word in another language, but in that language they actually mean something different. Examples of these include ‘no’, which in Polish is an informal version of ‘yes’ or ‘tak’; in Scandinavian languages ‘rent’ means rate of interest, and an ‘offer’ is a sacrifice; ‘sensible’ in French and Italian means kind or sensitive, and ‘lecture’ means reading. There are many more examples of false friends across many languages.

Sounds

English has a Northern European alphabet, which differs from Eastern Europe and Russia, and is very different from elsewhere in the world. The sounds that the letters make, even when the letter is the same, often seems to be different between languages, i.e. in Polish the 'e' and 'i' sounds are reversed, as are 'v' and 'w'. This can make pronouncing a word like twelve more demanding than it looks. Some languages, such as Chinese, German, Spanish and Turkish have no 'w' sound at all, so mispronunciations can occur. Dutch speakers, however, tend to soften the ends of words, so the 'v' sound becomes an 'f'.

As a native English speaker, I can hear the difference in the pronunciation of second language English speakers, and equally, if I learn another language, first language speakers of that language will hear differences in my pronunciation; this is what gives us accents in another language. It is notoriously challenging to acquire new sounds later in life, and the early years are known to be crucial for developing an understanding of the sounds of a language. Other languages have sounds that do not exist in English, and vice versa.

English has many vowel and consonant clusters which are not present in other languages, which add to the challenges of speaking and listening. For instance the 'th' sound so ubiquitous in English does not occur in Danish, Dravidian languages, Farsi, French, Irish, Norwegian, Polish or many West or East African languages, hence the number of learners who struggle to pronounce words like thirteen or thirty.

In a number of languages including French, German, Irish and Spanish it is common to use a mark above a vowel to change the sound, rather than use vowel clusters, as we do in English. These marks can be called accents or umlauts. It is unfortunate that English has no consistency of use of vowel pairs, as we can hear in the difference in the 'ou' sounds in 'ouch' and 'cough'. There are many other examples of this lack of consistency, which all add to the work load of learners.

The stress placed in a word can also lead to it sounding different, and languages differ in where they place the stress in words and sentences. For instance in Japanese each syllable is pronounced equally, but in English the stress is usually on the second syllable of a word.

The endings of words are often not heard in Chinese or French, and the languages are adapted to cope with this, but in English it is often critical to hear the ends of words or the meaning is lost, as in the difference between 'thirteen' and 'thirty'.

Mathematical Symbols, Procedures and Terminology

There are a number of ways in which symbols and mathematical procedures differ between countries and languages, in addition to that given at the start on the use of Greek letters for formulae. These include a variation between the use of the comma (,), and the full stop (.). In non-English languages generally the use of these punctuation marks in decimal numbers, including money, and large numbers is reversed, i.e. Three euros and fifteen cents is commonly written as E 3,15 but three pounds and fifteen pence is written £3.15. Also 100.006 will look like 100 point oh, oh, six to English speakers, a decimal number, but one hundred thousand and six to many other people.

The division symbol differs in the UK and USA compared to the rest of Europe; in the former it is written as ÷, but in the later it is written :. This is potentially very confusing to learners, as we use : for ratios. The way division sums are performed is also different on the European continent, and does not involve changing the position of the numbers in the division sum. Given the issues that many adult learners seem to experience with division there may be some justification for evaluating the two methods to see if the 'rest of the world' method improves retention and understanding.

Traditionally in the English speaking world a dot placed between two numbers about half way up the numbers signifies a decimal point, but in Poland this is the symbol for multiplication, as it can be in the UK in higher levels of mathematics.

Rounding and estimation seem not to be present in languages that are pictorial, where one character has a meaning, such as Chinese and Japanese. My Chinese learners tell me that is pointless to move from one character to another before calculation, as it just increases their work load, so they are resistant to estimation and rounding, even in English.

Many countries, such as Spain, do not use the 12 hour clock, only the 24 hour version, so learners will need to be taught how and when they are used in English, otherwise it can lead to errors in time calculations, as learners understand something different when they translate the sentence or question.

There are further differences in time as in many languages, including German and Norwegian, 1330 would translate literally as 'half two', but in English we say 'half past one' often shortened to 'half one'. Perhaps 'half two' has been shortened from 'half to two'.

