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Chief Editor
Janet Taylor

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Objectives

Adults Learning Mathematics – an International Research Forum (see http://www.alm-online.org/) has been established since 1994, with an annual conference and newsletters for members. ALM is an international research forum bringing together researchers and practitioners in adult mathematics/ numeracy teaching and learning in order to promote the learning of mathematics by adults. Since 2000, ALM has been a Company Limited by Guarantee (No.3901346) and a National and Overseas Worldwide Charity under English and Welsh Law (No.1079462). Through the annual ALM conference proceedings and the work of individual members an enormous contribution has been made to making available theoretical and practical research in a field which remains under-researched and under-theorised. Since 2005 ALM also provides an international journal.

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- Research and theoretical perspectives in the area of adults learning mathematics/numeracy
- Debate on special issues in the area of adults learning mathematics/numeracy
- Practice: critical analysis of course materials and tasks, policy developments in curriculum and assessment, or data from large-scale tests, nationally and internationally.

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Adults Learning Mathematics - An International Journal

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Volume 2 (1) – November 2006

In this Volume

Editorial

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This is the third issue of *Adults Learning Mathematics — An International Journal.* A number of changes have taken place since the inception of the Journal in 2005. For this issue we now have a newly constituted Editorial Team of which I am the Chair. My colleagues on the Editorial Team and I would like to take this opportunity to acknowledge and thank Gail FitzSimons, the previous Chief Editor, for her help during this changeover period and her dedication and professionalism during the establishment of the journal. Building on Gail's and the previous team's work we plan an exciting future for the journal with an increased number of contributions supplemented each year by special issues on topics of particular interest to the Adults Learning Mathematics research community.

In this issue we again demonstrate the international flavour of our publication with two papers; one from the United Kingdom and one from Austria. Wolfgang Schlöglmann's paper comments upon the affective conditions within an adult further education program for mathematics in Austria. The paper has an historical flavour containing both reflective and empirical components. He initially reflects on why lifelong learning in mathematics is important and then investigates the views of students in these courses through statistically analysed questionnaires focusing on students' values of higher education and their motivation for participating. Using the results of this empirical study the author discusses the state of mathematics education within the Austrian adult education system.

Diana Coben from United Kingdom also reflects upon the state of mathematics education for adults but through a different lens. Zooming in on our understanding of the nature of numeracy, mathematics and literacy, she reflects on our conceptualisation of research in these areas hoping to partially clear a pathway forward in a still evolving field, placing strong emphasis on the interrelationship between practice and research. This paper also has an historical focus as the author clarifies the many milestones of research, policy and practice that have led mathematics education for adults to its present location and structure.

Finally, I must thank the reviewers of this issue for their professional, timely and constructive reviewing of manuscripts. Without them this issue would not have been possible. I also extend my personal thanks to my colleagues in the Editorial Team, Mieke van Groenestijn, and Juergen Maasz for their encouragement and support in this changeover period and their continued enthusiasm as we move together into future issues.

Lifelong mathematics learning – a threat or an opportunity? Some remarks on affective conditions in mathematics courses.

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Abstract

In the last decades of the 20th century lifelong learning became a key concept for solving social and economic problems in highly industrialized countries. Lifelong learning was the societal response to conditions in a rapidly changing economic world. Humans have always learned in the normal course of their lives, but this learning was informal. Modern conditions require formal education in formal courses with a controlled output. In many reports by international organizations lifelong learning is seen as a necessity and also as an opportunity for adult learners. But does this picture reflect the affective situation of all adults in mathematics courses? Many adult learners in mathematics courses are unemployed, and instead of being willing participants, they were forced into courses which include mathematics as a compulsory component. They have not chosen to participate in a learning program. This paper discusses the motives of adult learners for pursuing mathematics courses, as well as their emotional state in these courses, by using the results of a previous empirical study of the state of mathematics education within the Austrian adult education system.

Key words: Lifelong learning, participation, cognitive, affective, basic skills, motivation, Austria.

Lifelong learning – a consequence of technological development and globalisation?

For a long time, only philosophers and pedagogues discussed lifelong learning (Aspin, Chapman, Hatton, & Sawano, 2001). In the final decades of the 20th century, lifelong learning became a key concept in solving social and economic problems in highly industrialized countries. International bodies such as UNESCO, the OECD and bodies within the EU declared that education has to be a lifelong undertaking (Aspin et al., 2001; FitzSimons, Coben, & O'Donoghue, 2003). That means that education could no longer be considered as a process that finishes at the beginning of adulthood, and adults could no longer be considered experts in their job based only on the competencies acquired in their youth. To understand this development we must understand the power of change and its driving force.
Highly industrialized countries are characterized by the use of technologies because technology determines the structure of society (the philosopher Heinz Hülsmann uses the term

"technological formation" (Hülsmann, 1985)). While Hülsmann emphasizes the significance of the natural sciences for the development of technologies, it is important to note that the technological formation of our society is also a consequence of other sciences, particularly the social sciences and economics (Schlöglmann, 1992). That means that research leads to technological development and consequently to a change in competencies required to fulfil the demands of the technological change.

Lifelong learning was the societal solution to conditions arising from rapid economic and technological change. Lifelong learning, according to this view, has various functions:

> [We] suggest that lifelong learning policies currently introduced across the globe could be classified into four categories: (1) a compensatory education model, which aims at compensating for inequality in access to initial school education, and improving basic literacy and vocational skills; (2) a continuing vocational training model, which aims at coping with changes occurring in the workplace and solving problems arising from unemployment; (3) a social innovation model, or civil society model, which aims at overcoming social estrangement and promoting socio–economic transition and democratization; (4) a leisure orientated model, which aims at enriching the leisure time of individuals and personal fulfilment. (Aspin et al., 2001, p.XXII)

The concepts embodied in these four categories address the problem of lifelong learning and its role within a society in a very general way. Within specific nations and societies, these four categories are realized in a variety of ways. It should also be kept in mind that even in highly industrialized countries – which are the focus of the present paper – the context for lifelong learning can be very heterogeneous. Although in industrialized countries, too, a need exists to eliminate inequalities in education and improve basic literacy and vocational skills, there are nevertheless distinctions that ought to be made: for instance, between people who have passed through the education system with a low level of achievement and people who have emigrated to these highly industrialized nations from countries with a weak education system (Note: At least in Austria many refugees from war or political persecution come from countries with a strong education system). Moreover, in economically advanced countries, more people want a higher level of education.

When authorities speak of lifelong learning, they usually have in mind the continuing vocational training model:

> This economic justification for lifelong learning is highly dependent upon two prior assumptions: one, that 'lifelong education' is instrumental for and anterior to some more ultimate goal; and secondly, that the purpose of lifelong learning is highly job related and economic–policy–dependent. This approach, as we have seen from discussion at the OECD (1996), UNESCO (1996), the European Parliament (1995) and the Nordic Council of Ministers (1995), has now been rejected as presenting too narrow and limited an understanding of the nature, aims and purpose of 'lifelong education. (Aspin, et al., 2001, p.XX).

From the point of view that lifelong learning is a means of coping with the consequences of technological development and globalisation - bearing in mind that governments and supra-national bodies often resort to rhetorical set phrases when referring to lifelong learning (FitzSimons et al., 2003) - we must extend the concept of lifelong learning to encompass the needs of people in a democratic society. The concept of lifelong learning ought to be seen as a social innovation model or civil society model that stresses structural and political aims. This concept is often called “critical citizenship” and means “engagement with discussions and debates about individual, family and public well-being, and about describing, appreciating, evaluating, deciding on future directions of public policy” (Evans & Thornstad, 1994, p.65).

While the third category introduced by Aspin, et. al. (2001) in the quotation above emphasizes people as social beings (the social innovation model), the fourth category (the leisure model) emphasizes the individual side of people.

In order to account for all of these aspects of lifelong learning, Aspin and Chapman (2001) in another paper mention three elements that are necessary in lifelong learning:

> The central elements in what we have described as the 'triadic' nature of lifelong learning – for economic progress and development; for personal development and fulfilment; for social inclusiveness and democratic understanding and activity – are now seen as fundamental to bringing about a more democratic policy and set of social institutions, in which the principles and ideals of social inclusiveness, justice and equity are present; and a richer range of provision of those activities on which individual members of society are able to choose to spend their time and energy, for the personal rewards and satisfactions that they confer. (Aspin & Chapman, 2001,p.29)

This quotation expresses an important point. Lifelong learning is often seen as institutional organized learning, repressing the fact that life and work is always combined with learning. But this kind of learning – learning in context, "situated learning", workplace learning – is not the focal point when one speaks of lifelong learning. Consequently democratic societies ought to broaden the scope of institutional learning, and thereby create more opportunities for adults to pursue further education.

