Adult Numeracy: Crossing Borders of Discourse

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In a presentation to TSG 6, ICME 10 (FitzSimons, 2004), I drew upon the work of Basil Bernstein to distinguish analytically between mathematics and numeracy as vertical and horizontal discourses respectively. It is commonplace that adults feel that they 'cannot do maths' and that people in all kinds of trades and professions believe that they 'never use any of the maths they learned at school'. I propose that this is because they have only encountered the vertical discourse of mathematics, recontextualised by educators into 'school mathematics', with generally unproblematic assumptions about transfer through so-called 'real-life' applications. In this paper I elaborate further on this theoretical foundation to argue that it is necessary to cross the borders between the two discourse types in order to successfully teach mathematics to adult learners.

Numeracy, whether for adults or children, is a social construct. It draws upon mathematical skills and knowledges developed over a lifetime. These may be learned informally from — and even taught by — family, friends, and other significant others. In the case of pre-school children and unschooled youth and adults, learning is dependent on the social and cultural settings available to the learner in their various communities of participation. In countries where formal education is the norm, funded to a greater or lesser extent from the public purse, decisions are made by governments (advised by bureaucrats) about the quantity and quality of education for various groups of learners. Decisions are made based on, for example, perceptions of the good of the nation and, where governments are elected, and perceptions of the likelihood of re-election. Accordingly, the voices of certain groups of stakeholders are privileged over others, depending on the political complexion of the government of the time. The major focus may be on, for example, improving business or national economic outcomes or on democratic citizenship, or some combination of these. Whatever the focus, numeracy is necessarily related to mathematical skills and knowledges.

The provision of formal mathematics education in school as well as adult and vocational education (even if it is labelled as numeracy) is necessarily political in that certain selections are made to meet the interests and needs of certain social and economic groups above others. Curricula are determined — whether at the state level or even the individual school or classroom, and again this is a political decision — drawing on an arbitrary selection from the discipline of mathematics. Official and local pedagogic practices then combine to recontextualise that arbitrary selection in differentiated ways. Evaluation of the learner's performance — whether via international or state-wide testing, or teacher-designed assessment or individual classroom/online feedback — may also be heavily influenced, if not determined, by political decisions: for example, mandated testing for accountability purposes, ongoing funding, and local, national, or even international comparisons.

In different countries different terms are used to apply to the use and even construction of mathematics outside of the classroom. *Numeracy* is very commonly used, often with the pejorative tag 'basic' attached in the case of adult education. One perspective is that this term is used in an attempt to disassociate from the cold, hard, judgemental image of the discipline of mathematics in an attempt to popularise it with school children and their parents, as well as adult learners. Other terms used are *quantitative literacy*, *mathematical literacy*, *democratic numeracy*, and also *functional mathematics*. However they are labelled, the curricular content, pedagogy, and assessment still remain political phenomena. The intended outcome of mathematics and numeracy teaching is *numerate activity* but a focus on the discourse of (school) mathematics alone will not guarantee such activity.

Discourses of Mathematics and of Numeracy

Bernstein (2000) describes mathematics as being a *vertical discourse* due to its coherent, explicit, and systematically principled structure. It takes the form of a series of specialised, codified languages, with many sub-disciplines (e.g., algebra, geometry, trigonometry). In formal education, the discipline of mathematics is recontextualised for the purpose of enculturation. Just as the school subject of woodwork is qualitatively different from the trade of carpentry, so school or formal adult mathematics education is different from professional mathematics or statistics; also from workplace numeracy.

Following Bernstein (2000), I argue that the construct of numeracy is an example of a *horizontal discourse*. This is due to the strong affinity between the burgeoning corpus of research reports on workplace and everyday activities involving the use and re/construction of mathematical knowledges (e.g., Eraut, 2004; Hoyles et al., 2002; Kent et al., 2004; Wake & Williams, 2001) and Bernstein's description of a horizontal discourse as "a set of strategies which are local, segmentally organised, context specific and dependent, for maximising encounters with persons and habitats" (p.157). He continues that the knowledges of horizontal discourses are "embedded in on-going practices, usually with strong affective loading, and directed towards specific, immediate goals, highly relevant to the acquirer in the context of his/her life" (p.159). This description bears close resemblance to the characterisation of arithmetic in Lave's (1988) research on shoppers and weight-watchers.

