Brooks, C. (2015). Making Maths Useful: How Two Teachers Prepare Adult Learners to Apply Their Numeracy Skills in Their Lives Outside the Classroom. Adults Learning Mathematics: An International Journal, 10(1), 24-39

Making Maths Useful: How Two Teachers Prepare Adult Learners to Apply Their Numeracy Skills in Their Lives Outside the Classroom

Carolyn Brooks

Anglia Ruskin University

<carolyn.brooks@anglia.ac.uk>

Abstract

This pilot case study of two teachers and their learner groups from Adult and Community settings, investigates how numeracy teachers, working with adult learners in discrete numeracy classes, motivate and enable learners to build on their informal skills and apply new learning to their own real-life contexts. Teachers used a range of abstract and contextualised activities to achieve this. Similarities and differences between teachers' approaches were analysed using a Context Continuum model. Whether teachers started with real-life situations then moved to the abstract mathematics within them, or approached it the other way around seemed less important than ensuring there was movement back and/or forth between the different discourses of numeracy and mathematics.

Keywords: context continuum, numeracy, out-of-school practices

Introduction

The inherent complexities of developing an adult learner's numeracy knowledge and skills in a way that will both enable them to pass a summative assessment in order to gain a qualification, as well as develop the motivation and ability to 'transfer' and use their skills and knowledge to support their own real-life problem solving, are widely debated, and relevant internationally. This research investigates whether and how numeracy teachers of adult learners enable learners to apply their skills to real-life uses, particularly in 'discrete' numeracy classes, i.e. those which are not vocationally or workplace- based.

Mathematics and numeracy qualifications in the Further Education (FE) & Skills sector in the UK identify the contextualised and embedded agendas within which adult numeracy teachers are working:

> Functional skills are the fundamental, applied skills in English, mathematics, and information and communication technology (ICT) which help people to gain the most from life, learning and work.
>
> (Ofqual[1], 2012)

Prior to the relatively recent introduction of the Functional Mathematics curriculum, the preceding Adult Numeracy core curriculum (BSA, 2001) stated that it is deliberately context free so that numeracy teachers can relate the curriculum to their learners' own contexts.

The stated intentions of helping people to gain the most from life, learning and work, and relating the curriculum to learners' own contexts, raise some interesting questions; for

[1] Ofqual – the Office of Qualification and Examinations Regulation.

example, are these intentions consistent with learners' and teachers' intentions and aims? Research (Coben et al., 2007; Swain, Baker, Holder, Newmarch, & Coben, 2005; Swain & Swan, 2007) suggests that many learners simply want to gain a qualification to enable them to gain access to other programmes of study or to enhance their job prospects, other learners wish to be able to help their children. In summary (Swain et al., 2005) explain that:

Students' motivations are varied and complex but few come to study maths because they feel they lack skills in their everyday lives.

There are also difficulties associated with teaching numeracy and mathematics in a way that enables learners to apply what they learn outside the classroom, partly because of the differences between the approaches used to problem solve inside the classroom - to ultimately enable learners to gain a numeracy qualification - and the approaches we use to problem solve in real life (Ivaniĉ, Appleby, Hodge, Tusting & Barton, 2006), further amplified if the summative assessment is not fully aligned with the intended outcomes. These approaches are sometimes respectively referred to as 'school maths' and 'street maths' (Nunes, Schliemann, and Carraher, 1993). Therefore teachers need to make choices about the extent to which they balance these different approaches or types of numeracy (Kanes, 2002), and the methods they use to aid learning.

Other considerations must be where and how numeracy is likely to be used in learners' lives in terms of citizenship, learning, work, and life in general, and the extent to which it is possible to help learners to apply their knowledge of mathematics or numeracy to real-life scenarios, and to 'transfer' their skills to different situations (Lave, 1988). How successful are teachers in achieving this?

In summary, a number of underlying questions are raised:

1. What are teachers' aims for numeracy learners?
2. What are learners' aims? (Do their aims include learning maths in order to be able to apply it to their own real-life contexts?)
3. To what extent are teachers successful in enabling learners to apply the mathematics they learn?
4. What methods do teachers employ in order to help bridge the gap between abstract mathematics and useable numeracy?

This paper, based on a pilot case study of two numeracy teachers and their learner groups, gives a brief summary of the findings of the first two questions, but focusses mainly on questions three and four. During the data analysis stage I developed a 'Context Continuum' model which might be of use to teachers, teacher educators and possibly researchers in providing a means of discussing the extent to which different teaching and learning activities are embedded into real life contexts, and to discuss ways in which teachers can help learners to make links between the methods and processes of discrete mathematical concepts and applied problem-solving in real-life contexts.

Prior to outlining the study's methodology and findings, a review of relevant literature and research is presented to provide further background to the study, as this was used to inform the collection, and to some extent, the analysis of the research data.

Theoretical background

In particular, this section focuses on two main areas: firstly, the different kinds of numeracy that exist, and the difficulties and contradictions that this creates in terms of learning and teaching; and secondly, consideration of the adult numeracy teacher's role in facilitating learners to make sense of these different types of numeracy.

Different kinds of numeracy

Many research studies in the late 80's and 90's, for example, Lave (1988), Saxe (1988), Nunes, Schlieman and Carraher (1993), Harris (1991), and Hoyles, Noss and Pozzi (1999), investigated the numeracy practices that people used in life and in work, and examined the differences between the maths learning that takes place in work (often referred to as 'street' mathematics), and the maths learning that takes place in a more formal learning environment such as school (referred to as 'school' mathematics). Lave's research (1988) challenged the idea that mathematics can be taught in a formal setting and then that knowledge can be transferred and applied to a vocational area or to everyday practice. Nunes, Schliemann and Carraher (1993) also suggest that the maths used in working practices is best learned within those practices, which supports the idea of 'embedded' learning being carried out in the vocational context rather than in the classroom. This research supports Barton's (2006, p. 13) social practice perspective in which he questions the idea of "numeracy as itemised, transferable skills" as he suggests that numeracy processes are not easily detachable from their context. However, in the UK not all numeracy learning takes place in vocational contexts, instead, discrete numeracy classes are available to adult learners.

One aspect explored in these studies is that formal and informal techniques use different mathematical practices, for example in street maths, there is often more emphasis on mental maths and estimation, whereas in school maths learners generally expect to use specific written algorithms to apply to problems that they do not see as real life scenarios. Such differences in approaches were borne out in Jurdak and Shahin's study (2001, as cited in FitzSimons, 2008) which explored the differences in the types and sequences of the actions of a group of five experienced plumbers and a group of five school-children in creating a cylindrical container (given a specific height and capacity) from a plane surface. The plumbers engaged with the physical resources available and used a kind of trial and error approach to refining their model whilst the students engaged mainly with cognitive tools to select the formula and calculate the unknown. Obviously these different approaches have implications for numeracy teaching and learning, particularly if the intention is for learners to be able to apply their learning to work and other real-life contexts.