Why lifelong learning of mathematics?

Present discussion of lifelong learning does not generally address the role of content. Rather, the focus is usually on catch-phrases such as globalisation and technological development, particularly in information technology. One may therefore ask, why should the lifelong learning of mathematics be a viable option? To answer this question, we have to look at the role of mathematics in society and technology.

> 1. Mathematics in our society is a tool used to organize our everyday life. Mathematics is also used as a tool in many occupations. The use of mathematical black boxes in the form of computer programs gives them a new quality.
>
> 2. Mathematics is a part of our culture. Democratic principles such as equality, justice and so on need an operational concretization. On the one hand, democracy demands a means for communicating and discussing principles in a rational way. Mathematics, with its close relationship to rationality, is our concept to do this. On the other hand, democracy demands operational procedures for its concrete implementation. Mathematics is again the tool that facilitates this. (Schlöglmann, 2002, pp. 143-144).

This quotation stresses the significance of mathematics in the democratic organization of our society as well as in everyday life. But this was also the significance of mathematics in earlier times. If mathematics is to become an important part of lifelong learning today, the teaching of the subject must reflect the new demands of our time. Analyzing this situation, mathematics also has a central role in the development of new technologies and this role gives mathematics a central position in processes occurring in highly industrialized countries (Schlöglmann, 1992, 2002). Briefly, we can say:

> Mathematics is the basis of all new technologies, since algorithms are the basis of software, and materialized mathematical logic is the basis of computer hardware (microprocessors).
> Mathematical theories and models are becoming increasingly important as the basis of a variety of forward-looking alternatives, in simulating planning in economic and technical fields, for example, in control, automation and construction; or in political and social life.
> Mathematics has long been established as the scientific core of the natural sciences and, to an increasing extent, also of social science. (Maasz & Schöglmann, 1988)

This characterization opens the way to understanding the meaning of mathematics in the lifelong learning concept. In the light of the categories of lifelong learning given in the "triad" of Aspin and Chapman (2001), the role of mathematics in lifelong learning may be taken to be the following:

- As the basis of new technologies, mathematics is central to economic progress and development.
- Mathematics is used to structure our everyday life and democratic processes, and is therefore a necessary precondition for social inclusiveness and democratic understanding and activity.
- As part of our cultural development, mathematics can also be valuable for personal development and fulfilment.

An empirical study

In the above two sections, I have argued on theoretical grounds that lifelong learning in general, and lifelong mathematics learning in particular, is important for the functioning of highly industrialized societies. But it is the "reality" of lifelong learning that is important for research and practice. Hence, between 1993 and 1997, Jungwirth, Maasz and the present author explored the state of mathematics education within the adult education system in Austria (Jungwirth, Maasz, & Schlöglmann, 1995). Adult education in Austria is characterized by the diversity of agencies offering programs: state-run institutions of adult education; community services; services for vocational education run by the trade union or by the federation of industry; universities; industrial enterprises; and the education departments of public or private service enterprises. This diversity is also reflected in the numerous courses and programs on offer, in mathematics as in other subjects. In our empirical study, we distinguished between the courses according to whether mathematics teaching explicitly took place or whether mathematical concepts and methods were used in an implicit way (for instance, in courses in CAD (computer-aided design), Excel or other computer software). Furthermore, courses could also be distinguished by the level of mathematics (basic, upper secondary or university) as well as whether they were part of general education or vocational education. To explore the state of adult education in mathematics (this part of the research was done by Jungwirth) we selected 419 participants (80.5% men and 19.5% women) from 19 courses at 7 institutions within the Austrian adult education system. In all of the courses, mathematics was either explicitly or implicitly included, and the courses ranged from basic (10.3% of the participants) to upper secondary level (36.3%) and vocational education (53.4%). The extensive questionnaire elicited each participant's personal data including sex, age, vocation and education, and contained questions characterizing the course of study, the institution, as well as the participant's attitude toward mathematics and school; their use of computers and mathematics at work; their motivation for participation; their appraisal of the value of further education; the goals and priorities of the course they were studying; the participant's learning problems; and suggestions for improvements in mathematics education. In the second part of the questionnaire, we asked for the participant's beliefs and attitudes toward mathematics. Besides the questionnaire for the participants, we also asked the teachers of the courses to answer another questionnaire with partly analogous questions. This quantitative part of the study was complemented by interviews with participants and teachers. Even though the data were collected between 1993 and 1997, they are still relevant today because the situation in adult education in Austria has not changed; moreover, the state of adult education in mathematics is more stable than in other subjects. Mathematics teaching in adult education courses and in schools for adults has a high level of

stability. Although the responses to some of the items are correlated with economic factors (we elaborate on this below), the categories are still relevant.
In the present paper, we only refer to a small portion of the results of the study, namely those pertaining to the motivation for participation in an adult education course and to the individual's attitudes toward mathematics and mathematics learning.

Results

After investigating the data from the survey, we found that the frequencies were correlated with the year the questionnaire was administered, as well as with the type of adult education the participants were engaging in. For example, the low response for the motive, “job threatened”, can be accounted for by the rosy state of the labour market at the time. (In 1993, the Austrian labour market was strong with low unemployment.) Also, participants in basic programs cited “improvement of personal education” (74.4%), “increased vocational demands” (62.8%), “joy of learning new subjects” (60.5%) and “to cope with life problems” (48.8%) as their main motives for taking adult education courses (Table 1). It should be noted that in interviews, some of these participants cited their own physical condition and the necessity to prepare for a new job as their main reasons (many were undertaking vocational training because they had to change jobs for health reasons); however, this category did not appear in the questionnaire. In contrast, the motives profile of the vocational education group consisted of “acquisition of latest professional knowledge” (62.9%), “increased vocational demands” (57.9%), “improvement of personal education” (57.9%) and “security in economically unstable times” (48%).

To get a better insight into the structure of participants’ motives, principle component analysis was used to extract the factors of motivation (explained variance 63%). The results showed four significant factors at work in motivating the participants to take part in adult education courses. The first factor was “professional and economic advancement” and includes preparation for a better position as well as protection of the position already attained. The second factor was “personal motives” such as the desire for more knowledge, as part of the individual's general thirst for knowledge. The third factor was “general professional performance orientation”, which means that the participants considered their job to be significant to a greater degree than usual. The fourth factor was a “change in job”, the change being either an aspiration or a forced move.

Table 1. *Percentage of students who agreed with nominated motivation for participation in adult education* (n = 419)

Motivation for participation in adult education	Completely agree	Partially agree
Job threatened	6.5%	8.2%
financial gain	42.1%	30.3%
increased vocational demands	51.9%	21.4%
security in economically unstable times	43.0%	26.9%
dissatisfaction with job conditions	20.9%	21.2 %
higher position in the company	41.1%	23.1%
acquisition of latest professional knowledge	57.0%	22.8%
changing scope of duties	30.0%	26.7%
improvement of personal education	65.1%	21.2%
to cope with life problems	24.3%	19.5%
Joy of learning new subjects	54.6%	32.2%

In order to obtain a better understanding of participants' motives, it was fruitful to consider their opinion of the value of Higher Education (Table 2). As a word of explanation about this issue, we should say that the concept of "Bildung" has a long history in the German educational tradition. "Bildung" means more than "education" in a narrow sense. An individual that is "gebildet" not only has knowledge and the ability to acquire new knowledge, but he or she is also able on the basis of this knowledge to develop their inner abilities to the full extent (see Klafki, 1975). The significance of Higher Education (höhere Bildung) in German tradition can give a better insight into the participants' motives.

