ICME-13 Monographs

Katherine Safford-Ramus
Jürgen Maaß
Evelyn Süss-Stepancik *Editors*

Contemporary Research in Adult and Lifelong Learning of Mathematics

International Perspectives

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Chapter 1
Introduction

Evelyn Süss-Stepancik

Abstract At ICME-13 in Hamburg, Germany, the participants of Topic Study Group 6 "Adult and Lifelong Learning" presented papers that spanned a wide range of topics. The areas that they covered fell into four groups. Those in the first part of this book give an overview of the concept "Numeracy", the second part addresses a student's focus in adult learning while the third looks at adult mathematics education from teacher's viewpoint. The final group consists of papers that touch on multiple aspects of teaching mathematics to adults.

Keywords Adult · Mathematics · Education

1.1 An Outline of Adult Learning, Lifelong Learning and Lifelong Mathematics Learning

Looking in the manifold literature on adult learning it becomes clear that this topic has been discussed scientifically in different aspects for about twenty-five years. First of all, one has to know what constitutes this particular group of learners. Usually adult learners are defined as a very diverse group with the typically age 25 and older. The heterogeneity of this group is large and covers learners who start, resume or continue their education beyond the normal age of schooling in their societies (ICME 13, 2015). So, one can imagine that adult learners are different from traditional college students. Most of them are highly motivated but have a lot of responsibilities and situations that can interfere their educational purpose (Merriam & Caffarella, 1999). Discussing the topic of adult learning, lifelong learning must also be considered. With the decreasing number of young population and the increasing number of elderly population the demand of lifelong learning

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gets more pertinent. Although there are different definitions of lifelong learning, it can be assumed, that lifelong learning will help adult learners to continue developing on a personal level. Beyond that Agget and Neild (2014) see a wide range of benefits that flow from lifelong learning to society and the economy. But what about lifelong mathematics learning for adult learners? Safford-Ramus, Misra and Maguire state that:

> Adult learners practicing lifelong mathematical learning are supposed to be more productive, economically active, and individually satisfied. (Safford-Ramus, Misra, & Maguire, 2016, p. 1)

Despite this fact, adult learners still feel reluctant to lifelong mathematics learning. The reasons are many, but three fundamental ones are to be presented here. First the negative perception about mathematics that occurs often together with math anxiety must be called. Second, although adult learners do a lot of mathematics in their everyday life, they do not perceive it. Wedege pointed out, that:

> They do not connect the everyday activity and their own competences with mathematics. Most of them only associate mathematics with the school subject. (Wedge, 2010, p. 89)

Finally, it should be mentioned that mathematics instructions often emphasis on memorizing procedures and rarely focus on conceptual understanding which lead to a situation where learners started hating mathematics (Chisman, 2011).

This brief discussion reveals that adults' mathematics education is facing a number of challenges. For that reason, it becomes obvious to discuss different researches about adult mathematics education.

1.2 The Field of Adult Mathematics Education

The research in the field of adult mathematics education is a very broad one. Therefore, only those topics that were issued at the Congress in Hamburg 2016 will be highlighted in this part.

One of these topics concerns the obstacles to and the advantages of the adult learners. Actually there is an extensive scope of research that link beliefs and attitudes about mathematics. A large number deals with math histories and math biographies of adult learners. The core findings show, that students see a massive gap between the mathematics they encounter in their personal or work life and the math they could not do. The latter is what they called mathematics; the first is what they call "common sense" (Coben, 1997). Also related to this topic is the phenomenon "math anxiety". Some investigations are devoted to the teachers' behavior (e.g. Yuen, 2013); some analyze how adult learners can overcome math anxiety. In contrast to math anxiety self-efficacy is a predictor of success in the adult mathematics classroom. However, there are fewer studies about self-efficacy. These studies mirror self-efficacy from two angles. The first angle reveals the teachers' opportunities to enhance students' self-efficacy (e.g. Dweck, 2006). The second

angles looks at own contributions adult learners can make to enhance their self-efficacy (e.g. Safford-Ramus, 2015).

From the very beginning, the publishing conduit for adult mathematics educators has had a strong pedagogy spirit. In this view mathematic education for adults always aims for empowerment. Benn (1998) for instance is convinced that a low level of numeracy in our society limit participation and critical citizenship. In this context Freire's pedagogy plays an important role. His approach to education aims to transform oppressive structures by engaging people drawing on what they already know. In Brazil teachers were accustomed to using his work in literacy program but struggled to transfer that experience to the teaching of mathematics (Dias, 2000). Another aspect in this area is the empowerment of parents who often return to study mathematics to be able to help their children learn math. Whether in Ireland, Denmark, in Hispanic communities or anywhere else in the world there are research projects and workshops on parents and grandparents as adult learners of math. Some of them not only lead the parents to a better conceptual understanding of mathematics but also allows them to experience the pedagogical changes being implemented in the children's classroom (Ginsburg, 2008).

As already stated above, mathematics makes an important contribution to citizenship but also for further credentialing. Some adults learn mathematics because the lack of basic mathematics education or because they were unsuccessful in school or because they need it for their career path. The common feature of many offers and curriculums for adult learners is that mathematic tasks are drawn from real life situations, everyday life and workplace tasks. Overall, it can be observed that adult learners bring a treasure of intrinsic and extrinsic motivation, and a desire to understand "why", not just "how", the procedures work (Safford-Ramus, Misra, & Maguire, 2016). Finally, it should be noted, that the rapid evolution of the technology also affects adult math education and first approaches to design multimedia tools for teaching math in adult basic education are made.

Another important group of adult learners are teachers. Two basic categories of teachers as adult learners can be distinguished. The first includes students that are becoming teacher while the second addresses practicing teachers who seek to upgrade their mathematical knowledge and/or their teaching methods. In addition to this distinction, however, they each have a different target audience. Some of them teach children, the others teach adults. Unfortunately, only a few countries and international projects are supporting initiatives to improve adult mathematics teachers' competencies.

