BROADENING THE FOCUS IN MATHEMATICS EDUCATION RESEARCH: THE IMPORTANCE OF ADULTS' MATHEMATICS EDUCATION

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1. Introduction

In this talk, I will draw on my own work in several areas, and also on work done with Tine Wedege and Keiko Yasukawa for the *Third International Handbook of Mathematics Education* (Evans, Wedege & Yasukawa, 2012). In this pre-conference version, I aim to highlight some issues that are relevant to the topic, and which I will expand on in the presentation.

Most of us, as teachers and researchers, in mathematics education, are used to focussing on the education of children and young people. However, adults' mathematics education (AME) is now a focus of increasing interest for several reasons:

(a) AME displays a broad range of settings where teaching and learning take place (formal, non-formal, informal), and hence a variety of contexts for research such as workplace mathematics, mathematics for citizenship, and "financial literacy".

(b) At the same time, studying its activities allows a perspective on the dynamic context of globalisation, competition, and social insecurity in which AME and indeed all education is currently developing. It also provides insight into the dilemmas of AME, and its struggles for justification, for example between humanistic and economistic goals of education, particularly lifelong learning.

This leads to multiple and contested meanings of key terms like lifelong learning and numeracy (numeramento, alfabetismo matemático), and how definitions vary, depending on whether they seek to emphasise the individual learners' needs or particular economic imperatives (for example, labour market needs).

(c) Further, much of the teaching and learning of mathematics at school 'looks ahead' to the lives of pupils when they reach adulthood. And, of course, teachers are adults, too.

We begin by characterising adults: we adopt a broad understanding of adults as including people of a wide range of ages, who:

- participate in a substantial range of social practices, such as working (or seeking work), parenting, caring and housework, budgeting and organizing consumption, voting; and
- are conscious of having social or political interests (cf. Wedege et al., 2008).

In particular, this definition includes adults over 65 years of age and many adolescents.

1.1. Why study AME?

One reason for studying adults' mathematical learning is the concern of policy-makers and educators nationally and internationally – to ensure that entrants to the workforce, as well as relatively established employees – in a particular country or sector – can meet standards of knowledge or skill required in their work.

Other studies have aimed to describe adults' learning, knowledge and use of mathematics in the wealth of different settings in which adults participate – some of these settings, though not all of them, are related to work (e.g. Evans, Alatorre, van der Kooij, Noyes & Potari, 2010). We discuss these more below.

Discussions of the context of the learning, and of the use, of mathematics relate closely to the problem of learning transfer, i.e. the application of insights or skills learned in one context, to activity in another. This remains a crucial concern for research and learning in a subject claiming wide applicability, like mathematics – and it is highlighted by studying adults' use of mathematics in their various activities.

The traditional use of the term "transfer" as a metaphor describing a situation where a person carries the learning product from one problem, situation, or institution, to another has been widely criticised in psychology and in adult educational circles.Transfer of mathematical learning has been reformulated in several ways: for example, in terms of (a) *translation* across contexts (Williams & Wake, 2007b) or across discourses (Evans, 2000b); (b) as *consequential transition*, involving a developmental change in the relationship between an individual and social activities (Beach, 1999); and (c) as *boundary-crossing* of a person across activities (Tuomi-Gröhn & Engeström, 2003).

Another central aim of AME research has been to clarify relationships between cognitive and affective aspects of adults learning mathematics. Because of the importance in post-compulsory education of the adult's motivation to learn in ways that are meaningful to him/her, the tendency to emphasize the study of affective factors (beliefs, attitudes and emotions towards mathematics) in AME has always been strong; see below.

A useful idea that comes from considering issues in AME is the contrast between *generalising* and *subjective* perspectives on its purposes. The 'generalising' approach starts either with claims about societal and/or labour market requirements for adults' mathematical competences, or with demands from the academic discipline of mathematics. We have also found it useful to take up a 'subjective' approach, starting with adults' own perceived needs for mathematical competences and their beliefs and attitudes towards mathematics (Evans, Wedege & Yasukawa, 2012). These two approaches relate, for example, to different understandings of the aims of lifelong learning.