Compared to the discipline of mathematics, numeracy is weakly classified in terms of its necessary integration with context. Whereas in mathematics there is a well-known hierarchy from common sense up to so-called uncommon sense, in numeracy common sense is of the essence. High level abstractions alone are insufficient and may even prove counter-productive. Numeracy cannot be said to have a specialised language, except at the most local level of use in context. For example, the use of the term "thou" (i.e., thousandths) is widely used in the building and automotive industries, but may not have meaning elsewhere. Numeracy is not necessarily explicit or precise (but can be if required), and its capacity for generating formal models may be limited to the context at hand rather than generalisable.

In essence, then, numeracy is a *horizontal discourse* which draws upon foundations of mathematical knowledge developed by individuals over a lifetime of personal experience and enculturation but which, unlike the *vertical discourse* of the discipline of mathematics, relies on common sense and is context-specific and -dependent, directed towards the achievement of specific, immediate, and highly relevant goals.

Vertical discourses such as mathematics consist of specialised symbolic structures of explicit knowledge; its procedures are linked hierarchically. The formal pedagogy is directed towards some unspecified projected application and is an on-going process, generally continuing over an extended period of time. By contrast, according to Bernstein (2000), the pedagogy of horizontal discourses is usually carried out through personal relations, with a strong affective component. It may be tacitly transmitted by modelling or showing, or by explicit means. The pedagogy may be completed in the context of its enactment, or else it is repeated until the particular competence is acquired. From an individual's perspective, "there is not necessarily one and only one correct strategy relevant to a particular context" (p.160). Bernstein concludes that horizontal discourse "facilitates the development of a repertoire of strategies of operational 'knowledges' activated in contexts whose reading is unproblematic" (p.160).

Whereas the transmission of formal mathematics knowledge is likely to progress from the concrete to the mastery of simple operations, to more abstract general principles, the teaching of numeracy to adults may have more in common with the reverse processes which take place in workplace learning. In other words, general principles are understood but need to be made concrete in order to be realised. Ultimately, the learner will be expected to develop a repertoire of context-dependent strategies, based on experiential learning from a more 'knowledgeable' person (or persons) in a given situation, where achieving the task itself is the priority — not the learning of mathematics per se. As discussed above, context-specific and localised models may also be developed and practical knowledge/expertise, together with common sense, is highly valued.

Pedagogies of Numeracy

It is well recognised that the mathematics classroom is a community of practice distinct from that of professional mathematicians; also from the workplace. In my opinion, then, numeracy is composed of mathematical knowledges and skills, however derived (i.e., formally & informally), in combination with reflective knowing in context — knowing which draws upon a lifetime of experience. Numerate activity is concerned with acting within the discourse practices *and* socio-cultural practices appropriate to the task at hand. It entails both explicit, codified knowledge and implicit or tacit knowledge. That is, the borders of vertical discourse and horizontal discourse must be crossed and re-crossed in order to develop the capacity for numerate activity, and they must be continually crossed and re-crossed in its pedagogic processes. In short, the teaching of the discourse of mathematics alone (even with 'applications') can never guarantee a numerate person.

Keitel, Kotzmann, and Skovsmose (1993, p.275) suggest a process which reverses the traditional order of pedagogy — that is, to start "from powerful technological constructions or identifying rich contexts in which serious social problems are posed" (see also Borba & Villarreal, 2005, particularly with respect to technology-based programs). Mathematical concepts and modelling activities should then be used to enable understanding of the problem, formulation of alternative solutions, and negotiation with others about their acceptability. In this way, students and teachers should become directly involved in issues such as improving the local environment. In the case of adults, even at the most 'basic' levels, any contexts must be realistic and/or engaging, rather than the trivialised and demeaning pseudo-contextualisations which appear when the focus is on the mathematical process and the context is used as a camouflage. As I have demonstrated in FitzSimons (2000), it is possible to satisfy externally driven curricular demands with actual needs of the learners through a deeply respectful and ethical investigation and sharing of some of the realities of their everyday work and life, conducted as a partnership, and concluding with a reflection on how things might be done differently. As Keitel, Kotzmann, and Skovsmose observe, the processes of learning, knowledge generation, and possible interventive action need to be combined. Self-confidence will be enhanced when learners feel as though they are being listened to or consulted. The prime focus is on connecting mathematical knowledge to other types of insight and activities. Thus, they say, "students could obtain *knowledge about knowledge* which we have called reflective knowledge, and the combination of reflective knowledge and social activities forms a part of what we have called democratic competence" (p.277). Interestingly, democratic competence is included in Wedege's (1995) definition of technological competence in the workplace, which also included professional and social qualifications. In her words democratic competence is "to evaluate and take part in decision-making processes regarding new technology in the workplace" (p.58).