Last, but not least, the disparate and competing conceptualization of numeracy should be mentioned here, because it often occurs in literature as well as in the Topic Study Group "Adult Learning". It is a matter of fact that the discourse on how numeracy is conceptualized and its relationship with mathematics and literacy is still going on. Following Maguire and O'Donoghue (2003) the concept of numeracy should be considered as a continuum starting with a limited concept of numeracy and culminating in a conceptualization of numeracy as a complex and multifaceted sophistic construct. Some others considered numeracy to be "not less than maths but more" (Johnston & Tout, 1995). Withnall (1995) has defined

numeracy as a socially based activity requiring the ability to integrate mathematics and communications skills. However, Safford-Ramus, Misra and Maguire (2016) rightly pointed out, that there is a clear need for numeracy to remain a dynamic construct. Many Governments are reacting to the poor results in International surveys (e.g. International Adult Literacy Survey) and are developing a wide range of initiatives to improve adults' literacy and numeracy. Crucial to the success of these provisions, however, are three factors. These are, the policy environment within teachers must operate, the conceptualization of numeracy being employed and the appropriateness of the teacher training provided.

This briefest synopsis of the work that has been accomplished in the field of adult mathematics education intents to introduce readers to the field and open the door to look at the following contributions that were made by the speakers at the ICME-13 in the Topic Study Group 6 "Adult Learning".

1.3 The ICME-13 Scientific Discourse of Topic Study Group 6 "Adult Learning"

At the ICME-13 the participants of Topic Study Group 6 "Adult Learning" had a lot of thought-provoking discussions based on the topics outlined above. To group the essential themes the contributions were grouped into four sections. The first section resumes the conceptualization of numeracy, the second addresses a student focus in adult learning, the third a teacher focus and the last covers overarching themes. A large number of publications deal with the math histories or math biographies of adult learners.

1.3.1 Numeracy

The articles from David Kaye, John O'Donoghue, Diana Coben and Jürgen Maaß debate numeracy as an important issue of adult learning. Kaye underlines the need to recognize how the terms "numeracy", "mathematics" and "maths" are used and by whom. During his long research with reference to Adults Learning Mathematics and numeracy he has identified different uses and interpretations of concept numeracy. In addition to this Kaye reflects on the term "non-traditional-student" as a new research problem in mathematics education because the adult sector is often ignored. O'Donoghue illustrates the specific situation and developments in mathematics education in Ireland as well as the impact on adult learners of mathematics. Furthermore, O'Donoghue discusses the so-called "Irish mathematical education landscape" (IMEL) and the Adult numeracy education in Ireland. Finally, he makes a very strong case fore the inclusion of numeracy within a school mathematics framework. Coben from New Zealand treats numeracy and literacy as both social

practices and technical skills. She presents a conceptual framework encompassing numeracy, reading, writing, speaking and listening practices, in real and virtual (digital) environments. The ultimate aim of this work is to develop a way of tracking changes how adults use numeracy in the workplace, at home and elsewhere. In contrast to these three articles with a rather national focus, Maaß gives an excellent political analysis and discusses numeracy—the confidence and skill to use mathematics in all aspects of life, at work and in practical everyday activities—at a global point. He raises the questions: What is reality? What is the reality of adults learning mathematics? How can adult teachers show the practical use of mathematics to their pupils?

1.3.2 Student Focus

The articles from Eun Young Cho and Rae Young Kim, Andrea Maffia and Maria Alessandra Mariotti, R. Ramanujam, and Zekiye Morkoyunlu are based on various studies where the subjects were adult learners. Eun and Rae emphasize the needs of mathematics education programs for adults in Korea. They interviewed seven adults. The reasons for the most adults to return to study mathematics are similar to the aspect (e.g. empowerment) discussed above. But there is also a small group that just for the pleasure of mathematics pursues their mathematics education. These findings may provide implications on educational policy and research in the field of adult learning mathematics in Korea.

Maffia and Mariotti are combining cognitive psychology with adult mathematics education. They were investigating adults' conceptions of multiplication. Therefore, they interviewed ten adults and made a qualitative analysis of the math histories and math biographies of these adults. The found out that the level of instruction and the duration of schooling are important variables in recalling and in choosing strategies for multiplications.

Ramanujam, an Indian adult math teacher and researcher present an experiential account of an adult mathematical classroom. He demonstrates the possibilities available to qualified and open-minded mathematics educators when they are released from the demands of following mandated curricula. In his class women that are working as vegetable sellers expected that mathematics lesson helps to increase their earning capacity. The staring point of the lessons was the typically daily routine of vegetable sellers and at the end they infer functional variations and optimize their physical efforts for packing the vegetables. From this experience Ramanujam requires a re-orientation of what we expect the learner to achieve but respects the learner's maturity and offers the learner a way of thinking that is enriching. His experience confronts the popular myth that adults and early school leavers need to be restricted to a remedial mathematics diet.

Zekiye Morkoyunlu analyses the impact of parental involvement in mathematics education for children as well for parents themselves. For this quantitative and qualitative research, a sample of students with their parents was selected from a

middle school. One important result is, that students need support from their parents from primary school to middle school. Another result is, that the common learning of parents and students led them to engage with mathematics in real life. As a conclusion of this study parents remark the necessity to deepen their mathematic knowledge and to extend their how to support their children properly.