In English we can classify numbers as odd or even, but it is much more usual in other languages to say even and not even, as in Italian, 'pari' and 'dispari', or Spanish, 'par' and 'impar'. An issue here for my learners was that odd and 'dispari' or 'impar' are in different places in the sentence, which led to them misunderstanding and reversing the meanings of odd and even.

Some words have more than one meaning in English, a 'normal' one, and a mathematical one. One example of this is the word 'product', which is used to mean an article that was produced, and is used for something we put on our hair, but in mathematics the product of two numbers means multiply. Other challenging words include table, change, expand, factor, modal and chord. All of these words have a general meaning, which differs from the quite specific mathematical meaning. Many native English speakers are also confused by this terminology.

A further set of words have specific mathematical meanings, and whilst they do not have the confusion of another meaning attached to them, they do need to be learned for success. These include such words as integer, factorise, indices and circumference.

The language of word based maths problems is clearly a factor in whether learners are successful, or not.

Impact in the Classroom

Some understanding of the issues faced by mathematics learners who are not learning in their first language, but in English, has caused me to make a number of changes to my teaching practice. For instance I now routinely put definitions of key terms on the board, leaving them up for the whole session.

Online translation tools up on the Smart Board can be very useful, as they can show words and phrases in almost everyone's language. This can help raise awareness about the different challenges that learners face, especially minority groups in the classroom, and create a more "culturally respectful learning environment" (Kersaint, Thompson, & Petkova, 2013, p. 139), where differences are seen as interesting and positive. The use of book and electronic dictionaries is also encouraged, although only paper based dictionaries are permitted in exams in the UK.

Displays incorporating all the languages present in the classroom around, say, key vocabulary, such as addition, subtraction, multiplication and division words and symbols, also helps in this process.

Pictures to illustrate and support the language in word problems can be very helpful, saving time on explanation or translation. In cases where the words used have more than one meaning they are particularly useful, such as completing a design for the location of stalls at a fair, or working out how much wood is needed to construct a shelf. This can benefit the English speakers as much as other learners in sessions (Adler, 2001).

Signposting learners to internet materials, such as the BBC Skillswise and Bitesize web sites, Khan Academy, You Tube videos and the British Council's ESOL Nexus website, along with my college's VLE (Virtual Learning Environment), is done in the second week of the course. Learners are very mixed in their use of these, owing often to differences in the availability of equipment, or competence with IT, but they are used by around half of my adult learners.

Some of the internet sites have language support modules in addition to mathematics content, such as BBC Skillswise and ESOL Nexus.

There is also a role for phone apps, such as Tessify and Block Puzzle. Some phone apps have no or very little language included, relying on a worked example to show the techniques required, but if they do have instructions in English learners may be able to access these in their first language, or they could use on line translation sites, dictionaries, or electronic translators.

Speaking in a clear voice, avoiding repetition and non-completion of sentences may also help learners understand what is required of them, as will repeating explanations slowly and carefully whilst you illustrate with an example. Changing the language used to explain an idea or concept can increase the confusion for learners, as now they have two sets of words to translate.

Conclusions

In conclusion, there are many ways in which a first language can impact on a learner's success in the mathematics classroom, and can interfere in the successful acquisition of English for mathematical purposes.

This interference can arise from differences in sentence structure, in the words that are available, along with their common first language usage, and in the sounds and intonations that are available to learners. Interference can also arise from a difference in mathematical procedures and symbols, and from both words that are specific to mathematics, and those which have more than one definition, a common feature of English.

An awareness of the issues and challenges learners face has raised an appreciation of the cognitive load many learners face in a mathematics classroom, where the content is delivered in a language that is not their first, or sometimes even second, language.

Finally, the focus on language and definitions can be seen to benefit all adult learners, including those who speak English as a first language, because of the amount of specialist vocabulary in mathematics classes. In mathematical problem solving the context can be critical to comprehension, and this is often only obtainable from the language.

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

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Firstly, I introduced the practical activity and gave 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 saw 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 constructed in this workshop was a truncated icosahedron. This was a very practical approach to create polyhedrons which is different from building it from a net of polyhedrons.

Secondly I discussed 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 different from practice exercises in textbooks, learners are able to acquire the skills and techniques of lifelong learning.

Then we considered 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 abstractions 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 thought 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, the "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 the real world.