Oughton's (2009) and Dowling's (1998) research is also consistent with these ideas. Dowling explores the difficulties presented in the linking of mathematics to real-life scenarios, in written mathematics school texts, highlighting the conflicts that result and the unrealistic scenarios that are consequently played out. He summarises:

> School mathematics may incorporate domestic settings in its textbooks, but the structure of the resulting tasks will prioritize mathematical rather than domestic principles. Alternatively, domestic practices may recruit mathematical resources, but the mathematical structure will be to a greater or lesser extent subordinated to the principles of the domestic activity.
>
> (Dowling, 1998, p. 24)

He is emphasising the important role that context plays in informing the approaches used in problem solving. In a maths classroom, a learner expects to use mathematics, whereas in a real-life problem-solving scenario, mathematics is but one factor. Oughton (2009, p. 27) supports the idea of unrealistic maths problems in classrooms, suggesting that often:

> students were required to willingly suspend disbelief where the narratives of word problems did not reflect the real world.

Clearly the careful selection and design of learning materials is important, if learners are to be able to make links between what they do in the classroom and how they can use their numeracy skills outside it. Such unrealistic problems have been identified as 'quasi' activities in the research study.

In fact, Kanes (2002) suggests there are three different kinds of numeracy, which he terms: visible-numeracy, constructible-numeracy, and useable-numeracy. Visible-numeracy is where mathematical language and symbols are used explicitly, usually in a learning environment; constructible-numeracy is where constructivism and social constructivism approaches enable learners to build on and transform previous knowledge adequately to problem solve; and useable-numeracy is where the specific numeracy tools and techniques used are “complex and deeply embedded in the context in which it acquires meaning” (Kanes, 2002, p. 4), for example, the workplace in which they are used. Building on the work of Noss (1998, as cited by Kanes, 2002), Kanes explains how the different kinds of numeracy might be considered to create tensions in designing a suitable curriculum, as they conflict with one another, for example concentration on visible-numeracy “oversimplifies issues relating to useable-numeracy, and this leads to numeracy becoming less “useable” than would otherwise be the case” (Kanes, 2002, p. 6). In designing a curriculum to meet the needs of all stakeholders, I propose that these tensions are at the core of curriculum planning for many teachers involved in numeracy teaching and learning.

Such challenges and tensions presented in teaching mathematics form the basis for Kelly’s (2009, 2011) research, which was based around those teaching mathematics in a vocational context and which “highlight[s] the tensions between learning relevant mathematics skills in the workplace and those in education contexts” (Kelly, 2011, p. 37). She developed a model for conceptual analysis of these tensions, and the example in Figure 1 explores the contrasting approaches used in the classroom with those used in the workplace, e.g. using centimetres and metres in the construction classroom (presumably based on curricula requirements) whilst it is customary to use millimetres in the construction workplace. Likewise, in (UK) industry it is commonly known that 60 bricks will build $1m^2$ of wall, whereas in the classroom, this knowledge may not be used as the basis for calculations.

In seeking a conceptual model for my own research, Kelly’s model (Figure 1) provides a useful starting point. In particular, the axis denoting Context (Work Life – Education) inspired ‘The Context Continuum’ model which I developed in order to support analysis of the extent to which contexts were embedded into different teaching activities, as identified in the collected data.

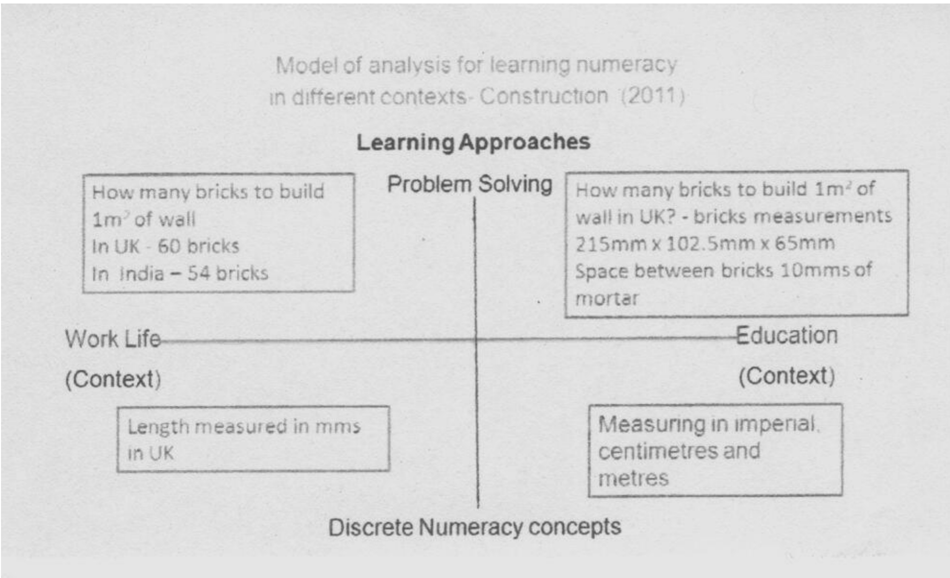


Figure 1. Kelly’s model of analysis for learning numeracy in different contexts – applied to construction (Kelly 2011, p. 41).

Having considered the different types of numeracy, the numeracy teachers’ role in navigating through these is explored next.

The teacher's role and contextualisation

Because of the different types of numeracy that exist, the numeracy used by people on a regular basis, embedded into their daily contexts, is often 'invisible mathematics', a term used by Diana Coben (2000, p. 55) to describe "the mathematics one can do but which one does not recognise as mathematics". She goes on to explore the idea that the mathematics that people can do is often considered by them to be common sense rather than mathematics, which is consistent with learner 'Selena's' views in Swain et al.'s research (2005). Both the invisibility of the mathematics people already use and the status of mathematics in society means that mathematics is often seen by learners and others as "unattainable", something they "cannot do" (Coben, 2000, p. 55), and this impacts on a learner's self-confidence and also their perception of their intelligence or their ability to learn.

For some learners, making maths less abstract can help them make meaning, i.e. understand what it is they are doing (Swain et al., 2005). Contextualisation is one of the methods of meaning-making that Johnston (1995) explored, and it is also supported by learners in Fantinato's (2009) research, who were explicit about the fact that thinking in terms of bags of rice, beans or sugar rather than just numbers, makes things easier to learn. Conceptually difficult areas are often those which seem most abstract, for example negative numbers, which can be usefully related to credit and debt, in making sense of why, for example, 'two negatives make a positive'.