1.3.3 Teacher Focus

The articles from Sonja Beeli-Zimmermann, Neomar Lacerda da Silva and Maria Elzabete Souza Couto, Terry Maguire and Afoie M. Smith and Lena Lindenskov focus on the teacher perspective. Beeli-Zimmermann reports on her finding of a qualitative study describing the mathematical beliefs of eight adult education teachers in Switzerland. Even if adult education, particularly adult basic education, does not play an important role in Switzerland's educational field, the vocational education enjoys a very high status in Switzerland and the Swiss Federation of Adult Learning is running different projects to professionalise the training of adult basic education teachers. She collected her data in the summer 2012. It is interesting that she asked the participants to create an image of mathematics as a starting point for her data collection. Her findings identify three dualities and clarify the beneficial of this research for adult education teachers.

Lacerda da Silva and Souza Couto present their research results from a qualitative study where they analyzed how Freire's premises influence the teaching practice of adult mathematic teachers. As already explained above Freire's pedagogy belongs to the spirit of adult mathematics education (citizenship) and plays an important role in Brazil. The results indicate that his pedagogy can slowly be translated into mathematics lessons.

Maguire and Smith are illustrating the concept of "Math Eyes" and its popularity in adult education, school and community in Ireland and internationally. Their article offers substantial information and guidance for adult mathematics professionals in what can be done to encourage public engagement with mathematics, as well as in the related and important area of teacher professional development for adult numeracy tutors. They also describe connections across Math Eyes and "big ideas". Their findings of their study also show possibilities to develop Math Eyes and the look at familiar things trough the lens of mathematics.

Lindenskov a researcher in the field of adults learning mathematics in Denmark opens with a very interesting historical and philosophical analysis of the evolution of adult education in Denmark. She focuses on two settings in this field. She is pointing out that mathematics in labor market training is only directed towards industry needs and preparatory adult education is only directed towards the personal development and citizenship. These differences go hand in hand with a lot of others aspects like teacher qualification. To conclude her contribution, she raises some

questions such as whether vocational mathematics education should also contribute to personal development beyond employers' needs, and the effect of placing a degree of compulsion on adult learners of mathematics.

1.3.4 At the Crossroads—Overarching Themes

The articles from Barbara Miller-Reilly and Charles O'Brien, Pradeep Kumar Misra, and Katherine Safford-Ramus draw attention to three different aspects in the research field of adult learning. Miller-Reilly and O'Brien, a pair of adult learners composed of an adult doctoral student and an adult mathematics student, reflect on their two decades journey interacting through their learning. Their literature review focused on adults returning to study mathematics and the relationship between women's way of knowing and adult education. Miller-Reilly was working on her doctorate when she taught O'Brien, a young man with completely negative association and attitude towards mathematics, in an initial six-month math course. His creative descriptions of his mathematics anxiety and overcoming it during this course provided inspiration for Miller-Reilly's doctoral study. Their mutually beneficial experiences resulted in personal and professional growth for both.

Kumar Misra opens his article with a literature review covering background information on life long learning. Afterwards he leads into the main theme, Open Educational Resources. While emphasizing the necessity of lifelong mathematics learning Misra is also outlining the different challenges to practice it. He affirms the importance of Open Educational Resources to overcome these challenges and presents details about the benefit and global initiatives to use Open Education Resources for lifelong mathematics learning.

Safford-Ramus presents an excellent summary of research and themes that surfaced in her literature review in the field of adult learning. Her paper highlights the voices of the students and teachers. She concludes with suggestions for future research and the necessity for an advanced degree specific to adult mathematics education as well as the incorporating of technology in adult learning mathematics.

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Part I
Adult Numeracy

Chapter 2
Defining Adult and Numeracy: An Academic and Political Investigation

David Kaye

Abstract I have for some time been working on the use of the term 'numeracy', particularly with reference to adult education research. I have identified many uses and interpretations of 'numeracy' in ALM proceedings and other publications. Over time I recognized the need to not only identify how 'numeracy' is used, but also 'mathematics' and 'maths'. The first part of this paper will summarize how these terms are used, when they are used and by whom, as presented at TSG 6 (ICME-13). The second part of this paper reflects on the experience of attending ICME-13 as an adult numeracy specialist. A new research problem is developed that explores how adults are considered in mathematics education research and the term 'non-traditional student' is considered. The content of the 'Scientific Program' of ICME-13 is explored to identify research topics of relevance to non-traditional students. Further investigations reveal the extent to which the adult sector is ignored. Some comments are made on the need to redress this situation.

Keywords Numeracy · Adult · Adult education · Non-traditional student
Lifelong learning · ICME-13

2.1 Section 1—TSG 6 Introductory Paper

2.1.1 Introduction

The theme of the first part of this paper is apparently simple: defining 'numeracy'. I have been considering what is meant by adult numeracy for most of my 'teaching' life, from around 1990. I personally always felt much more comfortable calling myself a numeracy teacher, rather than a mathematics teacher, but I did not feel a need to define it. However, I discovered that many questioned what numeracy is. I set myself the task of looking for answers, mainly in the papers published in the

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proceedings of the annual international conferences of Adults Learning Mathematics (Kaye, 2003b). I was inspired by the variety of what I found.

I have continued to identify definitions of numeracy and what has been said about mathematics. As an adult numeracy practitioner and latterly a teacher trainer (educator), I have always seen a direct link between how numeracy (or mathematics) is described and the content of my teaching. This makes the task a political one, as curricula are the subject of political debate. This paper identifies some key issues in defining adult numeracy, identifies the political significance of discussing what numeracy is (and what it is not), and considers why other terms are sometimes thought to be more appropriate.

2.1.2 Key Definitions

I will begin with some examples of definitions that have been published over the last 20 years or so. I have not addressed the evolution of the terms numeracy or numerate; a very good summary of this is provided by O'Donoghue (2003). Though I speak of 'definitions', I include descriptions of courses or teaching strategies in which 'numeracy' forms part of the explanation. It should be noted that the extraction of these quotations, from longer papers, has been my decision, and for my purposes, and the original author's intentions may not be that implied by my analysis.

