

Tagung: Alltagsmathematik:
(k)ein Problem in der Schweiz?
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Numeracy: what does it mean and is it a matter of life or death?

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I shall explore current meanings of numeracy, drawing on an interdisciplinary research and development study on numeracy for nursing

- Definitions - new ways of conceptualising numeracy
- A case in point: numeracy for nursing
 - An interdisciplinary project in Scotland to develop a benchmark for numeracy for nursing
- Situating numeracy for nursing in a new conceptual framework

What is numeracy?

- No universally accepted definition
- “*Literacy and numeracy: Simple and functional literacy, numeracy*” (UNESCO, 1997)

Numeracy as a “key competency”

- Numeracy appears in OECD’s ‘Competency Category 1: Using Tools Interactively’ as follows:

COMPETENCY1-A

The ability to use language, symbols and text interactively This key competency concerns the effective use of spoken and written language skills, computation and other mathematical skills, in multiple situations. It is an essential tool for functioning well in society and the workplace and participating in an effective dialogue with others.

Terms such as ‘communication competence’ or ‘literacies’ are associated with this key competency. Reading literacy and mathematical literacy in PISA and numeracy as defined in ALL are illustrations of this key competency. (OECD, 2005)

Numeracy in the Adult Literacy and Lifeskills (ALL) Survey

- “Numeracy applies to the knowledge and skills required to manage the mathematical demands of diverse situations.”
- “Numerate behaviour is observed when people manage a situation or solve a problem in a real context; it involves responding to information about mathematical ideas that may be represented in a range of ways; it requires the activation of a range of enabling knowledge, behaviours and processes.” (Gal et al., 2005)

Effective use of mathematics in context

- To be numerate means to be competent, confident, and comfortable with one's judgments on *whether* to use mathematics in a particular situation and if so, *what* mathematics to use, *how* to do it, what *degree of accuracy* is appropriate, and *what the answer means* in relation to the context. (Coben, 2000)

Mapping concepts of numeracy through increasing levels of sophistication:

Formative ---> *Mathematical* ---> *Integrative*

- 1. ‘**Formative Phase**’ numeracy = basic arithmetic skills
- 2. ‘**Mathematical Phase**’ numeracy = ‘mathematics in context’, explicit recognition of the importance of mathematics in daily life
- 3. ‘**Integrative Phase**’ numeracy = “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)

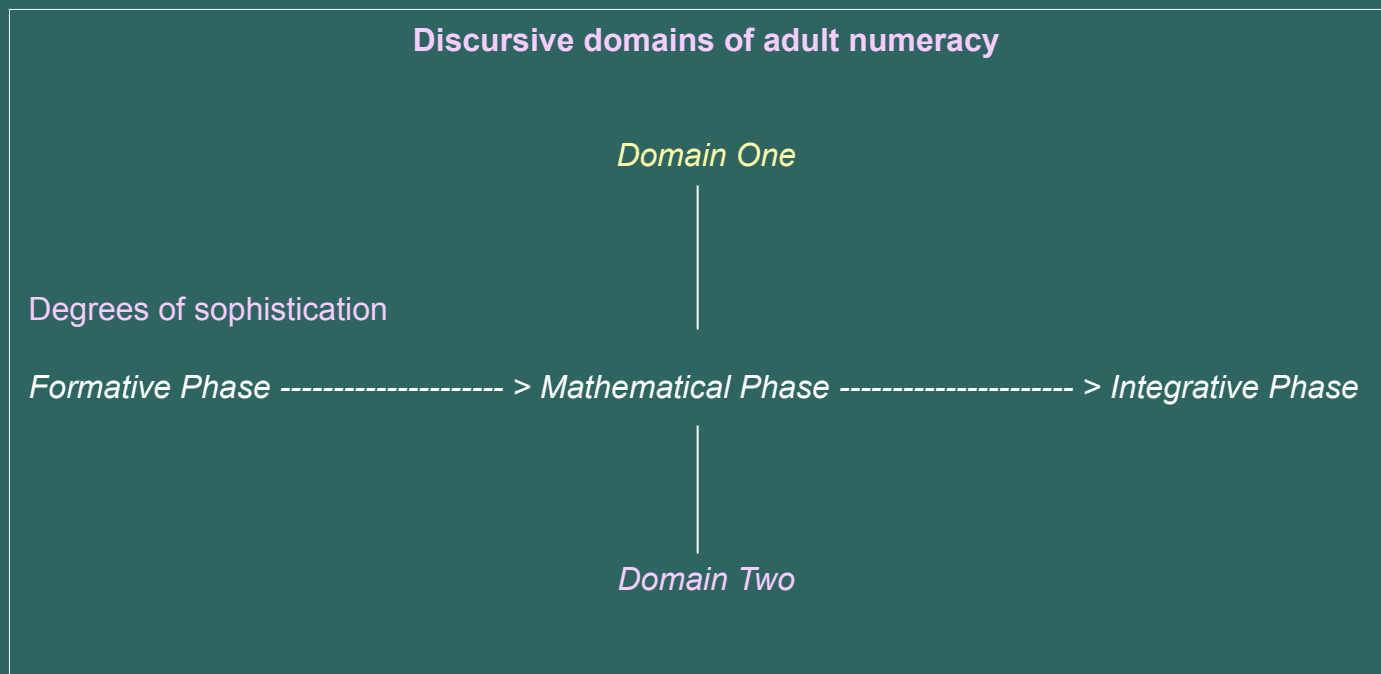
Discursive domains of adult numeracy: Domain One