2. The 'social turn': Adults' Mathematics in many settings

One of the key drivers for the move by mathematics education researchers into studies of the use and learning of mathematics in context was to find out what mathematics people *could do* in everyday and workplace situations, rather than documenting 'misconceptions' and failures to attain higher 'stages of development' (the mode of investigation which featured strongly in research in the 1970s-80s) – or their failures to 'transfer their learning'. The concern became to understand *how* people do mathematics (which is often observed to be in ways specific to the context), how to *describe the setting* - and how to support adults and students in *improving* their mathematical abilities (Evans & Kent, 2010).

The research in this area in the last 25-30 years comes from a rich variety of sources, for example - much of it from Brazil:

1. Ethnomathematics: Studying the distinctive mathematical practices among identifiable cultural groups (D'Ambrosio, 1985; Gerdes, 1996, in Mozambique; Knijnik,1993; Fonseca, 2010)
2. Street maths: Nunes, Schliemann & Carraher (1993), working in NE Brazil, drawing on ideas from Vergnaud (e.g. 1988); Saxe (1990), working in NE Brazil
3. 'consumer mathematics', e.g. Lave (1988) on shopping, preparing food activities
4. Workplace Mathematics: e.g. Hoyles et al. (2010): TmLs
5. Educational Second Chances for Adults: often drawing on Freire (e.g. 1972), often linking numeracy with literacy approaches, for example, EJA – see e.g. Conceição Fonseca (2002); see also Tobias (1990) in USA.

Certainly there is some overlap among these approaches; for example. a shared a concern for understanding how to describe the context. The contribution of some of these approaches is summarised in the following sub sections.

2.1 Street mathematics and school mathematics

Nunes et al. (1993) began from a concern with social class differences in school mathematics failure. However, when they began by studying how children were actually solving problems in their activities outside of the school, they found that

Tabela 1: Children 'in the street' had their own distinctive methods for solving 'mathematical' problems; and

Tabela 2: When they were allowed to solve problems in their own ways, many of the social class differences in school performance disappeared.

Tabela 3: Also performance in street maths (oral reasoning) appeared to be superior to school maths (pencil-and-paper, written reasoning).

Almost all of the approaches listed above contribute similar observations about distinctive methods which are highly efficient in particular contexts but may not readily generalise – whereas mathematicians are looking for the latter to be a key characteristic of formal mathematics!

Nunes et al. aimed to "solve the problem of transfer", by describing "oral mathematics and "written mathematics" and then looking for commonalities, found in Vergnaud's idea of a concept – having context, representation and invariant.

2.2 Techno-mathematical literacies for intermediate-level professionals

Hoyles, Noss, Kent and Bakker's (2010) initial focus was on the use of mathematics in workplaces in the manufacturing and financial service sectors in the UK. The first considered the requirements of work and the economy, and the policy context. Using historical and sociological evidence about major shifts that have occurred in the workplace – including increased competitive constraints on UK firms, and a need for more flexible customer communication – they showed that the type of mathematical skills required for work had greatly changed:

> [It is essential to attend to …] the essential characteristics of the knowledge required in technology-mediated work, where there has been a shift in requirement from fluency in doing explicit pen-and-paper calculations, to fluency in using and interpreting outputs from IT systems in order to [provide information for] workplace judgements and decision-making. (p. 7)

However, Hoyles et al. (2010) found that "mathematics", as traditionally perceived (both by employers and employees) is not perceived as relevant enough, to benefit workplace tasks faced by managers and intermediate employees (see also Noss, 1998). What matters are Techno-mathematical Literacies (TmLs), abilities which allow the adult employee to understand and communicate fluently in the language of mathematical inputs and outputs to specific technologies. Thus their research had three main aims:

1. To understand the TmLs required by employees at different levels in four different industrial and commercial sectors.

2. To identify specific cases in companies of techno-mathematical skills gaps.
3. To design, in collaboration, learning resources and interventions, making use of software tools that "adapt or extend symbolic artefacts [for example a graph] identified from existing work practice, to help employees develop new skills in order to work more effectively (pp. 17-19).

2.3. Landless peasants

The Landless Movement is the largest social movement in Latin America. It was estimated that, in 2003, the Movement comprised 1.5 million landless members organized in most states in Brazil. Research and pedagogic work with this Movement has been the basis of much of the activity of Gelsa Knijnik (2007) and her research group (see Bicudo, Knijnik, Fonseca & Domite, 2010).