2.1.3 Using 'Numeracy'

There are many definitions of numeracy and what they have in common includes: context; relevance to real situations; used for solving problems; personal choice of methods; and favors personal empowerment. Mathematics, or mathematical, is always mentioned to identify the nature of the activity, but something else is always there as well, and may well be more important. As Tout (1997) said "we can say that numeracy is not less than mathematics but more". Here are a few examples.

> Indeed, the idea of numeracy has been used to emphasise the need for "the maths" to be learned (and often used) in context. What distinguishes the context of everyday numerate thinking and problem solving from that of academic mathematics is the different activities and practices which form the different contexts. Thus, the numeracies used in the work of builders, pharmacists and shop-managers are all different - because they are based in different practices and hence are specific to them. (Evans & Thorstad, 1995)

> The term mathematics triggers very strong negative feelings in many people: anxiety, panic, fear, or anger. They may unconsciously label the everyday maths they use as 'common sense' to avoid triggering those emotions. Part of the problem of definition is nomenclature: what I am referring to as 'mathematics' is often called 'numeracy' by academics and policy-makers, (but not by the general population) although they often mean a much narrower field of knowledge and skills: what used to be called 'arithmetic'. (Colwell, 1997)

> We believe that numeracy is about making meaning in mathematics and being critical about maths. This view of numeracy is very different from numeracy being just about numbers, and it is a big step forward from numeracy or everyday maths that meant doing some functional maths. It is about using mathematics in all its guises - space and shape, measurement, data and statistics, algebra, and of course, number - to make sense of the real world, and using maths critically and being critical of maths itself. (Tout, 1997)

> When we talk about numeracy what do we mean? In practice the term may signify any one of a number of things including, basic computational arithmetic, essential mathematics, social mathematics, survival skills for everyday life, quantitative literacy, mathematical literacy and an aspect of mathematical power. These descriptions span a spectrum of personal abilities from basic skills to high-level cognitive abilities such as problem solving and communication. (O'Donoghue, 2003)

> We also wanted to have research evidence of the numeracy knowledge of domestic activities which emphasises understanding by the participation of adults and to leave behind traditional methods that stand for conception of adult as persons with a simple knowledge, lazy, dumb and with concrete reasoning. Some research at job settings have showed how mathematical procedures and explanations to solve problems are highly context dependent, talking about quantities, measures and procedures in a mathematical way is a form of knowledge when is built by cooperative learning, through processes of social interchange. (de Agüero, 2008)

> *Inbalance* defines numeracy as a particular behaviour involving mathematical skills to manage a situation or solving a problem in a real life context. In this regard, numeracy involves actions such as identifying and locating, acting upon (order/sort, count, estimate, compute, measure, model), interpreting and communicating. Of course, numeracy is more than just "do basic arithmetic". … Behind this picture, *Inbalance* assumes that numeracy concerns four different domains: everyday life, work-related, societal or community and further learning. Numeracy occurs every day. (Díez-Palomar, 2012)

> … we needed to define the domain within which we laboured. We decided to adopt the following generic definition of what it means to be numerate: To be numerate means to be competent, confident, and comfortable with one's judgments on whether to use mathematics in a particular situation and if so, what mathematics to use, how to do it, what degree of accuracy is appropriate, and what the answer means in relation to the context. (Quoted in Coben & Weeks, 2013)

Each of these quotations has been chosen to represent a key factor. Evans and Thorstad raise the issue of multiple numeracies, which differ in trades, professions and cultures. Tout introduces the idea that through numeracy we can be critical, not only in social and political analysis, but of mathematics itself. Colwell illustrates here an example of using mathematics, but in a way that others would use numeracy. Along the way she also recognises that other terms are also commonly used—such as 'everyday mathematics', 'arithmetic' or even 'common sense'. The brief statement from O'Donoghue presents us with the scope of numeracy, and also, by the way, provides us with other terms that have been used instead of numeracy, though each may be more limited, if used alone. The example from de Agüero places numeracy in an analysis of using mathematics in a very specific domestic context, with an emphasis on gender and class. Díez-Palomar is referring to a European project, Inbalance, which aimed to improve teaching adult numeracy by

providing resources to support learning and assessment. Here we see a very rich definition of numeracy as a tool for European citizens to improve their lives. The final example from Diana Coben is one that has been quoted on many occasions since it was first published in 2000 (in *Adults Numeracy Development: Theory, research and practice* edited by I Gal) and is here re-used by Coben herself.

All of these examples see numeracy as—'using mathematics'. This of course raises a considerable dilemma for teachers, and those researching adult education, as we struggle to decide what does it actually mean to be 'using mathematics' in a classroom—particularly in an adult numeracy classroom?

2.1.4 Models of Numeracy

Some authors have sought to produce models of numeracy, as tools for further analysis, for example Maguire's and O'Donoghue's framework for *Numeracy Concept Sophistication.*

> The organising framework of numeracy concept sophistication views the development of the concept of numeracy as a continuum with three phases: Formative, Mathematical and Integrative. The phases represent an incrementally-increasing degree of sophistication in the conceptualisation of numeracy. The phases are seen as a continuum with gradual rather than sharp boundaries. (Maguire & O'Donoghue, 2003)

This model presents numeracy as a dynamic system, which allows for the many different ways in which numeracy is observed. However, in any one situation the sophistication can be lost, movement along the continuum is blocked and the numeracy experience is restricted by curriculum boundaries.