Table 2. *Percentages of students who agreed with nominated value of Higher Education* (n = 419)

The value of Higher Education lies in	Completely agree	Partially agree
increasing one's reputation	29.3%	32.0%
understanding society better	48.1%	26.7%
increasing one's job opportunities	78.1%	15.4%
earning more money	57.0%	27.6%
understanding political affairs better	23.6%	33.4%
living more consciously	27.9%	27.2%
organizing leisure time better	14.7%	20.2%

Principle component analysis was also used here to extract the independent factors (explained variance 70%). The results suggested a model with three factors: the value of Higher Education lies in (1) its effect on vocational advancement, financial security and personal prestige; (2) its potential for personal development; and, (3) its contribution to a better understanding of society. We can see that these factors – explaining the value attached to Higher Education by the participants – are similar to the factors of the participants' personal motives. A closer look at the data showed that more men value Higher Education for its improvement of financial security than women (59.1% versus 48.1%). People with a lower level of education prefer Higher Education's potential for personal development, while younger people prefer its contribution to a better understanding of social and political conditions.

Regarding the mathematics content in the participants' courses, we found that in many cases adults did not have any choice in studying the mathematics component. For instance, if a participant desired to acquire a certificate for completing a lower secondary or a upper secondary school, they had to study mathematics as part of the program. Therefore, in order to understand the learning conditions experienced by adults in their further studies in mathematics, it was of interest to know their attitude toward their past experience in mathematics education at school, as pupils. A heterogeneous picture emerges:

- Interested in mathematics in school (57.7% yes, 37.7% no)
- Had ability in mathematics in school (50.2% yes, 42.5% no)
- Good rapport with mathematics teachers at school (60.3% yes, 30.3% no).

The correlation between interest and claimed ability is high ($r = 0.63$). Those who were interested in mathematics had no problems with mathematics (75%) and had good rapport with teachers (72.9%).

Regarding the adult education system in Austria, two groups with very different motives and personal situations could be discerned. Members of the larger group chose to participate in adult education, and viewed learning as an opportunity to increase their chances in the labour market, to raise their prestige and so on. They were highly motivated to learn. They usually had a positive recollection of their school experience. Members of the other group, in contrast, had been compelled to participate in adult education (in many cases they had lost their job or they had to change their job on health grounds). The existence of this group did not emerge from the data of the questionnaires (we had not asked the right questions to identify this group), but from the interviews with the participants as well as the teachers: from these we received hints as to the problems these adult learners faced. The number of persons for whom these conditions were relevant depends strongly on the state of the labour market. However, the existence of this group is not a specifically Austrian problem – see the paper by Wedege & Evans (2006), who consider the problem of adult learners who had a resistance to learning in childhood schooling.
Mathematics learning is not just a cognitive process. Mathematics education research in the last few decades has addressed the influence of affect on mathematics learning. While most of the research has been carried out in the areas of student and teacher education, beliefs and attitudes in relation to mathematics are very important factors which influence mathematics learning, particularly in adult learning (see also Evans (2000)). From narratives given by adult learners in particular, we know that many adults had negative experiences with mathematics learning in school (see Ingleton & O'Regan, 2002; Stroop, 1998; Adults Learning Mathematics Conference Proceedings). Hence below we consider influences on the emotional states of members of the second of the above two groups.

Must learn mathematics – some remarks on emotional influences

We ought to bear in mind that individuals who are forced into further education in order to prepare for a new job had originally lost their job, for instance, through an accident that incapacitated them, or because of company restructuring. Learning for a new job is not their decision, it is forced on them by circumstances. To understand the circumstances of such a person, we may use the concept of "situated learning" developed by Lave and Wenger (1991). This concept is applicable to many participants in Austrian adult education because most participants, after their compulsory schooling, are educated in companies as apprentices, while simultaneously – amounting to a much smaller proportion of their time – undertaking part-time studies at a vocational school. They acquire their qualification by working in companies, and therefore in most cases, at their previous workplace, they had been members of a "community of practice" (Lave and Wenger, 1991). In order to be accepted into such a community, a newcomer or apprentice must go through a long process of practice within the framework of legitimate peripheral participation:

> Viewing learning as legitimate peripheral participation means that learning is not merely a condition for membership, but is itself an evolving form of membership. We conceive of identities as long-term, living relations between persons and their place and participation in communities of practice. Thus identity, knowing, and social membership entail one another (Lave & Wenger, 1991, p. 53).

The goal of all learning processes amounts to becoming an experienced member of the community. Such a position requires numerous skills, experience of responsibility for various tasks, knowing codes within the community and so on. The result is a place within the community. A person is part of the community, part of the routine of a company (Schlöglmann, 2003). All of these together bestow a sense of prestige and of identity.

> Knowing is inherent in the growth and transformation of identities and it is located in relations among practitioners, their practice, the artefacts of that practice, and the social organization and political economy of communities in practice (Lave & Wenger, 1991, p. 122).

It is important to bear in mind that this kind of knowledge, together with the experience a person needs to gain a place within such a community, is often not explicitly and fully communicated. Therefore, acknowledgement of such knowledge is only possible within the community of practice, and is often without value outside the community because in many cases important parts of this knowledge are not transferable to other communities of practice.

For older people, in particular, the process of situated learning entails a confrontation. Although learning gives an inexperienced person the opportunity to gain experience – which is the process of reproduction of the community of practice - it has the further consequence of replacing older people by younger people:

> There is a fundamental contradiction in the meaning of newcomers and old-timers of increasing participation by the former, for the centripetal development of full participants, and with it the successful production of a community of practice, also implies the replacement of old-timers (Lave & Wenger, 1991, p.57).

Old-timers are replaced particularly keenly when experience is not valued by a company, and when they are perceived as inflexible and therefore unable to fit in with company restructuring. The upshot is a loss of self-confidence.

> I will argue that non-participation can take many forms – being an outsider, being a peripheral participant, or being marginalized – each with a different implication for the resulting identities. (Wenger, 1998, p.148)

Furthermore, many of these people have bad recollections of their time at school. Narratives give us an insight into these recollections (Ingleton & O'Regan, 2002; Stroop, 1998) and into their implications for mathematics learning. Taken together - loss of prestige and identity; marginalization of experience; low self-confidence; and low confidence in one's ability to learn mathematics as a consequence of the school learning experience - these influences make for emotional difficulties during new learning processes.

Is mathematics learning possible?

As argued above, learning in adult further education can be difficult. Successful learning often also requires motivation of learners by teachers, particularly learners who want to learn mathematics. Teachers in adult further education report anxiety and learning blockages in mathematics learning processes (see also Lindenskov, 1996 and Wedege, 1998). To understand learning better, we may use a model introduced by Hannula (1998). Hannula sees the "landscape of mind" continuously changing. The process of change is stimulated by information arriving from the senses, as well as by mechanisms and structures within the brain. One central principle of Hannula's model is the distinction between dynamic and static systems of representation. Dynamic representation includes all systems that are activated at a given moment. Static representation encompasses all the information stored in the memory systems of the various representational systems. The structure of each static representation – cognitive and affective schemata – is crucial for all processes. The schemata representing the static representations are changeable via learning processes. In all situations of interest to us, many brain systems are activated; in particular, so is a certain system that generates so-called “background emotions” (Damasio, 1999). We can observe these background emotions – if a person is discouraged or enthusiastic, down or cheerful – by interpreting physiological reactions called body language. Background emotions influence cognitive processes in a positive or negative way. Let me describe this through an example. In class, a teacher explains the solution method for solving equations in one variable; then he or she writes an equation on the blackboard. However, from the student's viewpoint, the information constituting the situation might be different. A successful student sees the different signs on the blackboard and grasps the principles – the structure of the terms – necessary to solve the equation. Another student who is not in a position to handle variables correctly might see the same equation as a set of signs with no structure. The student's fear, present as a background emotion during mathematics lessons, might be intensified, thus preventing the learning process from succeeding.