However, evaluating new technology is not the sole justification. Wedege (2000) identified disempowering consequences of workers not being able to participate in workplace mathematical discourses that management might use to control workers — technologies of management (FitzSimons, 2002) — and I have witnessed the same phenomenon in my workplace research in the pharmaceuticals manufacturing industry. These typically take the form of discourses which employ, for example, graphs representing change over time, statistical charts monitoring production output or wastage, days lost due to various causes ascribed to workers (and not to management failure or lack of adequate and timely maintenance of plant or machinery!), charts presenting percentages, percentage change, or production quantities involving very large numbers. Many of these topics appear at quite advanced levels in school curricula, and tend to be overlooked in worker education. Yet, my own experience shows that people are able to understand the concepts given time and contextualised situations well known to learners.

It is obvious that being able to answer pen and paper or computer generated assessment questions in a classroom situation may result in certification — and this is to be commended if it engenders a sense of achievement, even pride, in the learner and contributes towards enhancing their employment prospects and/or helping children with their homework — but it does not guarantee the creative adaptation of existing mathematical knowledge and possible innovation in the immediate context of a problem to be solved at work or in life generally. Moreover, there is a slippage between what a person is capable of doing and their disposition to do so within the particular work/life context in which they are situated at any given time. Buckingham (1998) identified compelling reasons why workers might stay silent and not participate in workplace mathematical discourses even when they are capable of doing so: keeping one's job or not drawing undue attention to oneself are serious reasons.

Issues at Stake in Adult Numeracy

There are four major questions to be addressed when addressing the complex task of crossing boundaries between mathematics and numeracy:

- Who are learning?
- Why are they learning?
- What are they learning?
- How do/might they learn?

The answers to these will frame the definition of numeracy and will necessarily be local rather than universal in its orientation. However, the answers to these four questions may even be conflicting in themselves — as any practitioner knows. The following brief set of questions is drawn from my current work-in-progress research framework and gives some indication of the complexity of the issue.

What are the motives for adult students to take on learning mathematics/ numeracy supported and delivered (wholly or in part) by new learning technologies?

- Is it to achieve a credential?
- Is it to achieve develop new and/or deeper understandings?
- Is it to prove something to one's self?
- Is it to be able to help significant others to learn mathematics?
- Is it to support their own or their family's business/financial interests?
- Is it to learn more about technology?
- Is it to learn more through technology?

Of course, the answer could be any combination of these, or something else all together.

Numeracy is logically connected with mathematics just as literacy is logically connected with language (Lee, Chapman, & Roe, 1996). However, numeracy is also connected with language. Beyond the semiotic resources of the symbolic system and visual displays of mathematics, the communication and sharing of meanings is an integral part of numeracy.

In the UK the definition of *Functional Skills* is given as:

> Functional skills are those core elements of English, maths and ICT that provide an individual with the essential knowledge, skills and understanding that will enable them to operate confidently, effectively and independently in life and at work. Individuals of whatever age who possess these skills will be able to participate and progress in education, training and employment as well as develop and secure the broader range of aptitudes, attitudes and behaviours that will enable them to make a positive contribution to the communities in which they live and work

The definition of *Functional Maths* is given as:

> Each individual has sufficient understanding of a range of mathematical concepts and is able to know how and when to use them. For example, they will have the confidence and capability to use maths to solve problems embedded in increasingly complex settings and to use a range of tools, including ICT as appropriate.
>
> In life and work, each individual will develop the analytical and reasoning skills to draw conclusions, justify how they are reached and identify errors or inconsistencies. They will also be able to validate and interpret results, to judge the limits of their validity and use them effectively and efficiently.
>
> *http://www.qca.org.uk/15895.html*

My personal view about the naming of competencies and other 'desired' knowledges and skills by governments is that they are done for good political reasons — rather than on educational grounds. Clearly this 'functional mathematics' privileges the views of some stakeholders over others. It has obviously left out any of the aesthetic side of mathematics, to begin with. Although it supports analytic and reasoning skills, I imagine that it excludes employing these skills to critique poor quality of management where it exists, and even to critique the government itself. It does not take any account of the hard-to-fill jobs which are so boring that no-one will apply for them, except illegal immigrants (personal communication from Ewart Keep, SKOPE, Warwick Business School — now Cardiff).