Gail FitzSimons provides a model that places numeracy within an analysis of the nature of mathematical knowledge

> Bemstein describes mathematics as being a *vertical discourse* due to its coherent, explicit, and systematically principled structure. It takes the form of a series of specialised, codified languages, with many sub–disciplines (e.g., algebra, geometry, trigonometry). In formal education, the discipline of mathematics is recontextualised for the purpose of enculturation.
>
> Following Bernstein, I argue that the construct of numeracy is an example of a *horizontal discourse.* This is due to the strong affinity between the burgeoning corpus of research reports on workplace and everyday activities involving the use and re/construction of mathematical knowledges.
>
> It is well recognised that the mathematics classroom is a community of practice distinct from that of professional mathematicians; also, from the workplace. In my opinion, then, numeracy is composed of mathematical knowledges and skills, however derived (i.e., formally & informally), in combination with reflective knowing in context – knowing which draws upon a lifetime of experience. (FitzSimons, 2007)

This situates the discussion about numeracy as one of epistemology and is of considerable importance in debates about what the content of an adult numeracy curriculum should be. Unfortunately more recent experience has shown that such

perceptive analysis has not informed the thinking of policy makers in England, as we will see below.

The final model is taken from Tine Wedege and Lena Lindenskov who worked on a new adult numeracy curriculum for Denmark.

> We, ourselves, operate with three analytical terms: numeracy, mathematics knowledge and maths-containing knowledge. In the research project "People's mathematics knowledge in technologies undergoing change", we employ the term 'mathematics knowledge' instead of 'mathematical knowledge' or 'mathematical skills': using this new term we wish partly to signal the extensiveness of the concept, partly to avoid the schism between knowledge and skills. The term *math-containing knowledge* is needed to speak about knowledge in which mathematics understanding is integrated with other kinds of knowledge. We shall continue our considerations concerning the relations between numeracy, mathematics knowledge and math-containing knowledge. (Lindenskov & Wedege, 2001)

This indicates the complex investigation by these two researchers in producing a national curriculum and shows the importance of discussing and interpreting the content and values that are implied by various terms associated with adults' mathematics education.

2.1.5 Numeracy in England 2001 and 2011

> **Numeracy** – 'Mathematics equips pupils with a uniquely powerful set of tools to understand and change the world' (The National Curriculum, (QCA)). Changing the world may not be the immediate goal of adult learners, but being numerate - acquainted with the basic principles of mathematics is essential to functioning independently within the world. It is important that as well as developing skills in manipulating numbers, learners understand and make connections between different areas of mathematics so that they are able to apply skills to solving problems in a range of contexts. In the process, they may also begin to discover the joy and power of mathematics. (Basic Skills Agency, 2001, p. 10)

This is the definition from the Adult Numeracy Core Curriculum (ANCC), published in 2001. We see as usual the immediate reference to mathematics, but that itself is then qualified by; 'being numerate', 'basic principles of mathematics', 'skills in manipulating numbers' and 'make connections between different areas of mathematics'. The publication of the ANCC was part of a whole package of developments addressing adults' basic skills, brought in through policy changes which included increased government funding, which started with the publication of the Moser Report (DfEE, 1999). These developments are summarised by Coben et al. (2003) in her review of research of adult numeracy. As an interesting aside this report, though speaking of numeracy throughout actually uses the definition of 'quantitative literacy as a proxy for numeracy skills' as used in the British IALS survey of 1997. The three literacy definitions of that survey are worth quoting.

> Prose Literacy: understanding and using information from text e.g. understanding a newspaper article

> Document Literacy: Locating and using information from other formats e.g. reading a bus timetable
>
> Quantitative Literacy: Applying arithmetic operations to numbers embedded in print e.g. working out the price of a loan from an advert. (DfEE, 1999, p. 98)

This set of reforms set in train considerable growth in the provision of adult numeracy classes, training of specialist teachers and increased research into adults learning mathematics and numeracy. Many researchers, as shown above, focused on the learners' needs and the relevance of the numeracy to the learners' lives. In contrast policy making in England prioritised the skills economy and workforce development. I will say more about this below. These policy initiatives were informed by a completely different set of research than I have been presenting. These used the evidence from long cohort studies and the very large comparative international studies on adult basic skills. Full summaries of these studies over the last 25 years are given by Carpentieri, Litster, and Frumkin (2009) and Windisch (2015). For example:

> … the Leitch Report (2006) … argued that in order for the United Kingdom to remain an economically competitive nation, it would have to greatly improve its literacy and numeracy skills – and that it would have to improve the latter more than the former. … In this strategy, it was argued that while England was making good progress in improving the literacy and numeracy skills of the population, it would need to greatly increase progress in numeracy in particular in order to avoid losing economic ground to other nations. (Carpentieri et al., 2009)

and

> Identifying effective policy interventions for adults with low literacy and numeracy skills has become increasingly important. The PIAAC Survey of Adult Skills has revealed that a considerable number of adults in OECD countries possess only limited literacy and numeracy skills, and governments now recognise the need to up-skill low-skilled adults in order to maintain national prosperity, especially in the context of structural changes and projected population ageing. (Windisch, 2015)

These are very significant studies, which raise many different issues about the way adult numeracy and mathematics is provided for in England. I have introduced them for two reasons. Firstly, it would be misleading of me to suggest that the only research about adult numeracy had been focusing on the importance of seeing numeracy as an enlightening and critical set of skills and knowledge. Secondly it was important for me to show that it was numeracy that these reports were discussing. What was meant by 'numeracy' in these various reports remains part of this debate, but it was called numeracy.

This was not to remain the case in policy proposals for England. In 2011 the British Government published a report that specifically identified replacing 'numeracy' with 'maths' as part of its new policy review.

The report 'New Challenges, New Changes' stated (BIS, 2011, p. 10)

> There has been a large improvement since 2003 in Level 2 and above literacy, but no improvement in lower level literacy and the nation's numeracy skills have shown a small decline. So, despite considerable efforts over the last 10 years to improve the basic skills of

> adults, our new national survey shows that 24% of adults (8.1 million people) lack functional numeracy skills and 15% (5.1 million people) lack functional literacy skills. This is unacceptable.

