Numeracies, mathematics and values – a cultural perspective.

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1. Introduction - numeracy in a global cultural context

Global citizenship has many implications for mathematics education.

Australia is predominantly a migrant country.

More than one in four of Australia’s population was born overseas.

They came from more than 150 countries.

In Japan the construct of ‘culture’ also has strong meanings, and therefore important implications for numeracy education.

Three main constructs in mathematics education:

curriculum, teaching, and learning, embedded in social, cultural and political contexts.

Focus here on two main areas:

culturally and socially-based numeracies, and

values in numeracy teaching.

2. The challenge of culturally-based mathematical knowledge.

In the last 20 years, two main strands of research have developed in mathematics education.

Strand 1. Ethnomathematics

Cultural roots:

Western Mathematics is one form among many.

Wasan is another in ancient Japan.

Interactions between mathematics and language:.

Languages and other symbol systems are the carriers of mathematical ideas and values in different cultures and societies.

Human interactions:

Focus on mathematical activities and practices in society.

Roles of other people in mathematics education.

Values and beliefs:

Any mathematical activity involves values, beliefs and personal choices.

Current curriculum structures show mathematics as culture and value free.

Usually we are preparing an elite who will study mathematics at university.

But this is inappropriate when considering numeracy.

Majority of the population debarred from discussion, critique, of the underlying mathematical constructs used in today's highly mathematically formatted and structured society (Skovsmose, 1994).

- Research needs: how to make mathematics curricula more culturally and socially responsive?

- A numeracy-based curriculum is one way to emphasise the societal and cultural aspects of mathematics.

Strand 2. The idea of ‘context’ within which the mathematical practice is situated.

“Situated mathematical practice” (Kirshner & Whitson, 1997; Zevenbergen, 2000).

Based on studies of mathematical activities occurring outside school (e.g. Abreu et al., 2002; Lave & Wenger, 1991)

These practices are the roots of numeracy education.

The context of school is different from the contexts outside school where numeracy practices occur.

How can we ensure that the school context doesn’t ignore the outside-school numeracy contexts?

How to develop a numeracy curriculum for schools, to satisfy

1. the needs of a modern democratic society for having fully educated and politically contributing adults, and also
2. the needs of the higher mathematical institutions which still want competent, and in some cases brilliant, mathematicians?

3. Numeracies and mathematical theory

Numeracy is being defined in many different ways:

- as a part of mathematics, often as simple or basic arithmetic
- as far more than just arithmetic
- as linked to literacy rather than to mathematics
- as mathematical literacy
- as quantitative literacy

I believe we need a conceptualisation of numeracy which meets three criteria:

- it recognises the existence of many numeracies
- it clarifies the links between numeracies and mathematics, and
- it clarifies the educational task facing those responsible for numeracy education.

- The cultural history of (Western) Mathematics shows us that its essence is its generality

whereas

- the ethnomathematics literature indicates that numeracies are all about particular practices, and they also include meanings, beliefs and conceptualisations

Both Mathematics and numeracies are powerful forms of knowledge in their own contexts.

The context of Mathematics is the abstract world of the theorist.

The context of numeracy is the pragmatic world of the ethnomathematical practitioner.

- So, the relationship between them is between *theory* and *practices*, with Mathematics being the theory and numeracies being the practices.
- Mathematics explains, theorises, and clarifies the rationales underlying those practices, and also gets applied through various developments of those practices.
- This conceptualisation meets the three criteria above.

- **The question "Why does any particular numeracy practice work?" is the key to clarifying the educational task.**
- **Learners bring many numeracy, and ethnomathematical, practices to their education, mainly from their families but also from their wider society contacts – friends, media, other adults etc.**

- But the naive learner lacks any understanding of the Mathematical theories that help to explain those practices.
- Without the Mathematical theories they lack the tools to understand, analyse and critique those practices.

Without these tools they become trapped by those practices, just as most adults currently are, without the understanding to question them, and perhaps even develop alternative practices.