My belief is that in contextualising mathematics, teachers can also help make the 'invisible' visible to learners. If teachers are successful in making the maths more visible, by relating it to learners' life experiences, learners will no longer see maths as something they just do in a maths class, but they will see maths as a tool they can use to help them make informed choices and decisions about, for example, purchases, financial decisions and other contexts relevant to their lives. In addition learners may see that they already do some maths in their lives, therefore that they *can* do maths, albeit the informal 'street' maths. This can be used to build confidence and to help turn learners from an "I can't" to an "I can" kind of learner, which Marr, Helme and Tout (2003) explain as a shift in identity towards someone who is more numerate. Marr, Helme and Tout's (2003) model of numeracy competency, which was developed by a group of experienced adult literacy and numeracy practitioners in Australia, is shown in Figure 2 below:

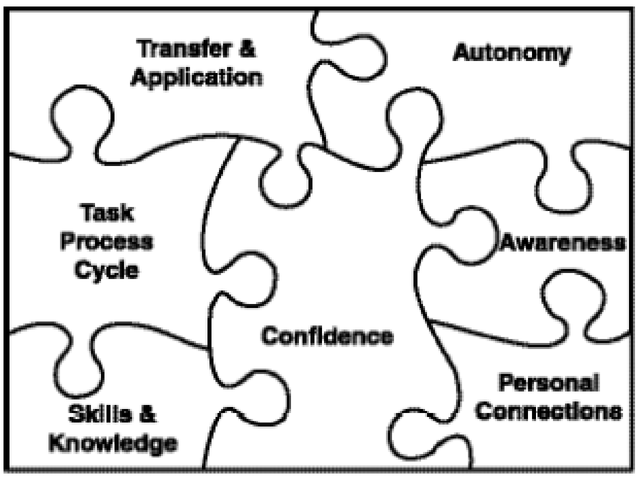


Figure 2. Model of holistic numeracy competence. (Marr, Helme & Tout, 2003, p. 4).

This model suggests that confidence is central, and perhaps the biggest single contributor, to a learner becoming competent in numeracy. The (cognitive) left hand side of the model considers different types and levels of skills and knowledge, which rise in complexity from the bottom to the top of the model, moving from abstract mathematical skills to numeracy skills applied in real-life situations, similar to Kanes' types of numeracy. The (intrapersonal) right hand side considers the building blocks which enable learners to become increasingly independent learners (from bottom to top), starting with linking learners' learning goals into their interests and motivations, and ending with someone able to take more control over their own learning.

Safford (2000, p. 6) identifies one of the roles of the maths teacher as being a mediator between 'street' maths and 'school' maths "to aid students in clarifying knowledge they already own, and to alter and enhance it with new knowledge acquired in our classrooms". Building on existing, informal skills is therefore a positive way to support learners to develop the kind of maths they need in the classroom. Saxe (1988, p. 20) suggests that otherwise:

> [the] processes of transfer are often protracted ones, ones in which [learners] increasingly specialize and adjust strategies formed in one context to deal adequately with problems that emerge in another.

Instances where the teacher has built on learners' existing, informal skills in the study have been identified as 'Validating'.

Safford and Saxe's suggestions are consistent with FitzSimons' (2006) research where she draws on Bernstein's work in discussing the need for teachers to help learners continually cross and re-cross "the borders of vertical discourse [of abstract mathematics] and horizontal discourse [of using numeracy in real contexts]" in the teaching and learning process "in order to develop the capacity for numerate activity" (p. 36). This suggests the need to move continually back and forth between formal, abstract mathematics and informal real-life uses, in the numeracy classroom, and evidence of this was found in the study.

Summary

In summary, it is evident that varying contexts foster different approaches to, and priorities in the use of mathematics. In particular, the contrast between the way in which learners approach (often unrealistic) mathematics problems in the classroom, compared to the ways in which they approach the use of mathematics knowledge in real life contexts (including in the workplace), is so great that learners are often unaware of the mathematics they actually use in real life. This invisibility compounds learners' beliefs that they cannot 'do' mathematics, which affects their confidence and motivation.

Therefore the role of numeracy teachers is to cross and re-cross the different discourses of mathematics and numeracy within their teaching, despite the conflicts and challenges associated with this, in order to help learners acknowledge what they already know and use, relate it to the mathematics they do in the numeracy classroom, and build on their knowledge and understanding in a way which enables learners to use their new knowledge in their real-life contexts.

Having established the complexities involved in teaching and learning mathematics for the purpose of transferring and applying mathematical knowledge and skills to real-life contexts, the aim of this research is to identify whether and how teachers can enable learners to achieve this.

The study

Punch (2009, p. 119) explains "the case study aims to understand the case in depth, and in its natural setting, recognising its complexity and its context", therefore this is a very appropriate methodology to develop an understanding which included the perspectives of numeracy teachers and learners in the research. For the pilot case study two teachers were selected by purposive sampling from numeracy teachers I previously worked with in my capacity as a numeracy teacher educator. Although the relationship between me (researcher) and the teachers introduced some bias, it also maximised the likelihood that the teachers were comfortable in allowing me access to their classrooms and their learners, and to discuss their approaches, thoughts and beliefs. The teachers were specifically chosen because I had previously seen them actively endeavour to link the mathematics taught inside the classroom with the potential uses that learners may have to apply their numeracy outside the classroom.

To maintain confidentiality and anonymity, teachers are referred to as Teacher 1 and Teacher 2, their learner groups, Group 1 and Group 2 respectively; learners who were interviewed were given pseudonyms and learning locations have been withheld. Having obtained ethics approval from Anglia Ruskin University, permission from the participants' learning organisations, and informed consent from the two teachers and their learners, data were collected from discrete numeracy classes in two different Adult and Community Learning settings towards the end of the academic year, once relationships between teachers and learners had been established, and once learners had some experience of learning numeracy in an adult class. Learner Group 1 were on a Family Learning course, designed to help them relate the numeracy they had previously learned on an Adult Numeracy qualification-based course to their children's key stages, and to explore ways they could support their children's learning. Learner Group 2 was attending a general numeracy class with an Adult Numeracy qualification outcome as its primary goal.

Teacher interviews, learner group interviews, and observation of classes were used to collect data. Semi-structured interviews were held with each teacher to investigate their aims and methods. The interview sessions were audio-recorded and the recording was fully transcribed for the purpose of analysis. For each teacher, two two-hour observations of their teaching were carried out, to observe the methods teachers use to help learners make links between their numeracy learning and the use of numeracy outside the classroom. The purpose of carrying out the observations was to enable verification of what teachers said they did at the interview stage (Robson, 2011), and to capture approaches that may not have been voiced during interview. Field notes were made during the observation to record non-audio information and audio-recordings were made using a digital recorder, to minimise intrusion. Relevant parts of the audio recordings were transcribed for the purpose of analysis, and integrated with the field notes.