Teachers in adult education can help adult students manage their learning situation. Above, we have discussed reasons for negative background emotions. The student has lost his or her position as an experienced professional and this position is likely to have been a crucial part of their identity – now, like children, they have to learn new things. In many courses, adult participants have had no formal education since their school years. They often feel unable to learn, because their learning processes have occurred over a long time, whereas they recognize that mathematics learning requires intense processes of abstraction and generalization. A frequent consequence of this is a student's fear that his or her memory is unable to hold all the abstract concepts required. Formal learning often brings back memories of mathematics learning in school and it is generally accepted that for many adults these memories are bad. It is important to impart onto the adult student the importance of their knowledge, in situated learning processes; to give them the feeling of having valuable knowledge at their disposal. Using situated knowledge as a starting point for mathematics learning processes is possible (Schlieman, 1999). Processes of abstraction and generalization must be done very carefully with resort to situated knowledge. Creating a successful learning process ought to include steps to help students better manage their fear (Goldin (2002) uses the term "meta–affect" to denote the process of monitoring and regulation of emotions) and to change their emotional background. However, it is important that students actually understand mathematics by doing real mathematics, and are not learning a diluted form of mathematics via what the present author calls “replacement strategies” (Schlöglmann, 1999). In the latter, the learner does not try to understand mathematical concepts because the learner thinks that he or she cannot understand mathematics. The learner looks for other strategies to solve a mathematical task; for instance, he or she might try to find a keyword in the text – such as "more", which might indicate that addition is required, or "fewer", which might mean that subtraction is required. Another strategy is to enter all the numbers contained in the text into the most recently learned algorithm. A characteristic of this replacement strategy is that the understanding of the mathematical concept and the analysis of a task with a mathematical flavour are replaced by strategies that have as an input non-mathematical features of the text.

Conclusion

Lifelong learning is one of the catchphrases that comes with globalization. International bodies in particular view lifelong learning as an appropriate answer to the demands of a rapidly changing labour market. The study presented here demonstrates that many adults view learning as an opportunity – an opportunity to improve their professional and economic positions and to secure their personal status within the companies and communities. These employees also see learning as an opportunity to make their lives richer, as well as a necessary prerequisite for participating in democratic life. Knowledge and possessing qualifications are important parts of these adults' lives.

However, current socio-economic conditions also lead to some adults feeling like losers amidst the present-day developments because they are unable to fulfil the demands made of them by the economy. The number of people belonging to this group is strongly correlated to economic trends. They are forced to participate in adult education courses and have not chosen to do so. They do it because they must. Many have had bad experiences learning at school and see adult education as a continuation of school learning. Mathematics in particular is often associated with negative memories, and so people try to avoid using mathematics in their everyday or vocational lives. This leads to a problematic affective situation in adult-educational mathematics courses.

In our study we were able to identify both these groups: the winners, with their positive attitude towards learning – including mathematics learning; and the losers, who view learning, especially mathematics learning, as a threat.

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What is specific about research in adult numeracy and mathematics education?

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Abstract

After decades of neglect, adult numeracy and mathematics education are coming to be recognised as worthy of serious research but the area is beset by conceptual difficulties. Adult numeracy and mathematics may at last be 'on the educational research map', but where exactly are they on the map? This article explores the question of what is specific about research in adult numeracy and mathematics education. It reviews ways of conceptualising adult numeracy and mathematics education for research purposes and considers the implications of these conceptualisations for research and for the development of the field.

Key words: conceptualisations, adult numeracy, mathematics education, policy, research, development frameworks

Introduction

In the latest International Handbook of Research on Mathematics Education, it is suggested that:

- ….adult mathematics teaching and learning deserve attention in their own right;
- practice and research in adult mathematics education demand a broad conception of mathematics that is not limited to specialized mathematics…;
- there is a coalition of interests in the field across a wide spectrum of related or contributing disciplines;
- there is a recognition that research must be closely linked with practice in a field where development and improvement in practice have priority status; and
- the community of researchers is truly international...

(FitzSimons, Coben, & O'Donoghue, 2003, p.117)

The inclusion of an adult-focussed chapter in the International Handbook attests to the growing international recognition of the importance of research and development in this area. While most research about mathematics education focuses on children (Dossey, 1992), adult mathematics teaching and learning both deserve, and are beginning to receive attention in their own right. Adult numeracy and mathematics are at last 'on the educational research map', but where exactly are they on the map and what is specific about research in this area?

In attempting to answer these questions, I shall first explore debates in the international research community, including the relationship between numeracy, mathematics, adult literacy and lifelong education, before turning to consider what kind of studies should be prioritised, given that "research must be closely linked with practice in a field where development and improvement in practice have priority status" (FitzSimons et al., 2003, p.117).

Adult numeracy and mathematics teaching and learning

The conception of mathematics implied by adult mathematics education is broad and inclusive, encompassing diverse areas of activity, including:

> specialized mathematics and service mathematics (as in higher education), school mathematics, vocational mathematics, street mathematics, mathematics for everyday living, and adult numeracy. (FitzSimons *et al*., 2003)

Against this background, the specificity of adult numeracy and mathematics teaching and learning is the subject of a wide-ranging and passionate debate amongst researchers and practitioners, much of it conducted through Adults Learning Mathematics – A Research Forum (ALM).

A key feature of the debate has been attempts to map the position of adult numeracy and mathematics teaching and learning (which I shall abbreviate to ANMTL) in relation to neighbouring fields of research and practice in order to establish what is specific about it. In one sense this is a question of positioning ANMTL amongst what Becher calls the 'academic tribes and territories' (Becher, 1989; Becher & Trowler, 2001). It matters because if research in ANMTL is to develop and inform practice and policy, it needs to have a sound academic base. Arguably this is what has been happening through the community of researchers and practitioners gathered together through ALM and other national and international fora, such as successive Working Groups of the International Congress on Mathematics Education (ICME). Becher concludes that groups of academics representing a discipline are closely linked to the characteristics and culture of the professional knowledge domain to which they belong. This is true of academic researchers in ANMTL, who reflect the diversity of ANMTL as a field of practice in their professional backgrounds as, for example, adult numeracy, literacy or ESOL (English for Speakers of Other Languages) practitioners, university lecturers teaching Mathematics as a service subject, tutors preparing students for access to further study or training for which Mathematics is required, teachers of vocational subjects, etc..

So how does ANMTL relate to the wider field of education research? In the *International Handbook* it is situated within the field of lifelong education and lifelong learning, encompassing ideas such as equality of educational opportunity, democratisation of education, and self-actualisation (Knapper & Cropley, 2000). Here it should be noted that the field of adult and lifelong education and lifelong learning is itself emergent rather than well-established in research terms. Like ANMTL, it is beset by difficult conceptual issues and has had to define itself in relation to a research field dominated by studies of children's education (Field & Leicester, 2000).

Within lifelong education, ANMTL practice and provision is located at the intersection of what Bishop (1993), building on the work of Coombs (1985), has identified as Formal Mathematics Education (FME), Informal Mathematics Education (IFME) and Non-formal Mathematics Education (NFME). These categories are developed in the *Handbook* in relation to ANMTL as Formal Adult Mathematics Education (FAME), Non-formal Adult Mathematics

Education (NFAME) and Informal Adult Mathematics Education (IFAME) (FitzSimons *et al*., 2003). FAME is provided through the formal and institutional structures which society intentionally establishes for this purpose (Bishop, 1993, p. 3) and involves

> full-time, sequential study extending over a period of years, within the framework of a relatively fixed curriculum [It is] in principle, a coherent, integrated system, [which] lends itself to centralized planning, management and financing. (Coombs, 1985, p. 24)

NFAME is part-time, shorter in duration than FAME, focussing on more limited, specific, practical types of knowledge and skills of fairly immediate utility to particular learners (Coombs, 1985, p. 24). It is an "organised, systematic educational activity, carried on outside the framework of the formal system, to provide selected types of learning to particular subgroups in the population" (Coombs, 1985, p. 23). IFAME is:

> The life-long process by which every person acquires and accumulates knowledge, skills, attitudes and insight from daily experiences and exposure to the environment. […] Generally informal education is unorganized, unsystematic and even unintentional at times, yet it accounts for the great bulk of any person's total lifetime learning - including that of even a highly 'schooled' person (Coombs, 1985, p. 24).