In the first and second phases of her work, drawing e.g. on ethnomathematics, Knijnik (2007) problematised the dichotomy between élite academic mathematics and the "popular" mathematics practised by rural workers, but which was often not regarded as socially legitimate.

Knijnik (1997) utilised concepts of *cultural capital* and *social capital* (from the sociologist Pierre Bourdieu), in investigating the traditions, practices and mathematical concepts of the landless peasants. She undertook the pedagogical work needed for them to be able to interpret and decode their knowledge, to acquire the knowledge produced by academic mathematics, and to establish comparisons between the two kinds of knowledge. In this way, she was able to analyse the use of the two kinds of knowledge and the power relations involved between them.

In the latest phase of her work, she has developed an ethnomathematical approach using poststructuralist ideas (from Foucault) to investigate deeply conflictive and unstable aspects of culture, and associated power relations, differences, and eurocentrism in academic and school mathematics discourses (Bicudo et al., 2010; Knijnik, 2007). According to Knijnik (2007):

> When they come to adult education projects, their peasant culture comes with them, even when the school curriculum tries to impose a sort of "forgetfulness" about who they are, [and] the grammar they use when adding, subtracting, multiplying and dividing. When this subtle imposition of denying their culture occurs, it is not surprising to see that it brings with it a resistance process. … When they go outside school, their peasant mathematics is revived, showing that it can survive the school conservative practices that are bound by only one kind of rationality. … Maybe it will be possible to enlarge our adult mathematics education world, including other mathematics, other rationalities … If so then our dreams of solidarity in our societies can be fulfilled. (p. 61).

So Nunes et al. and Hoyles et al. find ways of using a generalising approach, whereas Knijnik queries finds a way of being able to establish comparisons between the two kinds of knowledge, academic mathematics, and peasants' own knowledge.

2.4 EJA: Educação de Jovens e Adultos

Fonseca (2005) describes the work of herself and colleagues in Brazil as 'Youth and Adult Mathematics Education', an important feature of EJA, Youth and Adult Mathematics Education (see also Bicudo et al., 2010). In Brazil, as elsewhere in Latin America and in Africa, basic education must be offered for adults aged 18 years or more, since large numbers historically have been excluded from basic schooling in their youth. This raises issues of social justice, or "re-inclusion" both in the positive experiences of education and in the social benefits, in terms of opportunities for work and for access to the wealth of the culture, that flow from it. This approach sees strong links of numeracy with literacy.

The perspective on teaching here aims at a continual examination of the relationship between academic and popular knowledge, and also the power relations involved in their use. The adult courses aim at students learning to handle the 'texts' available in their social practices, and to produce their own texts by learning about new 'mathematical genres'.

But "re-inclusion" / "Second Chances" for adults is a concern of social justice / inclusion not only in Latin America and Africa –but also in NA and Europe: e.g. in the USA, Tobias's work (1990) with the "second tier", and in Scandinavia, the tradition of "folk high schools" (e.g. Hassi et al., 2010).

3. A well-rounded adult learner: emotions and thinking, as part of a whole

Besides locating adults socially, in terms of the context, or (concentric) contexts in which they are acting, thinking, learning, I argue that it is important to see the cognitive and the affective aspects of an adults as parts of a whole, the identity (or subjectivity/ies) of the adult who is participating in a range of social practices. Many recent studies in AME include a strong emphasis on the affective dimension (Evans, 2000), including consideration of motivation (Wedege & Evans, 2006).

This resonates with many reports of research and also with reports from the field of teaching and learning practice. But isn't mathematical thinking "cold" … "calculating" …rational … therefore dispassionate / unemotional? This sort of image of mathematics is reinforced by associations of mathematics with masculinity (Fennema & Sherman, 1976; Frade et al., 2010). We can approach this subject from several directions.

3.1 *Feelings about Mathematics, as reported by adults*

Two examples are:

(a) Liking or disliking

> … I dropped maths with a sigh of *relief*, for I had always *loathed it*, always *felt uncomprehending* even while getting tolerable marks, *didn't like* subjects I wasn't good at, and had *no notion of this subject's appeal or significance*...(Margaret Drabble, writer, *The Guardian*, 5.8.75; emphasis added)

(b) Fear / anxiety vs. confidence

> *Question: What do you dread as you open your eyes in the morning?*
> *Answer: That I'm still at school and it's double maths! [two periods of mathematics in a row]... (Shona MacDonald, 26, promotions manager, in City Limits (London), May 1991)*

Other feelings reported by adults in interviews, for example:

- *Enjoyment*, excitement, finding it "cool" …
- Valuing maths, perceiving it as *useful*
- Perceiving it as *difficult* or …
- uninteresting, *boring* and what else …?