A short focus group interview was undertaken with willing learner participants (the invitation was open to all) from each learner group, to ascertain their perspectives. These were also audio-recorded and transcribed. As part of an established learning group, learners were used to talking as a group, and Brown (1999, p. 115, as cited in Robson, 2011, pp. 295-6) suggests that a homogeneous group is beneficial in giving a sense of safety and facilitating communication, although it may lead to unquestioning similarity of views. Care was therefore taken to ask open questions, and learners were asked to be honest with me, to minimise the effect of any bias I might bring to the interview (Sim, 1998, p. 347, as cited in Robson, 2011, p. 296).

The family learning class (Group 1) was comprised of five female learners, between 20-45 years old. All were mothers of young children. **Jackie** and **Emma** (pseudonyms) were involved in the interview. The general Skills for Life Numeracy class (Group 2) was comprised of thirteen learners (including two males) between 19-75 years old, some of whom had joined the 30-week class during the year. The four learners involved in this group's interview were given the pseudonyms **Barbara** (mother), **Carol** (mother), **John** (unemployed) and **Maureen** (retired).

A thematic coding approach was used as the basis for analysing the transcribed interviews and observation notes, to identify themes arising (Robson, 2011). The themes arising under coding 'teachers' aims' and 'learners' motivations' are listed in Table 1. Examples of the themes arising under 'Learner Gains' are identified in the Findings section below, and they have been used as evidence to inform Table 1, i.e. whether or not teachers' and learners' aims have been met.

To identify the types of activities used in practice, some pre-determined codes were identified at the outset, informed by a review of the literature and prior experience, but these were amended and other codes arose during data collection and analysis, on the basis of the research findings. Corbin and Strauss (2008, p. 66) liken the process of coding data to "'mining' the data, digging beneath the surface to discover the hidden treasures contained within data." This approach was essential in minimising researcher bias and in seeking to represent the data as truly as possible. Finally, the types of teaching and learning activities were categorized according to how 'abstract' they were, i.e., devoid of any non-mathematical context, and, at the other extreme, how 'situated' they were, i.e., immersed in a real-life context. Categories that sat between these two extremes were also identified during coding and analysis, e.g., I used the term 'Quasi' to describe the kinds of mathematical word problems which are included in mathematics and numeracy textbooks, worksheets and test/exam questions, but which commonly bear little resemblance to real life (Dowling, 1998; Oughton, 2009). The number of occurrences of different types of activities that were either observed or outlined by teachers during their interviews was used to establish the extent to which the two teachers used similar or different types of activities, and comparisons between the two teacher/groups were made. The order in which different types of activities were sequenced during classes was also analysed and compared.

Findings

Before exploring the kinds of activities and methods that teachers used, a summary of the findings that emerged from the study relating to teachers' aims, learners' motivations and the identified learning gains, is given below.

Teachers' aims and learners' motivations and learning gains

Table 1 summarises the data obtained from interviews with teachers and learners regarding their aims (in the left-hand column) and judges the evidence of their achievement (in the right hand column), by comparing the data analysed under the theme 'Learning Gains'.

Table 1.
Table Comparing Teachers' and Learners' Aims with Actual Outcomes

Teachers' and learners' aims	***Learners' Gains – Is there evidence this has been achieved?***
Teachers' aims	
Change learners' identity from "I can't" to "I can" learners.	Yes, including gains in confidence.
Enable learners to pass their numeracy test	Unknown (not in scope).
Enable learners to apply their new maths to real life contexts	Yes – some already in place, some planned.
Enable learners to better support their children's maths learning	Yes, and children improving their maths as a result.
To promote autonomy in learning / more independent learners	Unknown (not in scope).
Learners' aims	
To understand the maths their children are learning at school to be able to more effectively support their children's maths learning. (See 4. above)	(See 4. above)
To gain a qualification (See 2. above)	(See 2. above)
To face up to maths demons – to do the maths that couldn't previously do. (Links to 1. above)	Yes – evidence of better conceptual understanding.

As expected, learners' stated aims (See Table 1) for joining a numeracy class were similar to those in other adult numeracy research studies (for example, Coben et al., 2007; Swain et al., 2005; Swain & Swan, 2007;). Similarly, 'Helping with everyday things outside the classroom' was one of the least popular reasons identified in others' research, and it was not stated as an aim for the case study learners.

During the group interviews, learners were asked whether they used maths before they attended their class, and if so, what kinds of things they used it for. Not unsurprisingly, their responses varied, e.g. Jackie identified she did basic budgeting but explains:

> I would have veered away from things like percentages and that. If I wanted to know what something was off, I would ask my husband, rather than actually try and work it out myself.

Other responses included:

> Carol: You use it without realising you're using it, don't you? Checking change in the shops, checking receipts.
>
> John: I used to ask people. I never used it…I'd never try because I'd know I'd either make myself look really silly or get it completely wrong, so I just wouldn't bother.
>
> Maureen: I was okay with money and things like that…But anything like working out how much carpet I needed, or wallpaper and stuff like that, I would always give it, say, to my husband: 'How much do you think we need?'

After they had each responded to this question they were asked whether, since they joined the class, they had used any of the maths they had learnt to do something outside the classroom, and if so to give some examples. Responses included:

> Jackie: I don't shy away from working out percentages now… I try and work them out now. I do still get my other half to check them….And when the children come with problems with their maths at school I feel more confident to tackle that, so they're getting a bit more confident because they can do it as well.
>
> Carol: Sorting out finances and things. I would have left it all to my husband, but, that's my job now, working out things like how much my car costs to run… Since doing all this [maths class] I think how can I use it?
>
> John: I work out the bills now. She [his wife] says to me sometimes: 'Do you want me to work it out?' and I say 'no, I'll work it out.'
>
> Maureen: I'd measure the room and actually think about working out those calculations for myself [how many wallpaper rolls] and then maybe say to my husband: I think so-and-so, what do you think? Whereas before I'd never have done it myself.

Emma and Jackie also gave examples of how they plan to use their new maths knowledge and skills to help them with future DIY[2] projects, such as, designing a patio or floor (Emma) and interior design (Jackie), things they identified they would not have attempted previously. In summary, a range of themes emerged from the resulting data, including: metamorphosis from an "I can't" (do maths) to an "I can" person, gains in confidence, being confident with their new knowledge to help their children with their maths learning, their children improving their maths, better conceptual understanding and using (additional) maths in their everyday and/or working lives.