The interdisciplinary nature of ANMTL is explored by Wedege and colleagues (Wedege, Benn, & Maaß, 1999, p.57) who locate it "in the border area between sociology, adult education and mathematics education". The research domain is described as a moorland, rather than a bounded field, because, like moorland, the land is wild and uncultivated. In this conceptualisation, adults learning mathematics are at the centre and adult education, mathematics education, and mathematics are the closest disciplines, as shown in Figure 1:

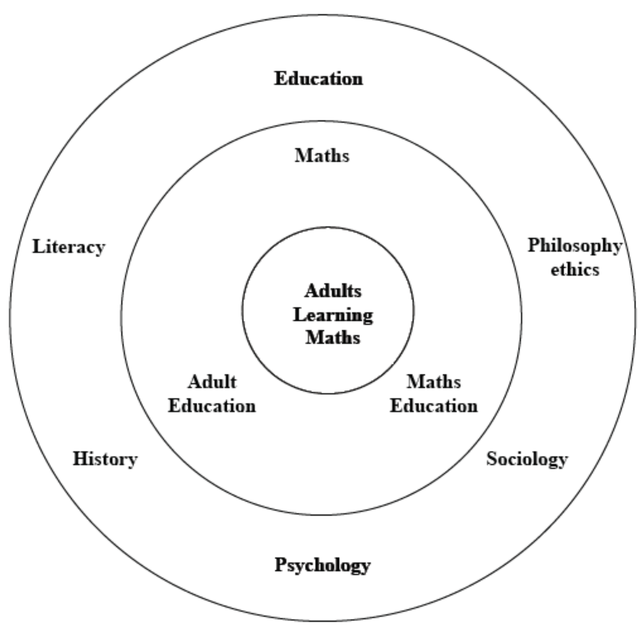

Figure 1. *Benn's conception of the research domain of adults learning mathematics (Wedege et al., 1999)*

For Wedege, the ANMTL research domain encompasses three superordinate subject areas: teaching, learning and knowing mathematics. She summarises the provisional conclusions of the debate as follows:

- Preliminary place in the scientific landscape: The [ANMTL] community of practice is accepted as a research domain within the didactics of mathematics;
- Subject area: The learner is the focus of the [ANMTL] studies and her/his 'numeracy' is understood as mathematics knowledge.
- Problem field: Didactic questions are integrated with general adult education questions in [ANMTL] and the studies are interdisciplinary.
- Two perspectives: The duality between the objective and subjective perspective is implicit, or explicit, in all [ANMTL] problematiques.
- Justification problem: The general aim of [ANMTL] practice and research is 'empowerment' of adults learning mathematics. (Wedege, 2001, p.112)

In my review of the debate (Coben, 2000, pp 50-51), I characterise ANMTL as an emerging research domain, interdisciplinary within the social sciences and spanning the sub-fields of mathematics education and adult education. 'Mathematics' is taken to mean mathematics learned and taught at any level, including the most basic and, in Wedege's terms, it includes 'numeracy', or mathematics in the social context. In the *Handbook*, FitzSimons, O'Donoghue and I examine the problematic relationship between the related disciplines and the core of the research domain. We contend that, "what is needed is a field-specific framework (or frameworks) for adult mathematics education that integrates all contributions from the core and elsewhere", with adults and mathematics making adult mathematics education specific as a research enterprise (FitzSimons *et al*., 2003, p.116). Such contributions must engage with the vexed question of 'what is numeracy?' and it is to this question we turn next, considering first, how it relates to mathematics and then how it relates to literacy.

How does numeracy relate to mathematics?

The nature of the relationship between numeracy and mathematics is elusive.
Concepts and definitions of numeracy with respect to adults are many and varied (Coben *et al.*, 2003)[1], but typically assert, or assume, some relationship between numeracy and mathematics. It is not a relationship of equals: conceptualisations of numeracy commonly refer to mathematics but the converse is not true; conceptualisations of mathematics do not usually involve numeracy.

The origins of 'numeracy'

The term 'numeracy' originated in the Crowther Report in England and Wales in 1959 (Ministry of Education, 1959) as the "mirror image of literacy" (Ministry of Education, 1959) (para.398). Numeracy here refers to a sophisticated level of familiarity with the numerate disciplines, just as 'literacy' means familiarity with literature – being well-read, rather than simply being able to read. The intention was to bridge the gap between literary and scientific cultures.

[1] See Coben *et al*. (2003) for a comprehensive review of concepts of numeracy.

Numeracy in the modern sense came to prominence later, in the wake of the Cockcroft Committee's influential 1982 report on mathematics education. The report proposed reform of the way mathematics was taught to children in schools based on the mathematical demands of adult life (DES/WO, 1982, p.11). The Cockcroft 'Foundation list of mathematical topics' (para.458, pp135-140) includes: number; money; percentages; use of calculator; graphs and pictorial representation; spatial concepts; ratio and proportion; and statistical ideas.

Current formulations of numeracy

Via the schools' National Curriculum in Mathematics, established in 1989, and the National Numeracy Strategy in schools in England from the mid-1990s (DfES, 2002), the Cockcroft list formed the basis for the Adult Numeracy Core Curriculum (DfES, 2001), part of the UK government's *Skills for Life* strategy to improve standards of adult literacy and numeracy in England (DfEE, 2001). In *Skills for Life* numeracy is defined as:

> the ability to use mathematics at a level necessary to function at work and in society in general [i.e.,] to: understand and use mathematical information; calculate and manipulate mathematical information; interpret results and communicate mathematical information (DfES, 2001, p.3).

Recently, a new and as yet undefined formulation, 'functional mathematics', has emerged in England following publication of Professor Adrian Smith's Report on post-14 Mathematics education (Smith, 2004), Tomlinson's Report on *14-19 Curriculum and Qualifications Reform* (Tomlinson, 2004) and the UK government's White Paper on *14-19 Education and Skills* (DfES, 2005). The relationship between 'functional mathematics' and adult numeracy has yet to be established in the English policy arena.

Meanwhile, on the international scene, the UNESCO International Standard Classification of Education (UNESCO, 1997), links literacy and numeracy together at a basic level, as "Literacy and numeracy: Simple and functional literacy, numeracy" and this is the sense in which the term is often used today. But what does this mean in practice and how can it be elaborated to inform policy, practice and further research in this area?

The latest survey of adult skills (and the first to include numeracy), the Adult Literacy and Lifeskills (ALL) Survey, attempts to do this. It defines numeracy as: "the knowledge and skills required to effectively manage the mathematical demands of diverse situations" (Manly & Tout, 2001, p.81). The ALL framework sets out five key facets of numerate behaviour, as follows:

- managing a situation or a problem in a realistic context such as everyday life, work-related, societal or community, and further learning;
- responding to a situation through identifying, interpreting, acting upon, and communicating;
- information about mathematical ideas such as quantity and number, dimension and shape, pattern and relationships, data and chance, and change;
- representations of mathematical information including objects and pictures, numbers and symbols, formulae, diagrams and maps, graphs, tables, and text
- enabling knowledge bases and reasoning processes including contextual knowledge, mathematical (and statistical) knowledge and understanding, mathematical problem-solving skills, literacy skills, and beliefs and attitudes (Manly & Tout, 2001, p. 81).

In addition, a scheme of five factors has been developed to account for the difficulty of different tasks, which, it is claimed, enables an explanation of observed performance in terms of underlying cognitive factors. These are: (1) type of match/problem transparency; (2) plausibility of distractors (including in text); (3) complexity of mathematical information/data; (4) type of operation/skill; (5) expected number of operations (Manly, Tout, van Groenestijn, & Clermont, 2001).

To summarise the relationship between numeracy and mathematics in the discussion thus far: in some conceptualisations of numeracy, including *Skills for Life* and the ALL Survey, numeracy is regarded as contained within mathematics, and some conceptualisations of adult mathematics learning, such as Wedege *et al.*'s (1999), see it as encompassing numeracy. In this view, numeracy is seen as an aspect of mathematics; adult numeracy learning (ANL) is seen as an area within adult mathematics learning (AML). This may be represented as M > N, with the corollary that AML > ANL.

An alternative conceptualisation, developed in Australia, sees numeracy as "not less than maths but more" (Johnston & Tout, 1995), a way of negotiating the world through mathematics (Johnston & Yasukawa, 2001). In this conceptualisation mathematics and numeracy are not congruent, nor is numeracy "an accidental or automatic by-product of mathematics education at any level. When the goal is numeracy some mathematics will be involved but mathematical skills alone do not constitute numeracy", as O'Donoghue writes of Ireland (O'Donoghue, 2003, p.8). In Denmark, also, Lindenskov and Wedege have introduced '*numeralitet*', which has been adopted by the Danish Ministry of Education. It focusses on functional mathematical competence in the changing social and technological context and Wedege defines it as "a math-containing everyday competence" (Wedege, 2001, p.27). In this view, numeracy encompasses more than mathematics (N > M) and adult numeracy learning encompasses more than mathematics learning (ANL > AML). The fact that some of the same people (e.g., Wedege and O'Donoghue) locate numeracy both within and beyond mathematics may serve to indicate some of the complexity and shifting nature of the conceptualisation of numeracy with respect to adults.