This is followed by a table of 13 key points, the first four of which are:

- Re-establish the terms 'English' and 'Maths' for adults.
- Prioritise young adults who lack English and Maths skills, and those adults not in employment.
- Pilot in 2012 how providers can be funded on the basis of the distance a learner has travelled.
- Fund GCSE English and Maths qualifications from September 2012.

The first key point is the most significant; the change in government policy was being signalled by abandoning the terms literacy and numeracy; however, it seemed strange and somehow perverse to me to change 'numeracy' to 'Maths', rather than 'Mathematics'. Colleagues at the time thought I was raising a trivial point; arguing that it is a very common abbreviation. I must admit that it is what many people use in many contexts; but this context was different. This is a government policy paper written specifically to change the language used to discuss adult basic skills education. It is also unusual to use informal language, such as abbreviations, in a government report 'because everyone does'. What was the motivation for this particular change? This must also be part of our debate. It should also be noted that this same document specifically prioritises 'young adults'.

What is certain is that following this statement the use of 'numeracy' in relation to adult education has considerably reduced and also so has the reference to 'mathematics'.

Carpentieri et al. in their review of research use both numeracy and maths in this paragraph (my emphasis).

> It is commonly accepted that there is less stigma about poor **numeracy** skills than poor literacy skills. Successful learning is equated with learning skills that are applicable in life … . Over the life course, adults develop many of their **maths** skills through activities in their daily lives, but their beliefs about **maths** tend to be based on their school experiences. (Carpentieri et al., 2009, p. 53)

In another example from a recent OECD report (Kuczera, Field, & Windisch, 2016, p. 31) on one page, in a section headed 'The policy response in England' all three words are used (my emphasis).

> England has in recent years adopted a wide-ranging set of measures to address the literacy and **numeracy** weaknesses of young adults at 16-19 and beyond. …
>
> To increase completion rates, and improve basic skills among young people, the participation age in education has been raised from 16 to 18, and English and **mathematics** have become mandatory for those not meeting minimum requirements. …
>
> *New initiatives seek better preparation of further education (FE) teachers of **mathematics** and English*

> With a view to upskilling the FE workforce in the teaching of **maths** and English, a GBP 30m-package was put in place for 2014/2015. It includes bursaries of GBP 9 000 for English teachers, and of GBP 20 000 for **maths** teachers to attract good graduates into teaching, and programmes to enhance the skills of existing **maths** and English teachers so they can teach GCSE. Support will also be offered for the professional development of up to 2 000 teachers who want to teach **maths**.

2.1.6 Numeracy, Mathematics, Maths

The use of the three terms alongside each other is now common, but what differences there are in meaning is not clear. There is one theoretical approach that may help our investigation. Coben (2002) considered if a 'duality of discursive domains exists with respect to adult numeracy' (following the work of Catherine Kell in literacy). These are distinguished as follows

> … Domain One is … characterised by formalisation and standardisation of the curriculum, technologisation, unitisation and commodification of learning and learning materials. It is competency-based and outcomes-focussed with certification being the desired outcome, and explicit equivalence with educational levels in schools.
>
> By contrast, Domain Two numeracy is about informal and non-standard mathematics practices and processes in adults' lives, which may bear little relation to formal, taught mathematics. (p. 27)

These two domains reflect much of what has been said about numeracy above. Perhaps the authors of the 2011 BIS paper wished to clarify the 'confusion' between the two domains of numeracy and use 'maths' for Domain One and leave 'numeracy' for 'Domain Two. Unfortunately, this resulted in Domain Two numeracy almost disappearing from adult education courses, thus reducing the choices of adult numeracy practitioners and adult learners.

The British government since 2011 have followed policies that have generally reduced support for adult education courses, focused on the 16–19 year old cohort and given exceptional support for the GCSE mathematics qualification (standard mathematics qualification in schools at age 16); (see BIS, 2011). This has been questioned by many of the teaching profession and education researchers, for example in FE Week on-line

> A government move to continue insisting on widespread GCSE maths and English resits – through the heavily criticized condition of funding rule – has left sector bosses "extremely disappointed".
>
> All 16 to 18-year-old students with a near-pass (previously grade D, now grade three) GCSE in the subjects have since August 2015 had to continue studying and resit them through the rule, alongside FE courses, rather than a level two functional skills qualification. (Offord, 2017)

The OECD report (Kuczera et al., 2016) was quoted above as an example of the use of mathematics, numeracy and maths in a research report. However, the main purpose of this OECD report is to review the UK government's policy initiatives on adult skills, and within that adult numeracy and mathematics. There is a very strong emphasis on the skills economy.

> Given the evidence that mid-life changes of career trajectory are hard but not impossible, one option is to encourage a 'contextual' approach, … This means identifying weak basic skills in the context of other learning, or in employment programmes or working life, and pursuing interventions that, so far as possible, link basic skills to a practical context, occupational skills in particular. (Kuczera et al., 2016, p. 34)

These policy changes have largely been brought about by changes in government funding, enabling certain courses, and shrinking many others. This means that available courses and qualifications have developed to match available funding, rather than from research-based decisions on appropriate content and teaching strategies. Since mathematics is seen as an essential subject it has been very directly affected, and it is within these policy changes that it is repeatedly referred to as 'maths' in all official documents. This has meant that in England at present there has been a reduction in adult education, and particularly in the adult numeracy education which has been the main focus of this paper. For example, Wolf (2015) describes the change in priorities for adult education as a whole but taken with the BIS (2011) policy paper this can be seen as a serious political attack on adult numeracy.