This research suggests that not only do the learners leave their course with benefits they had anticipated, but additional benefits are evident; in particular they are able to apply their new maths skills to their real life contexts. Therefore in answer to the research question: 'To what extent are teachers successful in enabling learners to apply the maths they learn?' it is evident that both teachers have been successful in enabling their learners to apply their maths skills, despite the complexities associated with the processes of learning and transfer.

[2] Do-It-Yourself.

Methods employed by teachers to help learners relate in-class learning to real-life uses

So how did the teachers achieve this? The methods that teachers used in their classes were analysed using a model I named 'The Context Continuum' (See Table 2), which I developed during the data analysis stage, from an adaptation of Kelly's (2009, 2011) research model (Presented earlier – see Figure 1).

Table 2.
Table Explaining the Context Continuum Categories

Category Name (& Code)	***Description of Category***	***Examples (from research data)***
Abstract (**R_0**)	Instances where the focus is on the numbers themselves, or on the underlying mathematical patterns, relationships and concepts, where the learning and teaching is devoid of any context other than mathematics.	*Learners designing their own fraction walls.* *Submerging 3-D shapes in water to calculate volume and discover 1ml = $1cm^3$.*
Quasi (**R_1**)	The kinds of mathematical word problems regularly included in maths and numeracy text-books, worksheets and summative assessment questions which are written as 'contextualised' questions but which commonly bear little resemblance to real life contexts.	*Learner trying to make sense of frustum volume formula to answer worksheet problem.* *When using a 'saving water' worksheet, learners identify that the example bath is rather large.*
Validating (**R_2**)	The occasions where teachers encourage and validate learners' informal calculation methods, and where learners show that they understand that their informal methods are legitimate.	*Teacher using whiteboards when doing mental maths, to encourage learners to use and identify informal methods they use.* *Learner 1 used traditional method of multiplication and got the wrong answer. Teacher asked how else they could calculate it. Learner 2 used informal chunking method (and got right answer).*
Making Links (**R_3**)	Instances where learners and/or teachers discuss and identify links between mathematics or numeracy and its real life uses. This includes discussion of mathematical terminology, identifying specific mathematical meanings compared with general meanings.	*Teacher sharing news items with learners, e.g. doctors and new ratios of doctors to patients.* *Learners thinking in pounds (£) to make sense of decimal numbers.*
Re-creation (**R_4**)	Teachers' attempts to re-create real life contexts within the educational setting. Often involves using real artefacts. Possibly context may not be directly relevant to learners' lives.	*Learners working out the volume of compost needed to fill some real plant pots.* *Using external surroundings to find examples of tessellation and angles.*
Situated (Code **R_5**)	Closest to Real Life. Where learners and teachers provide/use examples of their actual uses of mathematics within a real life context.	*A learner being able to check her payslip (presented to her in hours and decimals, rather than in hours and minutes).* *Learners reducing recipe when making playdoh.*

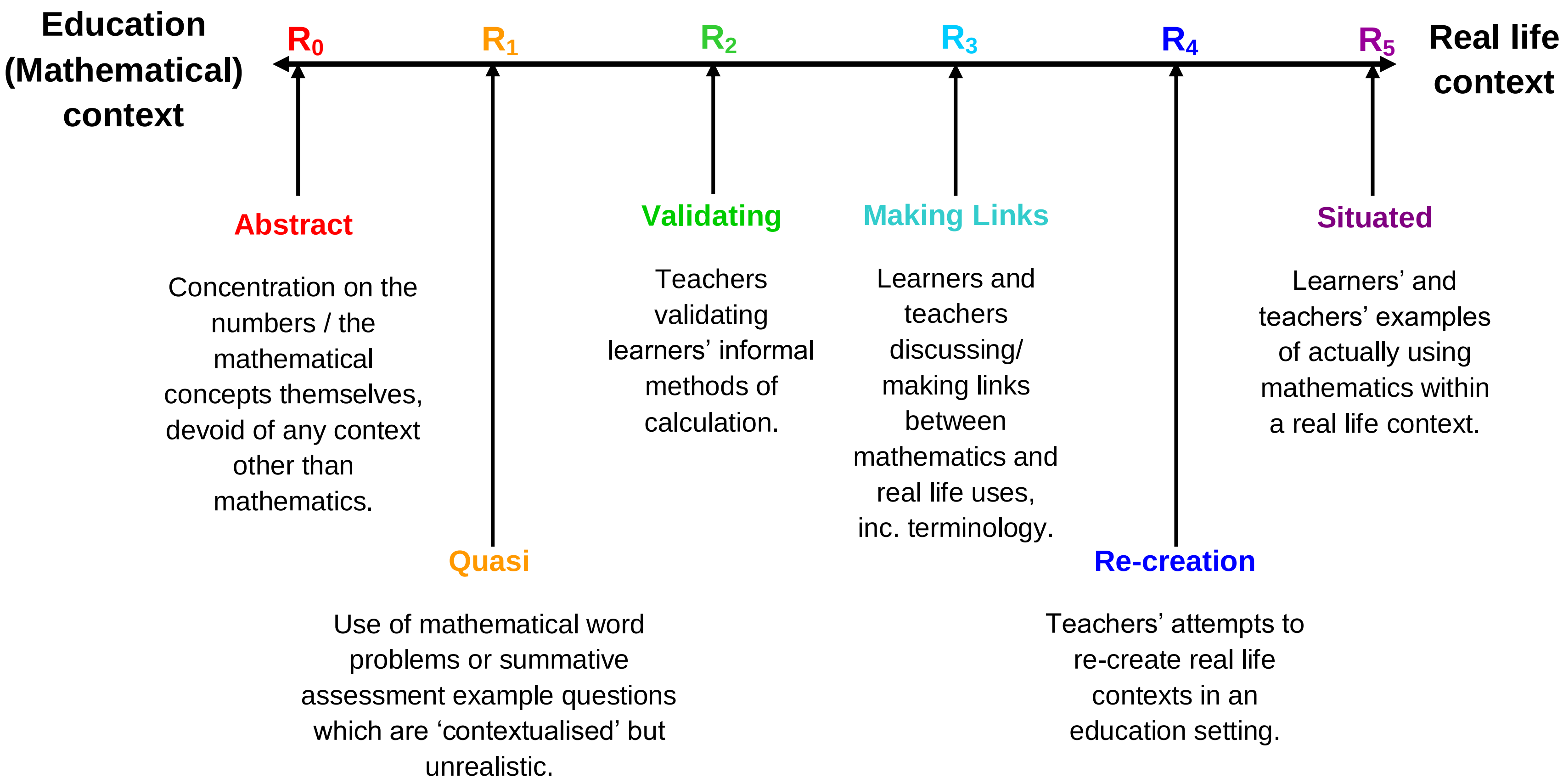
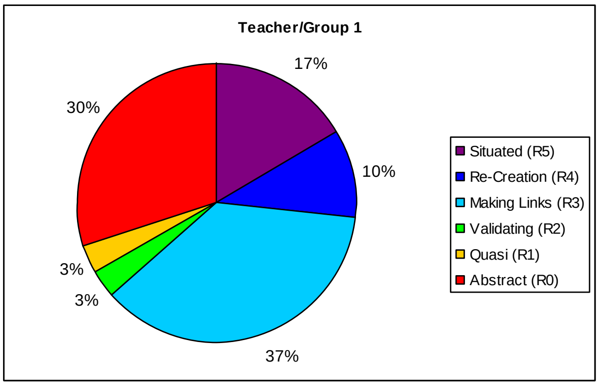


Figure 3. The Context Continuum.