- Formalisation and standardization of the curriculum
- Technologisation, unitisation and commodification of learning and learning materials
- Competency-based and outcomes-focussed
- Equivalence with educational levels in schools
- Supports normative claims about the beneficial effects of numeracy for the individual and for society
- Leading to certification - 'hard currency', tradeable on the labour market
- High exchange value but low use value

Numeracy in Domain Two

- Informal and non-standard mathematics practices and processes in adults' lives
- May bear little relation to formal, taught mathematics
- Often 'invisible' or unregarded by those directly concerned; often elided with 'common sense'
- High use value but no exchange value beyond the community of practice in which it occurs; it is 'soft currency' (Coben, 2006)

Conceptualising adult numeracy in terms of conceptual sophistication and discursive domain (adapted from Coben, 2006)



Conceptualising adult numeracy: new directions

- Numeracy operates in two discursive domains characterised by different degrees of use value and exchange value (Coben, 2006)
- Combining Maguire and O'Donoghue's (2003) conceptual framework with these domains offers a way of organizing competing definitions and locating frameworks, standards and curricula (Coben, 2006)
- Integrative definitions of numeracy have influenced recent pedagogical frameworks and standards in the USA and elsewhere
- Constructivist views of learning have been influential (i.e., learners actively construct knowledge by integrating new information and experiences into what they have previously come to understand)
- A broad range of research is relevant - on: learners' experience; numeracy situations and practices in the workplace and elsewhere; mathematics anxiety; brain research (see OECD, 2007); teaching and assessment for numeracy; professional development; theorising adult numeracy; adult learning; literacy and language learning; etc...

Modern definitions of numeracy imply:

effective **Use** not just knowledge and skills

Purpose making sense of use

Situatedness shaping use and purpose

Critical engagement on the
part of the numeracy 'agent'

Teaching for numeracy

- Builds on the knowledge students bring
- Exposes and discusses common misconceptions
- Develops effective questioning
- Uses cooperative small group work
- Emphasises methods as well as answers
- Uses rich collaborative tasks
- Creates connections between mathematical topics
- Uses technology in appropriate ways

(Swan, 2006)

- Uses formative as well as summative assessment

(Black & Wiliam, 1998)

Research-based principles of adult learning

- Learning is a purposeful, goal-directed activity building on prior knowledge and experience to shape and construct new knowledge and a social activity embedded in a particular culture and context.
- Effective learning requires that the learner understand not only the facts but the underlying principles, patterns and relationships acquired through the application of knowledge.
- Knowing when and how to apply what has been learned (procedural knowledge) is central to expertise, and can be acquired only through practice in an authentic environment.
- Teaching involves informed interpretations of, and responses to, learners' approaches to learning.
- Metacognitive strategies can be taught.
- Scaffolding instruction helps learners to develop their fluency, independence and range as they move from being a new learner to becoming an expert learner.

(Coben, 2000; Tusting & Barton, 2006)

Assessment for numeracy

*“An assessment is defined as serving a **formative** function when it elicits evidence that yields construct-referenced interpretations that form the basis for successful action in improving performance, whereas **summative** functions prioritise the consistency of meanings across contexts and individuals.”* (William & Black, 1996)

There is firm evidence that **formative assessment improves learning** (Black & Wiliam, 1998)

Use value and exchange value are both necessary

50% of employers are dissatisfied with the basic numeracy of UK school leavers

Many firms see a grade C or above in maths and English at GCSE as a benchmark of employability. But this year barely half (55.2%) hit that standard in maths

(CBI, 2007)