There are many ‘why’ questions that can be asked of school students within the current currulum, such as these simple ones:

- Why do the many different practices for counting, addition, subtraction etc. all succeed?

It is because of the underlying mathematical structures of those algorithms.

- **Why do two negative numbers when multiplied together give a positive number?**

  It is because of the wish to keep the rules of number theory consistent when dealing with positive and negative integers.

- **Why can you divide one fraction by another by ‘turning it upside down and multiplying’?**

  Because multiplying the numerator and denominator of a fraction by the same number doesn‘t change the value of that fraction.

- **Why does a three-legged stool always balance, while a four-legged one doesn't?**

Because 3 points determine a plane.

Asking these ‘why’ questions may seem inappropriate to some, especially since the demise of proof from the school curriculum in many countries.

Proofs are the ultimate mathematical explanation. But it is not necessary or appropriate to learn proofs of theorems just for examinations.

Far more important is to understand the role of the process of ‘proving’ in the development and education of the numerate and Mathematically literate student.

‘Why’ questions can be asked at any level of Mathematics and numeracy practice, and within Mathematics itself the answers to those questions will often be found by proving

My conceptualisation:

Numeracies are culturally, socially, and historically determined, and practically powerful.

Mathematics has developed culturally in a different way, and in a different context, as an extremely powerful way of theorising, explaining, and extending our knowledge of the world.

Some implications for numeracy/Mathematics school curricula:

- These curricula need to recognise, and to be built around, the many numeracy practices which the learners have learnt at home and in the wider society.
- Not all the curricular content can be determined centrally. Much must be determined locally within a national or regional framework.

- These curricula need also to introduce learners to the many numeracy practices which powerful others in society practise and which can impinge on their lives in crucial ways.
- These numeracy practices need to be clarified, theorised, and critiqued in terms of the Mathematical theories behind them.
- This is to reverse the usual approach of teaching the Mathematical theory followed by its applications.

The particular curricular challenge is therefore how to create a sensible framework which can structure both national and local numeracy/Mathematical curricula.

4. The challenge of ‘hidden values’ in numeracy and Mathematics teaching.

Many people still think Mathematics is universal and (thus) culture-free, and therefore also value-free.

If one asks “What values are you transmitting or promoting when you teach Mathematics?”

one is often met with a blank look.

In parallel curriculum developments such as Science and Technology in Society, values are taken as serious curricular content.

Values teaching and learning does occur in the teaching and learning of Mathematics and numeracy, as it does in any educational encounter.

- But values are never addressed explicitly in mathematics classrooms, which implies that any values learning which takes place there must happen implicitly.

- The values being learnt are not necessarily the ones which teachers would ideally hope for.

Why is there little explicit values education in Mathematics classrooms, and very little explicit addressing of values in the general discourse about Mathematics and numeracy education?

Why do Mathematics educators know so little about values in this context?

Is it because much teaching of values is done by modelling, by imitation, and by other implicit, rather than explicit, methods which we fail to see and recognise?

Values in Mathematics education appear to have the role of cultural ‘hidden persuaders’ (Bishop, 1990).

Could it be that it is the implicit nature of values teaching in Mathematics which has continued to feed the myth that mathematics is value-free?

Papers and articles referring to our early research in this area can be found at this web-site:

http://www.education.monash.edu.au/centres/scienceMTE/vamppublications.html

Values in Mathematics and Science Education publications

Publications and useful links on values in mathematics education, and related topics

Related publications on values teaching in (mathematics) education

Publications and useful links on values in science education, and related topics

There are two main kinds of values which teachers seek to convey: the general educational and the Mathematical.

Many examples of these general educational values are explicitly stated in official documents in countries which take the explicit teaching of values seriously:

- **Indonesia's 'Panca Sila'**
- **Malaysia's 'Nilai-Nilai Murni'**
- **Singapore's 'Shared Values'**
- **Thailand's recent educational reform documents**

BUT

How can we begin to understand the idea of Mathematical values?