Kelly (2009, 2011) focussed on workplace learning and compared education contexts with workplace contexts along one continuum (horizontal), and approaches to numeracy teaching along the other (vertical axis), from discrete concepts to problem solving. Because the methods teachers use to link classroom teaching to real-life uses form the basis of this case study, I focussed solely on the horizontal (contexts) axis, developing it to fit numeracy teaching that used 'real life' in general, rather than specifically a workplace context. Hence 'Real Life' context replaced 'Work Life' context. Based on the themes arising from the data, I divided the continuum into six subsections, hence 'The Context Continuum' (Table 2). Because my study was based in an educational context it also seemed more logical to start with the Education (mathematical) Context on the left. Codes were used to classify and sort the data, with 'R' representing 'Real', R_5 being as Real Life as possible and R_0 being devoid of any Real Life links. To illustrate, alongside their descriptions, examples (from the data) for each category in The Context Continuum is given in Figure 3.

For analysis, the specific examples ('occurrences') of numeracy teaching/learning methods identified throughout the data, i.e. in teacher and learner group interviews and class observations, were listed in a table and then the occurrences were sorted according to the six categories outlined in The Context Continuum. Although essentially a qualitative study, some quantitative analysis provided a useful means of identifying similarities and differences in teachers' methods.

The pie charts in Figure 4 below show that the number of occurrences of all but two of the different categories were similar across both teacher/groups, with 'Making Links' and 'Abstract' being the most prevalent for each teacher/group. This identifies that the instances of teachers and/or learners discussing and making links between real-life contexts and the mathematics they are exploring in the classroom form the highest occurrences of methods captured. Also focus on the abstract, including the development of conceptual mathematical ideas, forms a high proportion of the methods identified.



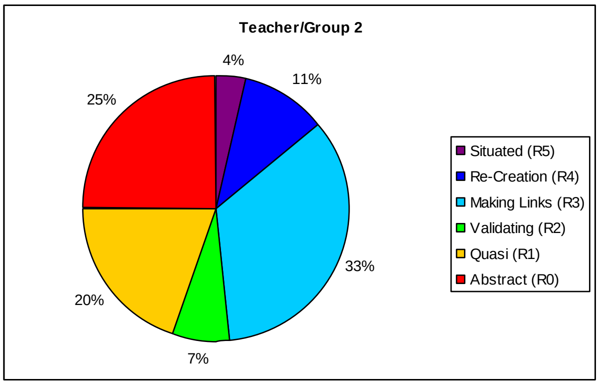


Figure 4. Pie charts showing analysis of methods by context, by teacher/group.

However, the next most-occurring category differed. A higher number of 'Quasi' methods (in orange) was listed in teacher/group 2 (20%) compared with teacher/group 1 (3%). A possible explanation is that in teacher/group 2 learners were working towards a national test as part of their intended course outcome, therefore focus on 'Quasi' methods such as practise test questions and typical word problems could be seen as conducive to supporting success in learners' test results. This contrasts with teacher/group 1 who were undertaking a short course for which there was no qualification outcome, and therefore 'Quasi' methods were likely to be less relevant in this situation.

In contrast, 'Situated' methods (in purple) made up a higher proportion of methods in teacher/group 1 (17%) compared with teacher/group 2 (4%). A possible explanation for this is that as a smaller, family learning group, all with young children, Group 1 were likely to have more common interests than the general Skills for Life group. These factors are likely to have made it easier to situate the learning in relevant real life contexts. Of course, it is also possible that these differences might be linked to teachers' naturally different styles.

Finally, aspects of the data were preserved in linked sequences within the analysis tables (matching sequences of activities either observed or discussed in interviews), so that the sequences of different classroom activities could be analysed for any patterns emerging. These sequences are presented visually in Figures 5a and 5b below.

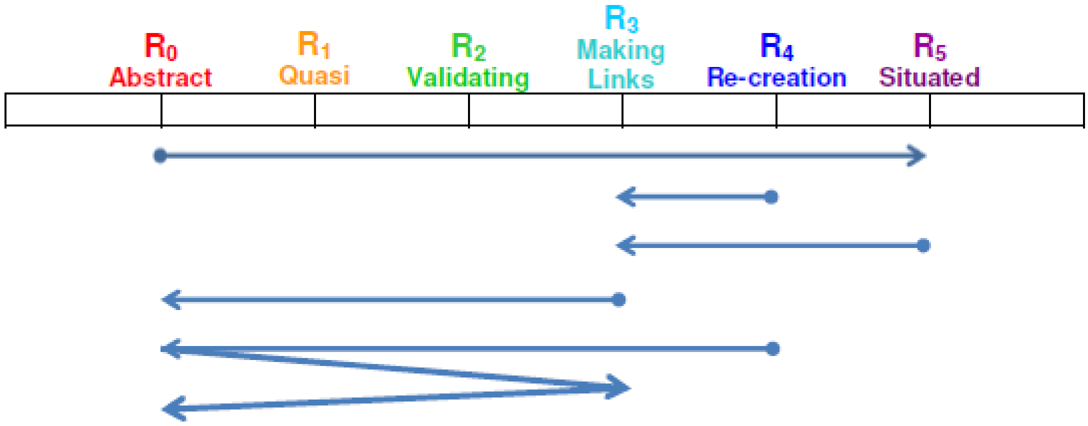


Figure 5a. Sequences of activities: teacher/group 1.