A case in point: numeracy for nursing

- worthwhile *purpose*: numeracy is a ‘core skill’ for *use* in safe and effective nursing practice
- strongly *situated in practice*
- need and demand for a ‘*hard currency*’ of summative assessment with high exchange value and accountability and ‘*soft currency*’ of proficiency in numeracy
- nurses need to be *critically aware* at all times

A proposed national benchmark in numeracy for nursing in Scotland

Derived from research-based principles in:

- adult learning
- supported, contextualised numeracy learning for safe nursing practice
- authentic and effective assessment

Pilot project focusing on medication dosage calculation

Interdisciplinary team

Establishing an Assessment Benchmark for Nursing: the example of Medication Dosage Calculation

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NHS Education Scotland (NES) <http://www.nes.scot.nhs.uk/>

2007-09 (Coben et al., 2007, in press)

Numeracy for Nursing - challenges (1):

- Lack of clarity over what numeracy for nursing is means that nursing gatekeepers (universities & employers) may be unclear about what numeracy is and how to teach/assess it, or they may think they know what it is and teach/assess it inappropriately
- Strong manifest disaster criterion: poor nursing numeracy may result in dead or injured patients, prosecution, the end of the nurse's career and damage to the profession

**“A Third of New
Nurses Fail Simple
English and Maths
Test....”**

**By Celia Hall,
Medical Editor
Daily Telegraph
05/08/2006**

These are the types of questions the ‘rigorously’ tested Christ Church students were having trouble with

You start your late shift at 8 p.m. Which of the following times is the same as 8 p.m?
a 18.00 b 19.00 c 20.00 d 21.00

Ambulance staff have a holiday entitlement of 27 days per year, rising to 33 days after 10 years service. Putting the small number first, how many must you add to get the larger number?
a 4 b 5 c 6 d 7

Under the Agenda for Change, all directly employed staff of the NHS will work thirty seven and a half hours per week. One half hour is?
a 15 minutes b 20 minutes c 30 minutes d 45 minutes

The price of a prescription is six hundred and fifty pence. What is the correct format for the price of a prescription in decimal nomination?
a 605p b £6.50 c £65.0 d £6.05

Blood can be frozen and stored for 10 years. The temperature of frozen blood must be greater than -40 degrees. Blood can be frozen at 40 degrees below zero. If frozen blood gets 40 degrees colder what is the new temperature?
a -80 degrees b -0 degrees c 0 degrees d 40 degrees

One non-emergency volunteer driver carries six people in one journey. How many journeys must the driver make if he is to transport 24 patients?
a 3 b 4 c 5 d 6

Numeracy for Nursing - challenges (2)

- There is no benchmarked standard for numeracy for nursing, so the measure of a nurse's numerical competence is:
...in the eye of the recipient of evidence of that competence, be it Higher Education Institutions, Regulators, Employers or Service Users. (Hutton 2004)
- Nursing lecturers may not know how to teach for numeracy
- Adult numeracy tutors may not know the numeracy requirements of the healthcare context (and there are too few trained, experienced adult numeracy tutors)

Integrating numeracy into healthcare education and training

Ways forward:

- Team approach - healthcare professionals and adult numeracy specialists working together on contextualised numeracy teaching and assessment
- Training, CPD, teaching, learning and materials geared to healthcare professionals' numeracy needs

Why benchmark numeracy for nursing?

- Universities must prepare their students for professional practice and play a part in ensuring a level playing field – but without a benchmark there is no clear standard to be met
- Without a clearly identified benchmark, employers don't trust enough to rely on registration proficiency and test for themselves (without a benchmark)...
- When nurses are newly qualified this is expensive repetition which risks credibility of courses and the relationship of trust between employers and educators
- Nurses who attend employment interviews find different standards, different modes of testing and different levels of expectation. This is ineffective and exacerbates stress and anxiety for applicants

Why not...

- Mathematics learning can be associated with anxiety. This is recognised to affect performance, and lead to aversion and avoidance for fear of failure. An ingrained ethos of healthcare is that mistakes are shaming... 'first do no harm...' and negative 'drug error'!
- Unless managed effectively, testing with the possibility of failure may add to this... and may create a vicious circle of stressed and under-confident professionals

Why medication-related calculation?

Most common exemplar for nursing numeracy

Incorrect calculation of medication dosage can harm patients and the reputation of the profession

There are currently no accepted national standards in the UK for teaching and assessing dosage calculation skills during pre-registration nurse training

Strategies to improve nurses' drug calculation

- The literature indicates that in order to improve drug calculations, strategies need to focus on both the mathematical skills and conceptual skills of student nurses, so they can interpret clinical data into drug calculations to be solved.