Some particular values have developed through the history of Western Mathematics (Bishop, 1988) and they may well apply to some numeracies also.

My analysis gives the following six sets of values, conceptualised as three dimensions of the value ‘space’:

1 Rationalism

emphasises argument, reasoning, logical thinking and explanations. Rationalism concerns theory, and theorising.

2 Empiricism

emphasises ideas in Mathematics as fixed, and rather like objects, with a symbolised form. Mathematical practices are also seen to be fixed and immutable.

3 Control

emphasises the power of Mathematical knowledge through the mastery of rules, facts, procedures and established criteria. It also promotes feelings of security in this knowledge.

4 Progress

emphasises the ways that Mathematical ideas grow and develop, through alternative theories and the questioning of existing ideas. It also promotes the values of individual creativity.

5 Openness

emphasises the democratisation of knowledge, through demonstrations, proving and individual explanations.

6 Mystery

emphasises the abstractness, and mystique of Mathematical ideas as well as the dehumanised nature of Mathematical knowledge.

In this conceptual ‘space’ each value is paired with its complementary partner, as follows:

- Rationalism with Empiricism, which is about the ideology of Mathematical knowledge
- Control with Progress, about the relationship of Mathematical knowledge with society, and
- Openness with Mystery, about how individuals relate to Mathematical knowledge.

Seah's (1999) research on values in textbooks confirmed my earlier hypothesis (Bishop, 1988) that the values being emphasised in Mathematics classrooms were mainly those associated with Empiricism, Control and Mystery.

These three values are just those which would underlie an approach which emphasises the mastery of routines, resulting in secure knowledge, which is treated as fixed and passed on from generation to generation.

What are missing are the complementary partners of

Rationalism, Progress and Openness, which would enable learners to experience the more theoretical, progressive and democratising aspects of a Mathematical education.

So how could this situation be changed?

Generally, the research literature indicates that values education involves two essential components.

1. The explicit development of awareness of certain values, be they general educational values or more Mathematical values as described above, and

2. the explicit awareness and development of alternatives, choices and choosing, preferences, and consistency (see for example, the advice of Raths et al.,1987).

So numeracy teaching must ensure:

- **the full range of values are being reflected in the teaching, and**
- **the numeracy and Mathematics learning context is a place of explicit choices and choosing for the learners.**

- **Teachers of numeracy and Mathematics should be presenting their learners with activities that encourage them to make choices, and to discuss and compare their individual choices about, for example,**
- **the various approaches to solving problems,**
- **the different criteria for judging the worth of solutions,**
- **the Mathematical interpretations of numeracy practices, and**
- **the wider relevance of the numeracy practices and the Mathematical models being taught.**

For example,

- **a task such as ‘*Describe and compare three different proofs of the Pythagorean theorem’* would inevitably engage secondary school students in discussing the values associated with proving.**
- **The choosing of symbols with which to represent Mathematical ideas and numeracy practices.**

- Even the simple act of presenting different problem-solving solutions to be compared and contrasted by the learners stimulates the ideas of choice, criteria and therefore values.

- A general teaching strategy would be always to take time, following some problem-solving activity, to discuss what happened, why, and what has been learnt which could help with the choices next time.

This is not a natural thing for learners to do, nor is it at present a typical thing for teachers to encourage, but this is where teachers can focus learners' direct attention on:

- the awareness of values;
- the clarification of values;
- the conflict between different values, and even
- the critique of values.

6. Concluding remarks

- Complex issues surround numeracy and Mathematics education.
- There are many implications here for the practice of numeracy education,
- Also there is scope for increased research on the whole area of numeracy education.

- In most countries it is currently an under-funded and under-supported research area.

- It should be better supported because it is already clear that research into ethnomathematics and other socio-cultural aspects of numeracy and Mathematics, are revealing the promise of more democratic approaches to Mathematics education.

- **This is a promise which all countries desperately need fulfilling if they are to develop a more critically aware citizenry.**

- **It is also what our global community needs**