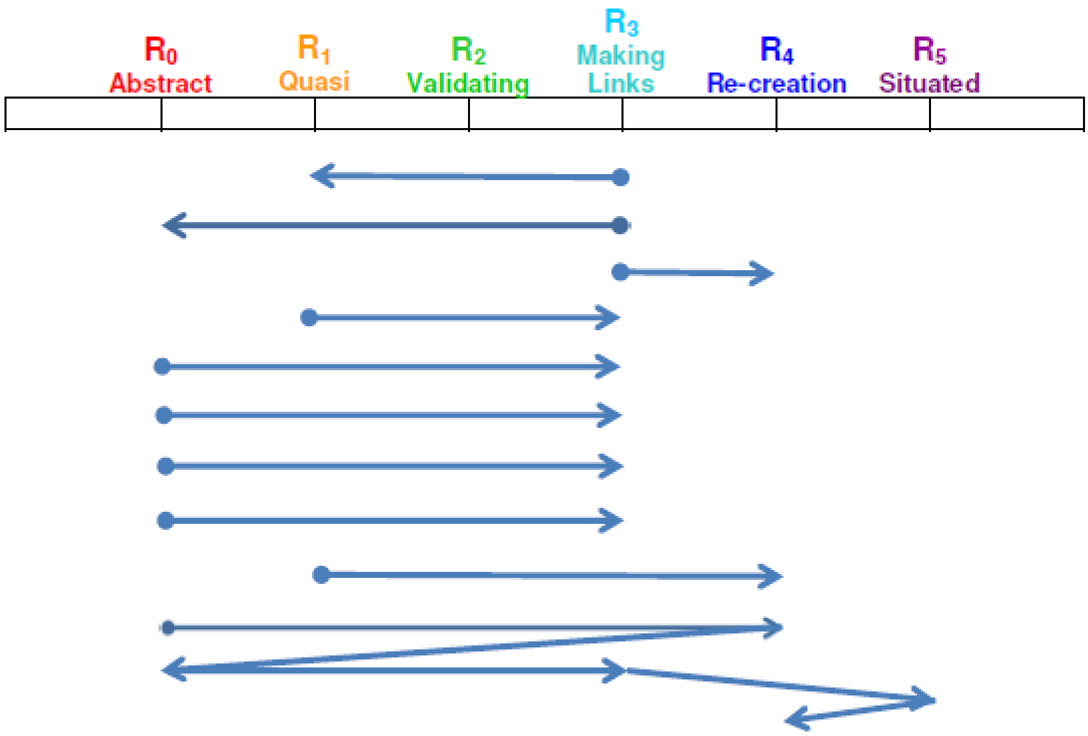


Figure 5b. Sequences of activities: teacher/group 2.

Analysis of the sequences of classroom activities shows that in general teacher/group 1 tended to move from the right hand side of The Context Continuum (Real Life context) (Figure 5a) to the left hand side of The Context Continuum (Education (mathematical) context). In contrast, teacher/group 2 generally tends to move from left to right along The Context Continuum, i.e. from an Education (mathematical) context towards a Real Life context. The differences in direction are consistent with the differences in methods identified. For teacher/group 2, focus on the quasi-mathematical word problems, which are prevalent in adult numeracy test questions, is a key focus, therefore it perhaps makes sense to start with the more abstract and move towards more real life contexts. In contrast, for teacher/group 1, opportunities to focus on the class's situated, real life uses of mathematics provided a more important focus, hence starting on the right-hand side of the continuum and moving left perhaps makes more sense.

Data from the teacher interviews suggest there may be other contributing factors. For example, Teacher 1 had less positive experiences of maths learning at school, so from first-hand experience she is aware of how a lack of understanding and feelings of failure can have a long and lasting effect on people. A focus on the individual, or the personal as the starting point for her teaching would therefore make sense. In fact Teacher 1 explained that she "always start[s] with what they know" and that she avoids 'contrived' contexts that are likely to be meaningless to some learners. In contrast, generally Teacher 2 seemed able to make her own sense of the maths she was taught, whether or not it was related to a context. Consequently she did not appear to have any real barriers to learning mathematics herself. Teacher 2 explains how in dealing with a group of learners with diverse interests and experiences, she tries to give multiple examples, to do things that people are familiar with in some way, to hopefully enable them to make their own links. Therefore the data suggest that teachers' personal experiences, as well as learners' contexts and course aims, may influence their approaches to teaching.

Discussion, implications and conclusions

The findings identified that both teachers in this study enabled learners to apply their new numeracy knowledge and skills to real life contexts, in addition to a range of other aims. These findings are relevant to other numeracy teachers including those in different contexts (e.g. vocational teachers) as well as those in different countries, where the drive for qualification outcomes sits alongside educators' aims of making the learning useful beyond the qualification outcome.

In particular, this paper set out to answer the following questions:

- To what extent are teachers successful in enabling learners to apply the mathematics they learn?
- What methods do teachers employ in order to help bridge the gap between abstract mathematics and useable numeracy?

Whilst unsurprisingly (Coben, 2000; Swain et al., 2005), applying numeracy in real-life contexts was not an aspiration for learners on joining their course, nonetheless teachers' methods increased learners' knowledge, understanding and confidence and also their awareness of, and their ability and motivation to use their mathematics knowledge to support activities and problem solving in their own lives.

The way both teachers achieved this was primarily by focussing on developing the underpinning conceptual understanding of learners as well as focussing on linking these abstract procedures and concepts to real life applications relevant to learners. The differences in approaches, where Teacher 1 placed emphasis on situating the mathematics in learners' real life contexts and Teacher 2 placed emphasis on using quasi (contextualised but perhaps unrealistic) examples, could be explained by different course outcomes, learners' contexts, as well as teachers' own experiences of learning mathematics in shaping their beliefs and approaches to numeracy teaching. Both teachers used all six approaches identified on the Context Continuum. Further research would be needed to establish whether the course outcomes, learners'contexts, or teachers' natural approaches were more influential in guiding their course planning, and to what extent these approaches could be adapted or developed.

The different sequences of activities suggest that it does not necessarily matter which direction the order of learning activities occur, i.e. starting with real life situations and moving to the abstract mathematics within them or the other way around, but that either way, learners can gain the confidence and skills to use the maths they have learned *in class* for uses *outside* the classroom. Therefore it seems that, along with developing conceptual understanding, the important factor in the teachers' success is the movement back and/or forth between the difference discourses of mathematics and numeracy (as discussed by FitzSimons, 2006), embedded in discussions with learners which make explicit the links between formal and informal uses of mathematics.

Both classes were discrete numeracy classes in that the learning focussed on numeracy rather than being embedded in a vocational or workplace context. As a result learners had a wide range of backgrounds and experiences, and this sometimes made it difficult for teachers to identify contexts which were truly relevant to all learners. This perhaps explained why Teacher 1 was able to use more situated learning activities, as her learners were all mothers of young children, so they at least had this in common, and learning could be situated in the context of mother-educators supporting the development of their children's numeracy learning. Teacher 2's solution to the diversity was to offer a range of different contexts on a regular basis. Both strategies seemed to work, which suggests that a vocational or workplace context is not essential and that discrete numeracy classes can also support development of numerate skills and attitudes, as long as the teachers have the skills, commitment and drive to make their classes useful to learners beyond any qualification outcome.