At this point it may be useful to consider Maguire and O'Donoghue's organising framework for gauging increasing sophistication in the conceptualisation of numeracy along a continuum (Figure 2).

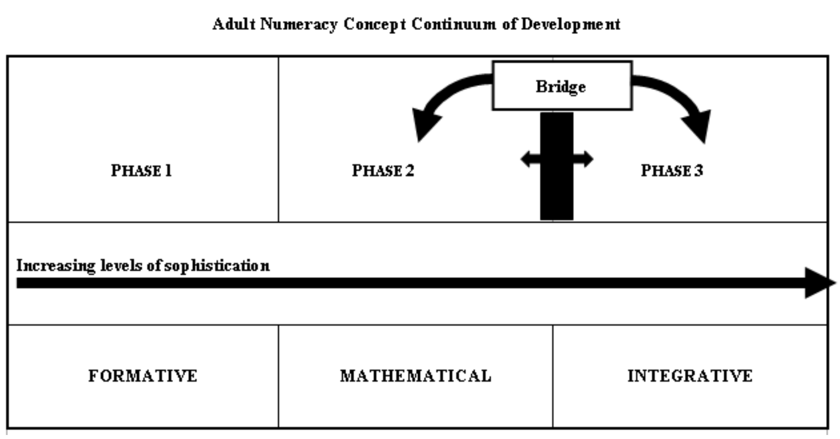

Figure 2: *A continuum of development of the concept of numeracy showing increased level of sophistication from left to right (from Maguire & O'Donoghue, 2005)*

The framework is intended to facilitate international comparisons. In the first, ‘Formative Phase’, numeracy is considered as basic arithmetic skills; in the second ‘Mathematical Phase’, numeracy is ‘mathematics in context’, entailing explicit recognition of the importance of mathematics in daily life. The framework culminates in the ‘Integrative Phase’, in which numeracy is viewed as “a complex multifaceted sophisticated construct incorporating the mathematics, cultural, social, emotional and personal aspects of each individual in a particular context” (Maguire & O'Donoghue, 2003, pp. 155-6). Maguire and O’Donoghue situate the Cockcroft conceptualisation at the upper end of the Mathematical Phase and that of the ALL survey at the beginning of the Integrative Phase, with a bridge and arrows between the two phases indicating that there is movement in both directions between them. In their comparison of the development of the concept of numeracy in policy terms in seven countries (Ireland, Canada, USA, UK, the Netherlands, Denmark and Australia), only Denmark and Australia are located in the Integrative Phase, with the UK in the Mathematical Phase and Ireland in the Formative Phase.

Overall, we can see that numeracy and mathematics are not totally distinct from each other: in some conceptualisations, numeracy encompasses mathematics, whereas in others mathematics encompasses numeracy. Either way, mathematics is key to conceptualisations of numeracy, and the degree of integration with and beyond mathematics is taken as a measure of the sophistication of concepts of numeracy in Maguire and O’Donoghue’s framework. Nevertheless, the relationship between mathematics and numeracy remains to a certain extent ambiguous. Any theorisation of that relationship must recognise that education is inherently multidisciplinary and that education is a field of practice as well as a field of research (FitzSimons *et al*., 2003). But what of numeracy’s other ‘neighbouring’ concept – often a very close neighbour in the realms of policy, practice and educational provision - literacy?

How does numeracy relate to literacy?

Adult numeracy is often subsumed within literacy in educational policy, practice and research. For example, Tout and Schmitt point out that “the titles of major legislative actions and documents authorizing and regulating adult basic skills provision in the USA stress the importance of ‘literacy’”, with numeracy appearing only sporadically or omitted entirely in major policy and public relations documents aimed at expanding and improving adult basic education (Tout & Schmitt, 2002).

In this configuration literacy is greater than numeracy: L > N. This conceptualisation has been challenged by Maguire and O’Donoghue (2002) with respect to Ireland and by Cumming (1996) with respect to Australia. Cumming contends that “the inclusion of numeracy as a component of literacy: sometimes explicitly included in literacy agendas, sometimes implicitly, sometimes omitted; is not sufficient”. What is lost when numeracy is subsumed within literacy in this way is the possibility of identifying and exploring key questions and issues in numeracy, including identifying the extent of expenditure of human, financial and other resources on numeracy and hence of redressing any imbalance. In policy and provision terms the effect is clear: expenditure and information on numeracy that might lead to improvements in practice are often impossible to disaggregate from information on literacy; numeracy is rendered invisible.

Gal, one of the authors of the ALL Survey numeracy framework, opposes this tendency. He characterises numeracy as a semi-autonomous area at the intersection between literacy and mathematics (Gal, 2000, p.23). He discusses the links between literacy, language and numeracy under three headings: mathematics as language, in which mathematics is viewed as a separate language system; language factors in learning mathematics, referring to the role of written and oral language in communicating mathematics; and language-mathematics links in real-world contexts, referring to the varying degrees of involvement of language in different numeracy situations (Gal, 2000, p. 22). Hence, insofar as numeracy is implicated in written texts and other situations involving literacy, literacy may be seen as a component of numeracy, rather than *vice versa*; in this sense, numeracy is greater than literacy: N > L.

The close association of numeracy with literacy and language has informed research on pedagogy, for example: Zevenbergen's (2000) investigation of the literacy demands of adult numeracy; and Durgunoglu and Öney's (2000) discussion of the numeracy needs of adult literacy students. Stoudt (1994) discusses the process of enhancing numeracy skills in adult literacy programmes and Tomlin (1995, 2002) discusses the use of approaches developed in adult literacy work to encourage student writing in numeracy classes. These and other studies show a lively interest amongst researchers in working out the potential benefits of an integrated approach to pedagogy, reflecting the fact that provision in adult numeracy is often organized alongside adult literacy, with some teachers working in both areas. This is so not only in the industrialised world but also in poorer countries, for example, in the REFLECT programme, where literacy and numeracy are integrated (Foroni & Newman, 1998).

Literacy and numeracy are also implicated in adults' life experiences and opportunities generally. The impact of poor literacy and numeracy on adults' lives has been investigated by Parsons and Bynner, using data from two of the British Birth Cohort studies. They asked *Does Numeracy Matter More?* and found that "For men the combination of poor literacy and poor numeracy was significant" while "For women, poor numeracy, independently of the standard of literacy, is more significant". This is due to changes in the nature of employment, since "Poor numeracy skills make it difficult to function effectively in all areas of modern life, particularly for women" (Parsons & Bynner, 2005, pp. 6-7).

In terms of research methodologies linking literacy and numeracy, a recent research project at King's College London has investigated low achievement in children's numeracy through an exploration of home and school numeracy practices, using a 'social literacies' approach associated with the New Literacy Studies (Street *et al.*, 2005). Mary Hamilton characterizes this approach as follows:

> The essence of this approach is that literacy competence and need cannot be understood in terms of absolute levels of skill, but are *relational* concepts, defined by the social and communicative practices with which individuals engage in the various domains of their life world. It sees literacy as historically and socially situated (Hamilton, 2000).

The project considered how far this approach could be applied in research in mathematics education (Baker *et al.*, 2000, p.159) but while many researchers (including this one) might be happy to substitute 'numeracy' for 'literacy' in Hamilton's statement, above, there are aspects of the social literacies approach which may not translate well to the investigation of numeracy. For example, Alison Tomlin, herself a member of the home and school numeracies project team, points out the invisibility of many numeracy events and practices (Tomlin, 2002). These may be deeply embedded in context (FitzSimons, 2002) and involve unobservable thought (e.g., calculating 'in the head'), rather than observable action (such as calculating on paper or with a calculator). As a result, a social literacies approach based in observation and discourse analysis may have limitations in the development of research methodologies in adult numeracy (Coben *et al*., 2003). However, such an approach may be helpful in locating different conceptualisations of ANMTL for research purposes, as we see next.