As Corinne Hahn has remarked on the concept of *numeracie* in France: "for most of the people numeracy is supposed to concern only a special part of the population (immigrants, people with no qualification)" (see http://www.statvoks.no/discuseng/ C. Hahn, 14th March 2006). This resonates with my reading of Bernstein (2000). That is, there is a classification of knowledge so that only some people have access to 'unthinkable knowledge', where [mathematical] knowledge is impermeable (p. 11). I believe that this is also the case whenever politicians and bureaucrats talk about 'basic numeracy' — only ever intending to encompass calculations of whole numbers and fractions — decimal and vulgar/common. I have written about this previously (e.g., FitzSimons, 2002): This practice is inherently undemocratic.

Secondly, Corinne's question: "Does it mean that other mathematics are not 'functional'?" suggests further questions to me:

- Who decides what mathematics *is* functional?

- Does it exclude Islamic geometry, for example? Euclidean geometry? Etc. etc. When? Why? For whom?
- On what basis are these decisions to be made and by whom?
- Is it always the voices of big business and industry, attempting to minimise their financial contributions and maximise opportunities to receive government funding, as is the case in some neoliberal economies? Or, is there a social contract between employers and educators working to support the best interests of the students and social cohesion, as in the Scandinavian countries?

Further to my previous discussion about vertical discourses (e.g., mathematics) and horizontal discourses (e.g., numeracy), Bernstein draws attention to the fact that vertical discourses "have their origin and development in official institutions of the state and economy", and horizontal discourses in "everyday or life world" (p.207). Clearly these two intersect — whatever we choose to name them — and maybe the UK definition of functional mathematics is an attempt to do so — but I believe that we need to be clear that they are different discourses with different practices, and not assume, as many people have in the past, that the teaching of (official) mathematics will ensure (locally) numerate activity. We need to strive for the integration of the two discourses in curriculum and pedagogy, including assessment. As has often been pointed out, word problems can never be a substitute for the messy realities of actual constraint-filled practice. This is what makes numeracy as defined here very difficult to assess 'officially'.

What can we as numeracy researchers and educators do?

Following the UK definition of functional skills as: "essential knowledge, skills and understanding that will enable them to operate confidently, effectively and independently in life and at work," I support the goal of enabling such behaviours. It is the use of the term 'essential' that concerns me. This is where the politics comes in — who decides what is essential and on what grounds? Although it may be possible to describe numerate activity in universal terms to cover the range of possible levels of mathematics and contexts of application in very general terms, the construct of numeracy is, in my opinion, provisional and contingent, and defies a unique definition.

The most important issue is to have our voices heard among the stakeholders in political decision-making. Our task as mathematics/numeracy researchers and educators is to argue for the inclusion of the broadest possible curriculum which balances the needs of the various stakeholders — especially those of the learners whose voices tend to be ignored (or who are not really in a position to articulate their own needs), while at the same time working from a deep understanding of numeracy, based on informed research into workplace and other social- and community-participation needs of adults. This means, for example, as well as responding to invitations to comment on proposed changes to curricula, also including a focus on the learners' actual needs and interests in research reports, and in research proposals. Baxter et al. (2006) are to be commended on their measurement project report which includes the broader picture that frames the constraints on what teachers and learners are allowed to do under increasingly restrictive accountability demands in the form of assessment-driven curricula combined with very limited teaching time. The research team of two university-based researchers and four teacher-researchers also argue the case for the future acceptance of adult numeracy students as (co)researchers in their own right.

One way that learners' needs could be supported is through the development of a teaching force valued for its professionality, allowed appropriate time for reflection and creative lesson planning, and enabled through ongoing and appropriate professional development to make judgements about the best outcomes for each particular group of students, situated in their unique contexts. In Denmark I recently visited a vocational education college where highly committed teachers were valued and encouraged by their managers to personally interact with students, along with a dedicated support team. For me, and probably for many others of my teaching generation, this approach represents a return to the halcyon days of the pre-neoliberal era. Denmark has a strong economy as well as strong commitment to the social contract. Perhaps other nations might draw some lessons from this.

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