3.2 *Researchers' concepts*

- *Beliefs [Students' & Teachers']:* confidence, self-concept, "self-efficacy", or "learned helplessness" ....
- *Attitudes*: liking, perceived difficulty, perceived usefulness
- *Emotion*: excitement, pleasure, frustration
- *Motivation*: desire to understand, perform well

3.3 Brief history of affect & emotions in (A)ME

Against a background of post-World War II studies of anxiety, especially in US Psychology, several stages developed.

(a) An early focus on maths anxiety / fear – in feminist explanations of girls' performance "deficit":

Gender -------------------------------→ Performance
↘ Maths Anxiety -----→ Avoidance --→ Course- taking ↗

Sheila Tobias (1978), *Overcoming Math Anxiety*
Fennema & Sherman (1976): *Mathematics Attitude Scales*

(b) Methodologically, besides small-scale groups of interviews, there developed surveys – to focus on gender differences, dimensions of anxiety, and explanatory models.

Richardson & Suinn (1972): *Math Anxiety Rating Scale (MARS),* for adults. Fennema & Sherman (1976): *Mathematics Attitude Scales*

- Attitude to Success in Math
- Confidence in Learning Mathematics
- [Perception of] Usefulness of Mathematics
- [Perception of] Math as a Male Domain

(c) There followed a move to *Process*, e.g. of problem solving, and a focus on *Emotion*, rather than Attitudes, Beliefs. And use of Qualitative Methods: observation, interviews, rather than (or along with) questionnaires. There was a move to focus on *positive* emotion - not only negative ones like mathematics anxiety. And the feelings of experts, not only novice learners; see McLeod & Adams (eds.) (1989*) Affect and Mathematical Problem Solving*

(d) A useful framework was summarised by McLeod (1992):

Beliefs	Attitudes	Emotion
<-->		
More "stable" / durable		More volatile
More reflective		More intense
self-completion questionnaires		semi-structured interviews
ALSO …	learning diaries, life history interviews	

(e) A number of recent developments have re-vitalised the area:

- turn to neuroscience (Damasio, 1995): "bodily processes"
- *systems of self-regulation* (Malmivuori, 2006; Hannula, 2006)
- psychoanalytic interviews (e.g. Cabral, 2004)
- *motivation* (Swain et al., 2005; Op't Eynde et al., 2006)
- development of sociocultural approaches that see emotions as *socially organised*

3.4 Relation between Affect and Mathematical Thinking

Perhaps obvious ? But research has had mixed results. If we consider first the "volatile" aspects of affect– namely, *emotion* – we find that describing problem solving episodes with experiences of blockage, frustrations leads to vivid descriptions, plausible explanations of the relationship [only?] (McLeod & Adams, 1989; Evans, 2000; Op 't Eynde et al., 2006).

Alternatively, with the more stable aspects – namely *attitudes, beliefs* – investigating relations with measures of performance, using *meta-analysis* has resulted in only weak general relationships being found so far (Ma & Kishnor, 1997; Hannula, 2006)

3.5 Where do affect, emotions come from?

Three main sources were suggested by FitzSimons (2002):

- Striking experiences at school, college OR in everyday contexts (one-off / repeated), and *interpreted/ remembered by learner*
- 'Socialisation' / Interactions with: Teachers, Parents / elders, and Siblings / peers (e.g. Fennema & Sherman, 1976)
- Images in popular culture: films, advertisements (Mendick, 2007; Evans et al., 2007)

3.6 Some findings

Mathematics *life history interviews* allow practitioners, as well as researchers, to gain a better understanding of adults' motivations and experiences with mathematics throughout life (Buerk & Szablewski, 1993; Coben, 2000; Evans, 2000; Martin, 2007; Swain et al., 2005).

For example, in Coben's (2000) study, in England, almost all interviewees mentioned the importance of mathematics and of success on mathematics examinations. One familiar theme in these stories was:

> *the door* marked "Mathematics," locked or unlocked, through which one has to go to enter or progress within a chosen line of work or study. This image was often used, reflecting the frequency with which mathematics tests are used to filter entry into training and employment (p.54).