Locating different conceptualisations of numeracy

My delineation of two domains of numeracy (Coben 2002, outlined in Figure 3, below) is adapted from a schema developed for adult literacy by Kell (2001) in South Africa. Adult numeracy in Domain One is characterized by formalisation and standardization of the curriculum, and 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. It supports normative claims about the beneficial effects of numeracy for the individual and for society. Adult numeracy education in *Skills for Life* is located in Domain One because, as Kell puts it, speaking of literacy in Domain One, it is "created through the standardising processes of fixing levels, writing unit standards and setting performance criteria" (Kell, 2001, p.100). By contrast, numeracy in Domain Two is "about informal and non-standard mathematics practices and processes in adults' lives, which may bear little relation to formal, taught mathematics". Domain One numeracy may have low use value but high exchange value "it is 'hard currency', yielding certificates tradeable on the labour market. Domain Two is the opposite: it has high use value but no exchange value beyond the community of practice in which it occurs...; it is 'soft currency'... [and] situated in Jean Lave's sense"; it is often 'invisible' or unregarded by those directly concerned; and it is often elided with 'common sense' (Coben, 2002, p.27).

Kanes' (2002) "three lenses each offering alternative and competing views of the terrain numeracy encompasses": visible-numeracy; useable-numeracy; and constructible-numeracy, may be aligned with Domains One and Two. Visible-numeracy "names the kind of knowledge which is intended when using commonly accepted mathematical language and symbols to formulate mathematical relationships and communicate these to others" (p. 341), these are the currency of Domain One. 'Useable-numeracy' is "the kind of numerical knowledge exhibited when a person is engaged in real-life problem-solving" (pp. 341-2). It is "complex, and deeply embedded in the context in which it acquires meaning" (p. 344); in my terms, it belongs in Domain Two. Constructible-numeracy brings the education process into play, since it is "produced by an individual/social constructive process usually in a learning situation" (p. 342). Kanes (2002) alerts us to the challenge for adult numeracy educators when he points to the tension between numeracy which is useable but not easily constructible, and numeracy which is easily constructible but less useable (p. 346). This is the tension I perceive for educators attempting to bridge the gap between numeracy in Domains One and Two. I agree with Kanes that "much of what makes numeracy interesting, challenging and important has to do with the ambiguity of its status among the senses of visibility, useability and constructability" (p. 42) and, I would argue, also its ambiguous position in relation to Domains One and Two. Adult numeracy in the two domains is outlined in the Figure 3. This delineation of two domains of adult numeracy may be brought together with Maguire and O'Donoghue's conceptual framework, as shown in Figure 4.

ADULT NUMERACY IN DOMAINS ONE AND TWO		
	DOMAIN 1 use value low; exchange value high	DOMAIN 2 use value high; no exchange value
Why?	To gain access to institutions of modernity; based on the belief that to be numerate is beneficial both to the individual and to society	To do something; to understand something
What?	Formalised, standardised, certificated curriculum, positioned as ‘basic skills’ (Kanes’ ‘visible-numeracy’)	Informal, non-standard mathematics practices which may be (dis)regarded as ‘just common sense’ by all concerned; invisible mathematics (Kanes’ useable-numeracy)
How?	Through teaching and learning materials that may be technologised, unitised, commodified	Through social activity and alone ‘in your head’
Who?	Learners: those deemed to be deficient in mathematics	Learners: everyone, as part of processes of enculturation into ‘communities of practice’.
	Teachers: professional experts (problematic in adult numeracy as the very concept of numeracy is debated and the field of professional practice is relatively new and poorly defined); non-professionals; volunteers	‘Teachers’: more experienced people, who ‘know the ropes’
When?	At set times, except in Open and Distance Learning (ODL)	Anytime, incidental
Where?	In set locations, except in ODL	Anywhere, in context, in ‘real life’; ‘everyday life’; workplace

Figure 3. *Adult Numeracy Learning in Domains One and Two (adapted from Coben, 2002)*

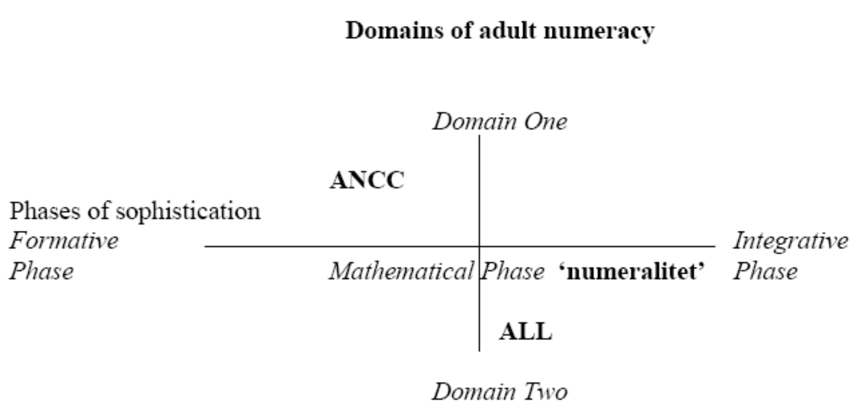

Figure 4. *Comparing conceptualisations of adult numeracy in terms of conceptual sophistication and domain of operation.*

Using this matrix, it is possible to plot the positions of different conceptions of adult numeracy both in terms of their degree of sophistication (along the horizontal axis) and in terms of the discursive domain in which they operate (along the vertical axis). Thus the conceptualisation of numeracy expressed in the English Adult Numeracy Core Curriculum (ANCC) is in the top left quadrant: it is located in the Mathematical Phase and operates primarily in Domain One. That expressed in the ALL Survey is located in the bottom right hand quadrant: it is in the Integrative Phase in terms of its degree of sophistication and in Domain Two because it is concerned with adults' 'numerate behaviours' in their lives as a whole. The Danish concept of *numeralitet* is also in this quadrant, but further to the right, since it is more firmly located in the Integrative Phase, and closer to the line dividing Domain One from Domain Two because it has the capacity to generate certification. Elsewhere, Kanes presents a way of thinking about numeracy as a cultural historical activity system, as shown in Figure 5.

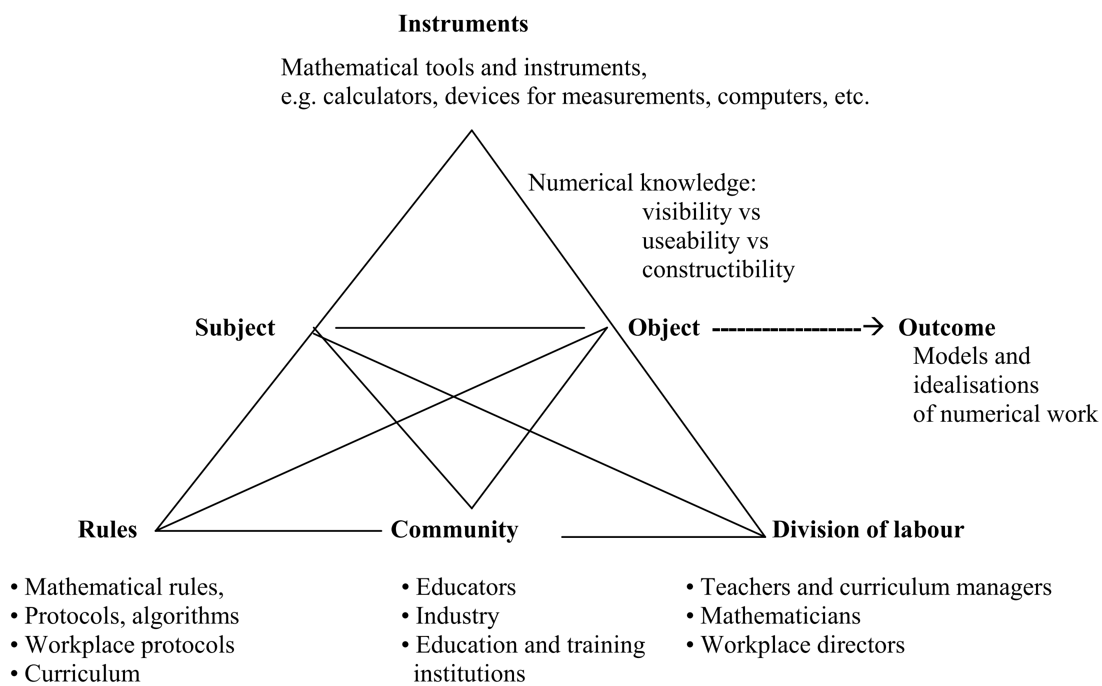

Figure 5. *Kanes' model of numeracy as a cultural historical activity system (Kanes 2002, p. 348).*

In this model, numeracy is the subject of the cultural historical activity system and numerical knowledge is its object (with tensions and anomalies between the visibility, useability and constructability of that knowledge, as outline above). The instruments of the activity system are mathematical tools and instruments such as calculators, devices for measurements, computers, and so on. The community engaged in the activity is comprised of educators, industry and education and training institutions and the division of labour comprises teachers and curriculum managers, mathematicians and workplace directors. The rules are mathematical rules, protocols and algorithms, as well as workplace protocols and curricula. These elements all interact in the activity system to produce the outcome of models and idealisations – conceptualizations - of numerical (or mathematical) work that we know as numeracy, conditioned by the cultural and historical contexts in which the activity system has developed and "intrinsic to the nature of numeracy in its current state of development" (Kanes, 2002, p.348).

