Report from Summer Institute 2002

Adult numeracy curriculum and assessment: How they shape and are shaped by our visions of 'competence'

by Beth Marr Center for Research into Post Compulsory Education and Training. RMIT University, Melbourne, Australia

Beth Marr put together a paper as a tool for reflection, argument, and perhaps a framework for future discussion.

Beth wrote to the participants:

To get the maximum benefit from this paper, it would be worth a few minutes, before reading it, to consider the following question from your own perspective:

'What would you look for in your students to decide if they were 'competent' at a particular level of numeracy?'

Considering the question beforehand will enable you to compare your own response with the opinion from Australian numeracy teachers described in the paper. At the end of the paper there are other, more general, questions regarding curriculum, assessment and teaching practices which you might like to consider as you make your way to the Institute.

During a recent project in Australia on assessment tasks and procedures, experienced adult numeracy teachers were asked about their notions of numeracy competence. The common themes in their responses led us to develop a model of Holistic Numeracy Competence in the form of a jigsaw puzzle. [Figure 1]

The seven interlocking, or interdependent, components of this model are seen as integral to the full picture – a developing 'identity' as a more numerate person. A change from an '**I can't** ...' to an '**I can** ...' type of person: a shift towards an identity as a more numerate individual.

Whilst we consider the components, on either side, to be equally important, we acknowledge that the divisions are arbitrary and that there is a degree of overlap. However, some essential features of a prospective model of holistic competence seem less arbitrary: There is a cognitive domain and an affective (feelings) domain, with confidence touching all aspects in a two-way relationship. Some confidence is necessary to begin the development of any of the other components, and it is likely to increase as any of them is strengthened.

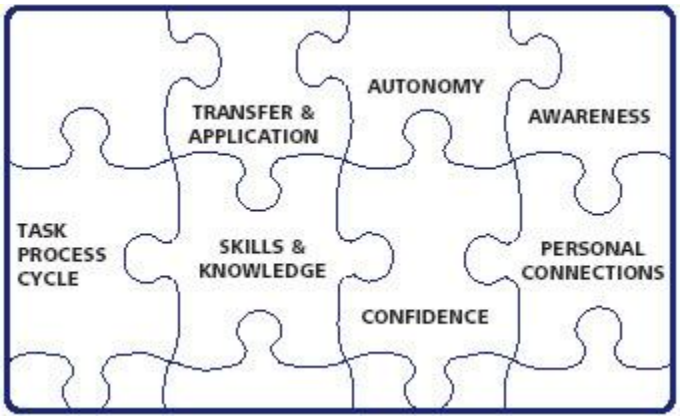

Figure 1: Model of Holistic Numeracy Competences - Numeracy 'Identity'

The Model

Here is a brief description of the components of the model, grouped as cognitive and affective aspects:

Cognitive aspects of competence

Skills and Knowledge

Achieving the skills and knowledge listed in the curriculum documents was seen as a basic requirement for competence. Three aspects were highlighted: *repeated demonstration, understanding, and integration*.

Repeated demonstration
Students are able to confidently demonstrate the skills on more than one occasion.

Understanding
This requires understanding of concepts that go beyond the demonstration of skills and processes. For example, considering the formula for the area of a triangle, 'Oh yes! I can see the triangle's half of a rectangle.'

Integration
Students can fit together different pieces of knowledge and connect new mathematics skills into their existing repertoire of past knowledge; different aspects of numeracy are integrated, or drawn together by the students. They can see numeracy as related competencies rather than isolated skills.

Task Process Cycle

Students are able to find a pathway through whole tasks, not just perform isolated, out of context, mathematical skills: before using the mathematical skills, students need to be able to select the information they will need and decide on the appropriate strategy to apply; after performing the mathematical operations, reflecting on the meaning of their results,

deciding how reasonable they seem in real-world terms and considering likely implications.

We have called this series of steps the 'Task Process Cycle.' In short, it can be conceived of as four related components as shown in figure 2.

Many teachers referred to the importance of fostering this approach to numeracy at all levels, and very early in the teaching program. They referred to it variously as 'thinking about thinking', or 'mathematical thinking.' 'So to solve that problem, what do I have to do?' Also, the evaluative aspect indicates an important difference in competence: "between getting the wrong answer and knowing you've got the wrong answer, and getting the wrong answer but not knowing."

Transfer and application (of skills and knowledge)

This means being able to apply numeracy outside the classroom in a variety of situations, to real-life problems that may involve skills from a number of numeracy maths areas as well as the problem-solving process. "Would this person, in a shop, be able to deal with the money, would they be able to find their way around the world … and could they recall if the need is there?"

Transferring and applying skills can be seen as the culmination of the cognitive domain. It complements the combination of skills and knowledge used within the task process cycle to handle new situations. However, teacher comments such as: "When I feel that they've gained the skills, can apply them over a variety of situations and have the self esteem and the confidence to do more" indicate that the affective components of the model are considered essential companions to the cognitive aspects.