The Context Continuum model was useful in classifying the different types of activities used in these discrete numeracy classes so that teachers' approaches and their similarities and differences could be explored and communicated. In using the model again I would consider additionally capturing and analysing the length of time spent on different types of activities. This was not appropriate in the pilot study as, in addition to observation data, the analysis considered interview data, i.e. it included discussions about un-recorded sessions and activities carried out on previous occasions with the same groups. I hope that the model, along with the findings, will be of use to other numeracy teachers or numeracy teacher-educators, and researchers, to support analysis and development of adult numeracy teaching practice. The continuum could also be adapted to be of use to practitioners and researchers of other subjects (e.g. literacy).

References

BSA (2001). *Adult Numeracy Core Curriculum.* London: Cambridge Training and Development on behalf of the Basic Skills Agency (BSA).

Barton (2006). A social perspective on language, literacy and numeracy. In *Reflect*, 5, p. 13.

Coben, D. (2000). Mathematics or Common Sense? Researching 'Invisible' Mathematics through Adults' Mathematics Life Histories. In Coben, D., Fitzsimons, G.E. and O'Donoghue, J., 2000, *Perspectives on Adults Learning Mathematics: Research and Practice* (pp.53–66). [e-book] Hingham, MA (USA): Kluwer Academic Publishers. Retrieved from Anglia Ruskin University Library http://libweb.anglia.ac.uk

Coben, D., Brown, M., Rhodes, V., Swain, J., Ananiadou, K., Brown, P., Ashton, J., Holder, D., Lowe, S., Magee, C., Nieduszynska, S., Storey, V. (2007). *Effective teaching and learning: Numeracy.* London: NRDC.

Corbin, J., and Strauss, A. (2008) (3rd ed). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory.* London: SAGE Publications.

Dowling, P., 1998. *The Sociology of Mathematics Education: Mathematical Myths/ Pedagogic Texts.* London: Routledge.

Fantinato, M. C. C. B. (2009). *Challenges of the ethnomathematical approach in adult education.* In G. Griffiths, and D. Kaye (Eds.), *Proceedings of the 16th International Conference of Adults Learning Mathematics – A Research Forum (ALM) incorporating the LLU+ 7th National Numeracy Conference*. London: Adults Learning Mathematics and LLU+ at London South Bank University.

FitzSimons, G.E. (2006). Adult Numeracy: Crossing the Borders of Discourse. In V. Seabright and I. Seabright (Eds.). Proceedings of the 13th International Conference of Adults Learning Mathematics (ALM) – Crossing Borders – research, refelction and practice in adults learning mathematics. Belfast, NI 16-20 July 2006. s.l.: ALM.

FitzSimons, G.E. (2008). Doing Mathematics in the Workplace: A Brief Review of Selected Literature. *Adults Learning Mathematics: An International Journal, 8*(1), 7-19.

Harris, M., (Ed.) (1991). *Schools, Mathematics and Work.* London: Falmer Press.

Hoyles, C., Noss, R., and Pozzi, S. (1999). Mathematising in practice. In C. Hoyles, C. Morgan and G. Woodhouse (Eds.), *Rethinking the Mathematics Curriculum* (pp. 48-62). London: Falmer Press.

Ivaniĉ, R., Appleby, Y.,Hodge, R., Tusting, K., and Barton, D. (2006). *Linking learning and everyday life: a social perspective on adult language, literacy and numeracy classes.* London: NRDC.

Johnston, B. (1995). Critical numeracy? In S. Kelly, B. Johnston and K. Yasukawa (Eds.) (2003), *The adult numeracy handbook: Reframing adult numeracy in Australia.* Sydney: NSW Adult Literacy and Numeracy Australian research Consortium.

Kanes, C. (2002). Towards numeracy as a cultural historical activity system. In P. Valeroand O. Skovsmose, 2002 (Eds.). *Proceedings of the 3rd International Mathematics Education and Society Conference.* Copenhagen: Centre for Research in Learning Mathematics. April 2nd -7th 2002. Retrieved from http://www.mes3.learning.aau.dk/Papers.htm

Kelly, B. (2009). From the classroom to the workplace and back again: Developing an understanding of numeracy teaching. In G. Griffiths and D. Kaye (Eds.). *Proceedings of the 16th International Conference of Adults Learning Mathematics (ALM) – A Research Forum: Mathematical Eyes – Numeracy Works for Life.* London. 6-9 July 2009. s.l.: ALM.

Kelly, B. (2011). Learning in the workplace, functional mathematics and issues of transferability. In T- Maguire, J.J. Keogh, and J. O'Donoghue (Eds.). *Proceedings of the 18th International Conference of Adults Learning Mathematics (ALM) – A Research Forum: Mathematical Eyes – A Bridge between Adults, the World and Mathematics.* Dublin, Ireland June 2011. s.l.: ALM.

Lave, J. (1988). *Cognition in Practice: Mind, mathematics and culture in everyday life.* Cambridge: Cambridge University Press.

Marr, B., Helme, S., and Tout, D. (2003). *Rethinking Assessment: Strategies for holistic adult numeracy assessment. A resource book for practitioners, policy-makers, researchers and assessors.* Melbourne: Language Australia.

Nunes, T., Schliemann, A. D., and Carraher, D. W. (1993). *Street Mathematics and School Mathematics.* Cambridge: Cambridge University Press.

Ofqual (2012). *Criteria for Functional Skills Qualifications.* [online] Coventry: Office of Qualifications and Examinations Regulation. Retrieved from http://www2.ofqual.gov.uk/downloads/category/67-functional-skills-qualification-criteria

Oughton (2009). A willing suspension of disbelief? 'Contexts' and recontextualisation in adult numeracy classrooms. *Adults Learning Mathematics: An International Journal, 4*(1), 16-31.

Punch, K.F. (2009). *Introduction to Research Methods in Education.* London: SAGE publications.

Robson, C. (2011). *Real world research: A resource for Users of Social Research Methods in Applied Settings.* (3rd ed). Chichester: Wiley.

Safford, K. (2000). Making Peace in the Maths Wars. *Focus on Basics: connecting research and practice,* 4 (B). Retrieved from http://www.ncsall.net/index.html@id=318.html

Saxe, G. (1988). Candy selling and math learning. *Educational Researcher, 17*(6), 14-21.

Swain, J., Baker, E., Holder, D., Newmarch, B., Coben, D. (2005). *'Beyond the daily application': making numeracy teaching meaningful to adult learners.* London: NRDC.

Swain, J., Swan, M. (2007). *Thinking Through Mathematics: Research report.* London: NRDC.