As I noted in my review of research on adult numeracy, any chosen concept of numeracy has significance for key decisions about what is taught, to whom, under what circumstances, and for what purposes, and it is important to recognise that some definitions carry more weight than others because they are enshrined within powerful policy formulations. Against this background,

> Kanes' formulation seems to offer a way forward to help us understand the complexity inherent in conceptualising numeracy; it may even help us to live with the uncertainty surrounding the term (Coben *et al*., 2003, p.21).

Locating adult numeracy and mathematics research

Research in adult numeracy and mathematics teaching and learning is still in the exploratory phase of development. There is much conceptual uncertainty, manifested in shifting relationships between numeracy and mathematics and between numeracy and literacy, and reflecting similarly shifting relationships between these areas in educational practice. Conceptual clarity is needed if research and development are to be clearly focussed, but not at the expense of ignoring awkward realities. Given the diversity of the field – or moorland – there are likely to be many of these. We probably have to live with many of the ambiguities in our present conceptualisations. The map of educational research is itself evolving. It is likely to change still further as insights from contributing disciplines and practices, including new information and communications technologies in the workplace (Hoyles, Wolf, Molyneux-Hodgson, & Kent, 2002) and education (Mellar, Kambouri, Sanderson, & Pavlou, 2004), and the fast-developing field of brain research (Kelly & Davis, 2004), shed light on teaching and learning in all its complexity. It is also possible to select from amongst the models currently available those that seem most suited to the task in hand. For example, anyone developing instruments to assess adults' numerate behaviours would be well advised to consult the work of the ALL Survey Numeracy team, while anyone attempting to understand educational or other activity involving numeracy and mathematics could choose to do so using the model of numeracy as a cultural and historical activity system outlined in Figure 5, above.

So what kind of research is needed now, given that "research must be closely linked with practice in a field where development and improvement in practice have priority status", with the relationship between research and practice interactive, mutually beneficial and supportive, and with research and development leading to improved practice in the field of adult mathematics education (FitzSimons *et al*., 2003, p.117)?

Drawing on a conceptualisation from the 'hard sciences', a recent review of educational research and development policy in England (OECD/CERI, 2002) advocates "use-inspired basic research", situated within what Stokes (Stokes, 1997) has called "Pasteur's Quadrant". Stokes recasts the conventional view of the tension between understanding and use, citing as a model the work of Louis Pasteur in laying the foundations of microbiology.

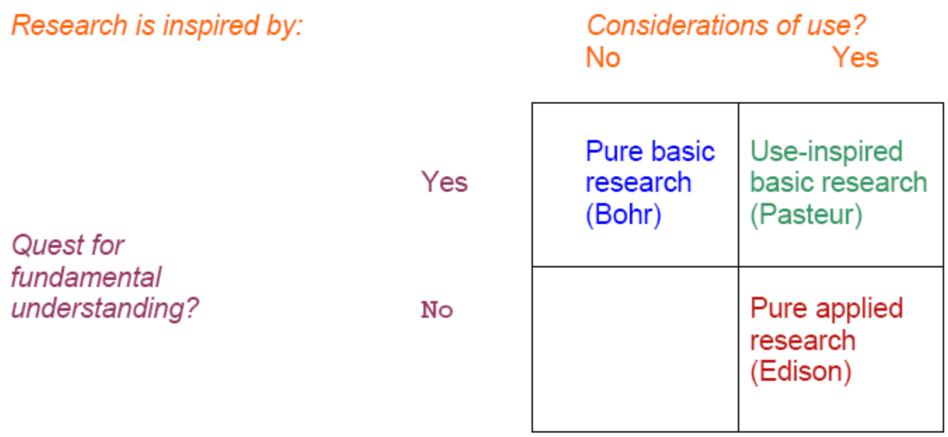

Figure 6. *Inspirations for research (adapted from Pasteur's Quadrant: Basic Science and Technological Innovation, Stokes 1997)*

Pasteur's Quadrant would seem to be an appropriate location for research in adult mathematics and numeracy teaching and learning, as Black (2003) argues it is for mathematics education research generally. "Use-inspired basic research" has the potential to generate useful knowledge and address issues related to the accumulation and dissemination of such knowledge. It must be both inspired by the problems and issues arising in practice and basic in the sense of laying the foundations for the further development of the field.

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ALM Journal

Adults Learning Mathematics
- An International Journal
- Special Issue

Guest Editor: Christine Keitel

The Future of Mathematics in Adult Education from Gender Perspectives:
Political Empowerment, Inclusiveness and Diversity in Mathematics Education

Call for Abstracts

Adults Learning Mathematics - An International Journal (ALM-IJ) is a peer reviewed online journal published by Adults Learning Mathematics – a Research Forum. ALM (http://www.alm-online.org/) is an international research forum bringing together researchers and practitioners in adult mathematics / numeracy teaching and learning in order to promote the learning of mathematics by adults. The Editor invites interested authors to submit abstracts for this special issue. **Abstract submissions (150 to 250 words) should be sent as a single email attachment, saved as a Microsoft word document to <keitel@zedat.fu-berlin.de> by 5 January 2007.**

OVERVIEW, AIMS AND PURPOSE

The aim of this special issue is to develop perspectives for adults learning mathematics from feminist perspectives that include gender and diversity and strive for political empowerment in a world more and more determined by use of mathematics and mathematical technology. Authors should address possible influences and substantial changes in mathematics education for adults that are guided by inclusiveness and aim at adults' mathematical literacy in particular addressing initiatives guided by gender awareness and focus on diversity perspectives. Possible themes to be dealt with could be:

- Gender differences in mathematics learning of adults
- Social images and political perspectives of mathematics education for adults;
- Blind spots in new mathematical media and technologies: Do women exist as addressees?
- Cultural shifts and new technological perspectives by active female presence in technological production and related fields;

The proposed schedule for the issue is:

• Abstracts submitted to special issue editors:	5 January 2007
• Authors notified of acceptance or otherwise :	31 January 2007
• Draft articles submitted to special issue editors:	30 March 2007
• Referees' reports sent to authors:	21 May 2007
• Final manuscripts submitted to special issue editor:	30 July 2007
• Publication :	September/October 2007

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Adults Learning Mathematics
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Chief Editor: Janet Taylor

November 2006

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Adults Learning Mathematics – an international Forum (see www.alm-online.org) has been established since 1994, with an annual conference and newsletters for members. ALM is an international research forum bringing together researchers and practitioners in adult mathematics/numeracy teaching and learning in order to promote the learning of mathematics by adults. Since 2000, ALM has been a Company Limited by Guarantee (No.3901346) and a National and Overseas Worldwide Charity under_English and Welsh Law (No.1079462). Through the annual ALM conference proceedings and the work of individual members an enormous contribution has been made to making available theoretical and practical research in a field which remains under-researched and under-theorised. We now seek to establish a refereed electronic journal to further develop the high quality work in this field.

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

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- Debate on special issues in the area of adults learning mathematics/numeracy
- Practice: critical analysis of course materials and tasks, policy developments in curriculum and assessment, or data from large-scale tests, nationally and internationally.

Both full-length articles and shorter reports may be submitted. No preference is given to any particular research methodology.

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The Special Issue '*The Future of Mathematics in Adult Education from Gender Perspectives'* is due in September/October 2007.

See Call for Abstracts on page 33 in this edition.