Poster sessions

Developing mathematical dialogue scenes for reading aloud with adult learners

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This poster identifies ways to develop scenes of dialogue that can be used with adults when learning mathematics.

My doctoral research (see, for example, Griffiths (2017)) has been focused around the use of a scene that was produced for a pack of nationally developed resources (DfES 2005). The scene involves a small group of individuals discussing potential answers to a mathematical task which concerns percentage changes in rail ticket prices. I am interested in the interactions that occur during, and following, the reading aloud of a scene of dialogue concerning mathematics. The overarching research question is as follows. What are the characteristics of the discussions between learners during and following the reading aloud of mathematical dialogue scenes?

While my research will be centred on this existing scene, it will be useful to have other such scenes as examples:

to use with learners before the main data collection;

that teachers could use in practice;

for thinking about features of the existing scene when analysing responses.

The intent is that learners engaging with such scenes will develop their mathematical thinking through discussion. There are two key features to the original rail price scene which may be replicated for the purpose of my study. The first key feature is that the scene is focused on a mathematical notion in which well-known errors made. In the rail price scene, the idea investigated concerns an increase in rail prices of 25% followed by a reduction in prices of 25%. The well-known error is that after the reduction, prices are back to where they were before the increase. Other well-known errors from different parts of mathematics are: (i) that dividing by a quarter is the same as reduction to a quarter (ii) that when an area is increased, so does the perimeter.

The second key feature of the scene to be considered is the inclusion of examples and reasoning that can be employed by learners in their discussions. For example, in the rail price scene, an example of a £100 ticket price is used with associated calculations, showing that after the increase and decrease the ticket price would be £96. In the case of dividing by a fraction, a conversation could be held about the amount of quarters there are in a given number. This could be seen visually within a context of abstract quantities, or utilise a similar visual presentation with the common example of the pizza (asking about how many people can have quarter pizzas) or within the context of money (asking how many 25p are in £5 perhaps in order to buy something).

When constructing new scenes, there are some things to consider.

The extent to which the mathematics discussed is set within a real world context (as in the rail price scene) and how learners might respond to this.

The order and extent of the details involved in the examples within the scene that act as potential resources for learners in their discussions.

Finally, it is possible to produce a scene in which no misconception is presented. For example, I have produced a scene in which there is a conversation about alternative ways to calculate a percentage.

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The original scene developed for DfES pack Discussing what happens when cost is increased and then decreased by a given percentage.

Rail Prices

In January, fares went up by 20%.

In August, they went down by 20%.

Sue claims that:

"The fares are now back to what they were before the January increase"

Do you agree?

If not, what has she done wrong?

Harriet: That's wrong, because … they went up by 20%, say you had £100 that's 5, no 10.

Andy: Yes, £10 so its 90 quid, no 20% so that's £80. 20% of 100 is 80, … no, 20.

Harriet: Five twenties are in a hundred.

Dan: Say the fare was 100 and it went up by 20%, that's 120.

Harriet: And, because 20% of £120 is more than 20% of £100. It will go down by more so it will be less.

Andy: What is 20% of 120?

Dan: 96…

Harriet: It will go down more so it will be less than 100.

Dan: It will go down to 96.

Sara: No, it has gone up £20 to £120 and then it went back down the same, so that's £100.

The dividing by fractions

Using a standard 'real world' context

Pizzas

Brian is explaining how to divide pizzas by a half.

He says:

"Dividing two pizzas by a half means 2 people get one each. The answer is 1."

Do you agree?

If not, what has he done wrong?

Kyle: Oh yes, that is a good example.

Sue: But isn't that saying two divided by two is one, not two divided by a half.

Kyle: I'm not sure.

Sam: Shouldn't we divide the pizzas into halves.

Sue: Yes, and two pizzas split into halves would give four pieces.

Kyle: So we could all have a piece. That's good

Candia: Do you mean two divided by a half is four? That doesn't sound right.

Sam: Well two divided by a half can't be the same as two divided by two.

Candia: I suppose not.

Sue: Two divided by a half is four.

Working on area and perimeter

Using images but abstract without numbers.

Areas and perimeters

Jenny notices that when you cut the corner off a rectangle then the area goes down while the perimeter goes up.

She says:

"If the area of one shape is less than another, the perimeter is greater"

Do you agree?