> A situation where the majority of funding comes from payments for full-time, non-employed 16-18 year olds is bound to shift the nature and focus of colleges which had once been focused on day-release, adults and part-timers.
>
> This shift is accelerated when the adult skills budget shrinks in real terms and when more of it is intentionally directed towards non-college providers and non-college-based activities. The former and the latter have been marked features of the adult skills sector in England, and appear set to remain so. (Wolf, 2015, p. 10)

I have been pursuing the meaning and use of the terms numeracy, mathematics and maths as a way of monitoring and categorising the policy changes in this field particularly in England and UK. With the recent changes we (UK adult numeracy practitioners) have experienced it is now even more important to continue to analyse the use of these terms. I stress even more what I have consistently been asking about the use of numeracy, mathematics and maths: when and where each term is used; about what; who is using it; for what purpose (Kaye, 2013, p. 74).

Finally I wish to reinforce what I said about the importance of using numeracy because of its multiple meanings, rather than in spite of them. Numeracy is not this or that, but a dynamic concept that changes over time, place and people (van Groenestijn, 2002), a far more challenging and interesting concept than 'maths'. Numeracy enables questioning and inclusion, rather than enforcing and exclusion.

2.1.7 Widening the View

The examples of numeracy definitions and uses are drawn from diverse sources, from many places and across many decades. However, the recent political and educational changes in the UK, though providing a significant case study on the evolution of adult numeracy and mathematics education in government policy, did reduce the focus to the events in one country. In concluding the first part of this paper it is worth noting that the debate around teaching numeracy, both to adults and in schools, continues to be explored internationally. An example is the ZDM special issue on numeracy (Geiger et al., 2015).

Mike Askew (2015) provides a very comprehensive overview to this volume which demonstrates all the issues about context, the nature of mathematical learning and approaches and strategies for teaching numeracy are still being reviewed and in many cases justified against more traditional mathematics education policies. Askew concludes by contrasting the generally held views about mathematics with those of numeracy practice, which are similar to many of the views found in this investigation into adult numeracy.

> But whereas there is some consensus on the practices of mathematics: abstracting, looking for generalisations, proving and so forth, we have yet to reach consensus on the practices of numeracy. Numerate behaviour is, by nature of the contexts within which it takes place, much more contingent than mathematical practices (Askew, 2015).

2.2 Section 2—Reflection on the ICME-13 Conference

2.2.1 Adult Numeracy

I went to the conference, and particularly TSG 6, with a focus on investigating the meaning and significance of 'numeracy' (as described above). I was representing an organisation called Adults Learning Mathematics, the aims of which are:

> Encouraging research into adults learning mathematics at all levels and disseminating the results of this research ….
>
> 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. (ALM website; Homepage accessed March 2017)

TSG 6 described the scope of its content in its abstract as follows:

> The Study Group encompasses all mathematics and numeracy education undertaken by adults for the purposes of personal, social, political or economic development, and as a course of study in its own right, or in support of learning another subject, developing a skill or furthering an activity. (ICME-13 Website)

However, the structure of the conference discussion groups did not provide the opportunity for discussion about 'numeracy' that was expected when the

introductory paper was prepared (as presented in the first part of this paper). It had been anticipated that some feedback from those working in different languages would provide a useful commentary on this particular use of English in the context of mathematics education research. Unfortunately, this did not happen, and there is a strong possibility that the whole premise of the paper, as presented, was irrelevant to many of the other TSG 6 participants.

In the Topical Survey associated with TSG 6 *The Troika of Adult Learners, Lifelong Learning and Mathematics* (Safford-Ramus, Misra, & Maguire, 2016) there is an extended discussion (pp 24–28) in which the concept of numeracy and adult mathematics education are identified very closely with each other. In the same publication there is a subtle distinction made between the term 'numeracy' and the concept within education that it represents, that may be described by many other words, depending on local contexts (p. 25).

Over the course of the ICME-13 conference I found the issue of what is teaching "adults" mathematics a far more significant issue to consider than my on-going investigations into the use of the term 'numeracy'. I began to think more about **who** is being taught, and in what institutions or contexts, than how to describe **what** is being taught. Within school and university contexts the question of what is being learnt can be answered by reference to curricula, syllabi, and degree regulations. However, this is not necessarily the case when considering adult learners. In reflecting on this situation, I have realised that the need to define the scope, meaning and significance of the content of **adult numeracy** requires looking at 'adult' as much as at 'numeracy'.

As stated in the aims of ALM above one of the motivating factors in this field of research is the lack of attention given to this sector, particularly when compared to mathematics education research for other sectors. Though there have been some improvements, the situation is still well described by Diana Coben in the summary of her review written in 2003.

> Adult numeracy is fast-developing but under-researched, under-theorised and underdeveloped. It is a deeply contested concept which may best be considered as mathematical activity situated in its cultural and historical context. Research and capacity-building are required in: theory; policy; teaching and learning; teacher education; communication between stakeholders; international comparative studies. (Coben, 2003)

2.2.2 Adults or Non-traditional Students

There were two sessions in particular (which I attended), which were pivotal in the evolution of this alternative research theme. The first was the Invited Lecture by Linda Furuto entitled *Pacific Ethnomathematics Navigating Ancient Wisdom and Modern Connections*. This was a session focused on looking at an adult context and made connections with a group of activities, educational approaches and research topics included under the heading of 'ethnomathematics'. The second was one of

the discussion groups *Research on Non-university Tertiary Mathematics* organised by Claire Wladis, and colleagues. I had not initially recognised this title as being relevant; the phrase 'non-university tertiary mathematics' was unfamiliar to me. The experience of these sessions suggested an alternative investigation rather than extending my discussion on defining numeracy and mathematics.

My focus now shifted to looking at mathematics education research of direct relevance to adults, but where the learners were not described as adults, or at all. As this research progressed I became aware that other researchers had considered this in other contexts and the term 'non-traditional student' was one that had attracted some attention.