4. Ways in Which AME is Specific: Differences from Mathematics Education in general

Our survey of AME (Evans, Wedege & Yasukawa, 2012) suggested that associated with the practices of teaching and learning of mathematics / numeracy for adults are a number of specific features. We start with the qualities of the learners:

- The diverse aims and goals that learners bring to learning may not always sit comfortably with the aims and goals of policy makers, or indeed with educators in general.
- The diverse ways in which adults' identities and engagements with mathematics learning mutually shape each other are likely to differ from individual to individual, and from nation to nation.
- The intensity of affective challenges for many adults, when mathematics is included in their educational programs, needs to be taken into consideration.

Educational and social environments also have their own specific qualities:

- There is a wide diversity of professional, vocational and community learning programs within which mathematics is a part, but not the primary focus for most learners.
- In official discourses there are many paradoxical claims made about mathematics being "basic," yet for many adults mathematics is largely invisible in their social practices, for example as engineers or a broad range of "technicians". (Evans, Wedege & Yasukawa, 2012)

And these specificities extend to the characteristics of research peculiar to AME. While children's experiences in learning mathematics are likely to be largely dependent on formal schooling, adults' knowledge and skills in mathematical areas are likely to be more dependent on informal (and "non-formal") learning. This makes a number of processes more challenging for AME research:

- Adults typically participate in a wider variety of practices than school students, and this can affect how "transfer" of learning, between different contexts by learners and doers of mathematics is described.
- It is difficult to provide empirical descriptions of an adult's mathematical knowledge, for it is encoded in different terminologies among different groups of stakeholders.
- Measurement of performance in numeracy is not a simple matter because of the likelihood that, by contrast with school-age students, adults have more "spiky profiles", that is an "uneven" set of areas of great strength, found alongside areas of relative weakness [example].
- Affective aspects of adults' positioning, vis-à-vis mathematics, is likely to need greater attention because of their greater life experiences. (Evans, Wedege & Yasukawa, 2012)

Nevertheless, the mutual interdependence between research fields in AME and mathematics education (ME) has been fruitful.

- Frameworks from ME have been adopted for AME research, straightforwardly, or in multi- or interdisciplinary fashion.
- Theoretical contributions from research in AME have been adopted in ME. That is true, for example, in the areas of (a) learning transfer and (b) the importance of affect.

4.1 Further Developments in AME as a Field of Study

Emphasis needs to be given to demands for re-skilling in a rapidly changing and increasingly competitive labour market. Further, on-going attention to adults' needs is required, within a context of changing dimensions of social difference, e.g., differently evolving skills of those in different age groups. And relationships between learning and identity formation (Swain et al., 2005) mean that the dynamics of changing identities, changing economic and cultural environments, and changing policy constructions of numeracy, will remain important foci for research and practice.

4.2 Further Developments in AME as a Field of Teaching Practice

In curriculum, new areas of numeracy (and literacy) are related to emerging social and political issues. These emerging issues include:

- Financial literacy (e.g. Bond, 2000)
- Health-related decision making: interpreting expressions of risk from specific diseases, and likelihoods of success of specific medical interventions (Gigerenzer et al., 1999)
- Environmental numeracy: the ability to participate skilfully in often highly quantitative public debates and decision-making, and also to implement informed “sustainability skills” in industrial, home and community settings (D’Ambrosio, 2010).

4.3 Further Developments in AME Policy

- We must work towards a richer notion of adults’ mathematical knowledge / numeracy, building it as an element of “powerful knowledge” (Young, 2010).
- We must develop connections with wider currents of educational and social science research that explore issues relevant to AME research and practices. For example, notions of skill, need to be further debated and broadened, as in debates by Moore (2007), and Sennett (2008).
- Numeracy tutors and adult tutors generally, need, and deserve, greater attention and support in most countries’ educational systems. This is so as to respond to the generalising trends in globalised education systems nowadays – especially with regard to negotiating tensions between their own personal philosophies of AME, the demands and needs of the students, and wider educational policies (Evans, Wedege &Yasukawa, 2012).

5. Conclusion

Overall, this is an up-and-coming and important area of mathematics education research. It gives us another way to think about education and learning at the school level, especially in the changing context of globalised economies and contested policies of lifelong learning.

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