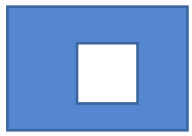
If not, what has she done wrong?

Diane: That's clever. If I cut a square off the corner of the rectangle. The perimeter also goes up. That sounds right.

John: Hold on. If you cut a square off the corner then the perimeter is the same.

David: If you cut a square out of the middle of the shape then there will be two perimeters.

David draws:



Beth: Maybe we shouldn't allow that. But if you cut out of a side then the area is smaller and the perimeter is bigger. So that would be right for Jenny.

Beth draws:

Beth: And if we add a square the then area and the perimeter is bigger.

She also draws:

John: So what does this tell us about what Jenny said? Is she wrong?

David: But she was right with her example.

Beth: But it is not always true.

Calculating a percentage decrease in two ways

Does not involve a misconception but rather two ways of doing the same thing.

Calculating a percentage

Graham is working out how much a shirt costing £50 is reduced to in the sale.

He says:

"I know that 10% is £5, so 40% would be £20 off. The sale price is £30"

Do you agree?

If not, what has he done wrong?

Jackie: I don't think you do it like that.

Anne: No, you divide fifty by 100 and then multiply by 40.

Albert: when I calculate that I get £20.

Sean: So that is the same discount that Graham worked out.

Jackie: But it won't work all the time, will it?

Sean: Are you sure?

Anne: I'm not sure now.

Albert: Try another price. Let's try with something that costs £60.

Jackie: So… dividing by 100 and multiplying by 40 makes… £24 off.

Sean: and 10% of £60 is £6 making four lots £24.

Do you have any ideas? For contexts or for dialogue to use.

Teaching Numerical Deception in Political Claims

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Research:

Initial coding through examination of analyses by FactCheck.org for numerical claims in 2015.

Verification and refinement of coding through PolitiFact.com

Categories	Cues:
Cherry-picking: picking only one study, methodology, data set, timeframe, or poll that supports a claim while leaving out any others which are not as "convenient" to the claimant.	(a) Extremely high or low numbers without noting a mean or median; (b) Citing only one study/survey/poll (are there others?); and (c) Use of time frames (why those particular years?).
Excessive rounding: rounding exaggerated beyond any reasonable rounding rules.	Sweeping statements or attention-getting sound bites with nice round numbers.
Speculating: when the claimant gives supportive data but there is no current data or there is no data for the particular location or circumstance.	Data with no source attributed or a reference to the existence of data is vague; and seemingly little time to have collected the data for the specified time frame.
Ignoring perspective: Accurate data is presented, however, the claimant fails to disclose the full picture. There is no context or comparison with other numbers.	Use of absolute numbers (would a rate or percentage be more appropriate?); and Numbers presented as unusual but no comparisons are given.
Using imprecise terms: The terms used are not clear and not defined and therefore open to interpretation	Use of terms that could have a variety of definitions or are not entirely clear.
Manipulating denominators: Percentages may inflate or deflate a denominator (or numerator) to change the relative size of the number being reported in order to place it in a more favorable light.	Use of a fraction, percentage, or probability (what is counted in the numerator/denominator?).
Presuming causation: Presuming a cause-and-effect relationship when all that is known is a correlation	Stating or implying a causal relationship between two variables with no evidence presented for linking the cause and the supposed effect.

Principles:

- *Use controversial, authentic topics without being controversial*
- *Be evenhanded*
- *Be critical not cynical*
- *Warn that the knowledge should not be used for evil purposes*

Lessons Learned:

- *No practice problems in online homework systems (but, easy to add with Lumen OHM)*
- *Time consuming to update with current examples andto keep political balance*
- *Time consuming to grade when requiring justification*
- *Students enjoy seeing some "real world" maths and that* $maths \neq algebra$

Student Assignment:

Find two political claims that are numerical in nature and have been judged to be deceptive to some degree. One claim must be from a Democrat and the other from a Republican. Provide the following:

- *The url for a fact-checker post about the deceptive claim*
- *What is the level of deception, if stated (e.g., half true, three Pinocchios, mostly false, etc.).*
- *Explain the mathematics of the deception.*
- *In which deception category (or categories) would you classify this deception? If none, can you suggest a new potential category?*
- *Is there a cue in the claim that might have alerted you to a potential deception? If so, what is the cue?*