(Wright, 2007)

Nurses' numeracy must be:

Situated in the healthcare context

Robust: to cope with stress, anxiety and time pressures of nursing

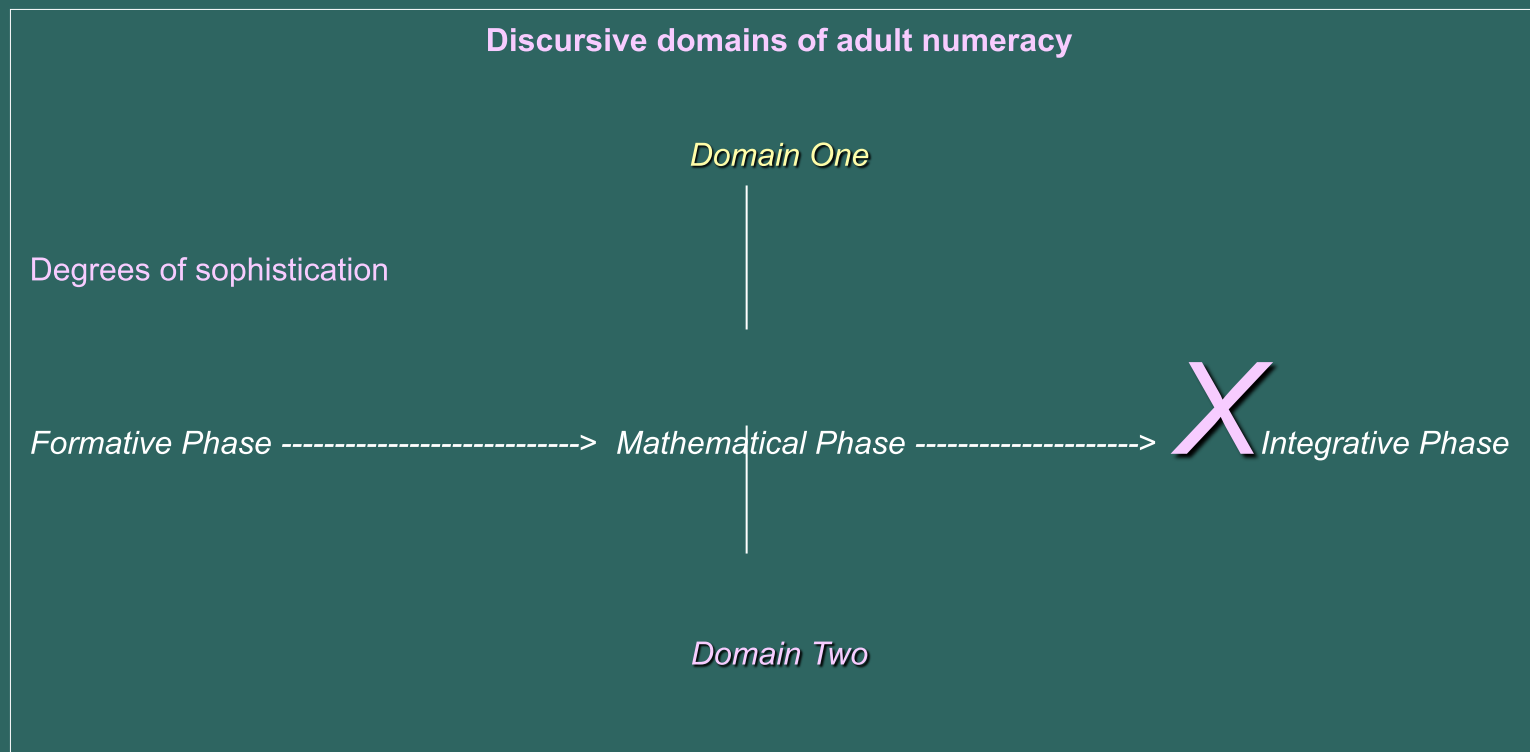
Teaching and assessment should generate:

- independence
- good critical judgment (e.g., on how accurate to be, when to estimate, within what tolerance and why)
- proficiency
- accountability

Teaching and assessment for nursing numeracy...

- must operate in both Domains One & Two - it must have high use value *and* high exchange value
- It must be integrative, i.e., incorporate the mathematical, cultural, social, emotional and personal aspects of each individual in a particular context
(Maguire & O'Donoghue, 2003)
- Assessment for numeracy in nursing must be formative (for effective learning) and summative (for accountability)

Numeracy for nursing - *X marks the spot*



Nursing must recognise the relative importance of numeracy in the whole context of practice



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