For example, in a study of US college education Eckel and King (2007) use a United States Department of Education definition of the 'non-traditional' student.

> Three out of four American college students are considered *nontraditional* – that is they possess one or more of the following characteristics: they are age 25 or older, have delayed entry to higher education after completing high school, did not earn a traditional high school diploma, are married, attend part-time, work full-time or have children. (Eckel & King, 2007, p. 1042)

Against this background of an under-developed but growing field of research, and an existing focus on 'adult numeracy' (or 'adult mathematics') I saw the programme of ICME-13 as a suitable primary source to explore mathematics education research relevant to adults or non-traditional students. My original purpose of exploring the meaning and uses of 'numeracy' is still relevant as adult numeracy can be defined as a 'mathematical activity situated in its cultural and historical context' (Coben, 2003). This can serve very well as a basic guideline when looking for examples in the ICME-13 programme of research that has a primary focus on the non-traditional student engaged with mathematical activity situated in a social, cultural, political or historical context.

This clearly describes adult learning as something that happens after school age (locally defined), but otherwise can be of any nature.

In the Topical Survey associated with TSG6 the authors combine the idea of adult learners and lifelong learning making connections with the social and political aspects of people's lives and a very broad view of relevant mathematics education research.

> The above discussions [on lifelong mathematical learning] clearly reveal that lifelong mathematics learning is necessity of our times. Promotion of this learning among adult learners offers multiple benefits ranging from personal to social to economical to political. Efforts have been made in different parts of the world to realize this potential but success still eludes us.
>
> The reason is that mathematics education is facing a number of challenges and these are equally applicable to adults learning of mathematics. To know about these challenges, it becomes obvious that one must study different researches about adult mathematics education that are spread across the publications of several disciplines—adult learning, mathematics education, and educational theory—or lies hidden in doctoral dissertations. (Safford-Ramus et al., 2016, pp. 7/8)

During the conference I became aware that there were contributions that represented the 'several disciplines' referred to above, that made no, or very little, reference to 'adults'. However, the focus of their themes did not specifically relate to children or school students. Therefore, I chose to take my research in a new direction, which looks at the content of the ICME-13 Scientific Program as a sample of mathematics education research.

2.2.3 ICME-13 Scientific Program

My new research task led to an investigation of all the lectures, groups and presentations at ICME-13 to identify those that I believed were 'equally applicable to adults learning of mathematics.' (Safford-Ramus et al., 2016) but were presented without any reference to adults or were labelled in such a way as to disguise the connection with adult learning.

I reviewed the whole of the ICME-13 conference content, using both the website and the printed programme distributed at the conference. I also made use of the Topical Surveys associated with some of the Topical Study Groups. In the appendix I present a summary of my investigation where I give the titles and presenters of the sessions I considered were significant and essential to researching adults' mathematics education. I found that two of the plenaries, six of the invited lectures, one of the ICMI study and survey teams, one of the Affiliated Organisations, 13 of the Discussion Groups and 16 of the Topic Study Groups (besides TSG 6) were of interest to this investigation. Though these remain a minority of the presentations and sessions, for example the 16 TSGs is only 30% of all the topic study groups, this is still a good proportion when compared to a single topic group that carries reference to 'adults' in its title.

2.2.4 Plenaries

I was surprised and pleased to find that two of the plenary presentations, by Bill Barton and Günter Ziegler, were easily identifiable as being relevant to adult learning, though the direct connections were not made overt. Bill Barton gave considerable emphasis to the development of studies that are now referred to as ethno-mathematics, which in their essence are to do with the way people (adults) within their everyday lives, through work, culture and traditions engage with numeracy and mathematics.

Günter Ziegler presented a very wide-ranging view encompassing history, culture and technology, but at the core he was asking 'what is mathematics?' One of his slides presented

Mathematics is …

I. Tool box *for everyday life*

II. Part of culture, *6000 years old*

III. Basis for high-tech, *essential*

IV. *A* human activity. (Ziegler, 2016 slide 26)

He was also concerned with the popular perception of mathematics and how images of numeracy are produced and received. This again easily identifies this presentation as relevant to those seeking to enhance the awareness of adults learning mathematics and is at the core of discussing people returning to learn mathematics at a different time in life.

2.2.5 Invited Lectures

Amongst the Invited Lectures there were some that addressed topics which supported the view that a considerable amount of research was taking place of direct relevance to studying mathematics teaching and learning amongst adults, but not labelled as such. I have already made reference to Linda Furuto's Invited Lecture within the context of ethnomathematics, *Pacific Ethnomathematics: navigating ancient wisdom and modern connections*; but there is also Cynthia Nicol's *Connecting mathematics, community, culture and place: promise possibilities and problems* falling into the same category. Another Invited Lecture is Yukihiko Namikawa's *Mathematical literacy and curriculum based on it—with several realizations in Japan*. The abstract makes a suggested link to the school curriculum, but the guidance given on what is understood by mathematical literacy goes far beyond learning in schools, and so yet again shares much with what we have as a focus for adult learners and the lifelong learning sector. In fact, of course, mathematical literacy is often used instead of the term 'numeracy', but referring to a similar concept, thus providing a direct link with adult numeracy research.

2.2.6 Discussion Groups

The conversation I had with Claire Wladis, John Smith, and Irene Duranczyk in the Discussion Group: *Research on Non-university Tertiary Mathematics* was the start of this investigation. I discovered that the work they were doing in the United States, mainly in Community Colleges, was very similar to my experiences in the Further and Adult Education sector in the United Kingdom. In fact the more we discussed the more we realised we faced the same institutional pressures, the same groups of learners, the same barriers to learning and the same aspirations for change. There was another Discussion Group entitled *Current problems and*