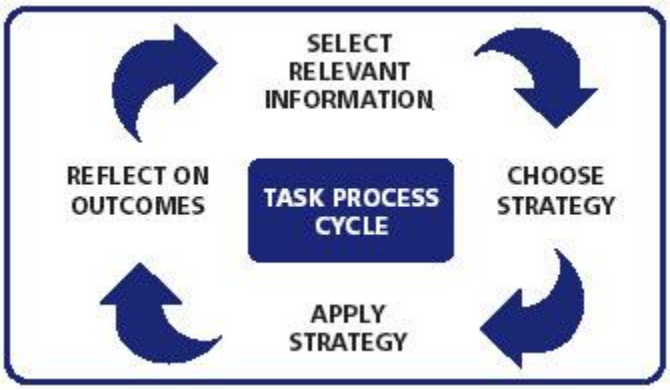

Figure 2

Affective aspects of competence

Confidence

The most interwoven component of all: the word 'confidence' arises constantly in descriptions of all other aspects. Since mathematics anxiety has a detrimental effect on

students' learning, "self- esteem has to be built up before a great deal of learning will occur." Shifts in students' confidence were, therefore, seen as vital. Experienced teachers explained that they look for more positive self-talk and confident body language as indicators of this kind of change.

Personal Connections

This aspect seems to touch on students' emotional relationship to their learning. It might be a connection with personal lives, interests and goals that motivates them to learn. Sometimes it is the ability to see how their learning is usable in their life outside the numeracy classroom that indicates real learning taking place: "making connections between what they do outside and what's happening in class". For example, "I won't use any of this stuff - I won't - I just get my brothers for things like that (building or painting). I would learn it better if I could see how it connects with things I might use in the office!"

Awareness of Themselves as Learners

Practitioners also highlighted students' awareness of the skills and knowledge they had gained, and the ways in which they had gained them – "to recognize what they know and understand … For somebody else to be telling them they're competent I'm not quite sure whether that helps. … I encourage students to become more aware of their own competence by pointing it out to them when they explain something to another student". Student participation in assessment discussions was suggested as another strategy for focusing on students' awareness of their learning. "It's a matter of them telling me how they're feeling and whether they can do it, whether they're happy, and they also get feedback from me".

Awareness of their learning style, "knowing how you learn," was also seen as important, for example, a visual learner who benefited from realizing that she could understand better if she drew diagrams or pictures. Other students who were "very active, touchy, sort of 'doing people' - mechanics and the like … That's how they've learned things". Their learning style was validated by encouraging the use of concrete aids like blocks and counters. "They know that's how they need to do it, then they can move on from there. Once people know that it is OK to do it any way that you like, then I think that is very important for them to grow."

Growth of Autonomy as a Learner

This dimension of competence describes a growing independence in the learner, "their move from dependence to independence," "taking some control over their learning," for example, taking class investigations home and extending them, or saying to the teacher 'I really don't know this well enough. What can I do to be able to do it better?' " the confidence to ask you questions about their learning". Growing autonomy is also evident in students' willingness to have opinions and take risks, to get started on new tasks with less assistance than before - not saying 'I don't know, I've got to ask somebody else' … "Some of these people have been so wrong for so long, there is a real risk in putting

anything down on paper at first."

Having seen the description of our proposed model you might like to pause and think back to your own responses to the questions of 'competence.' Are your responses reflected within the model? Do you agree with the aspects named? Are there important features missing?

Why a model?

After hearing the characteristics that teachers look for in their students when judging them 'competent,' we decided it was worth looking more closely at these aspects. We hope that explicitly 'naming' them might acknowledge their importance and raise questions regarding the focus in numeracy teaching, curriculum and assessment practices. We hope that this model, or others, might put both cognitive and affective aspects back on the agenda.

Naming the affective aspects

Some of the affective aspects were given a great deal of attention in the eighties when 'mathematics anxiety' was a new construct and adults were encouraged back to the classroom to right the old wrongs. However, more recently, with accredited curriculum, and restricted time to achieve prescribed numbers of learning outcomes, it may be considered dispensable, a non-essential and time-consuming aspect of teaching. Perhaps it is discussed in the first class, when students fill out a short questionnaire and discuss their feelings about past mathematics learning. Often it is never formally addressed again. Reflecting on the model now, it seems obvious and desirable to spend time on the affective side.

The model led us to recognize that we should reconsider strategies for working with the affective (emotional and reflective) aspects of students' learning. We have trialed discussion starters, and written feedback tools designed to focus on students' feelings about their progress. We are looking for strategies that encourage them to acknowledge and articulate their positive achievements, not just their problems.

Naming the cognitive aspects

Naming the three cognitive components specifically should highlight some fundamental priorities in curriculum and teaching practice. For example, for application and transfer to be possible, the curriculum and teaching resources should not limit students in unrealistic ways. For instance, adult curricula which specify that at certain levels students should only operate on 'whole numbers' or numbers below certain magnitudes, like 10 or 100, run counter to the reality of adults' lives. Lives are full of messy numbers: prices like $259.95 and trains that run at 12:56 or 18:09.

The 'naming' of the aspects has certainly raised questions about how each of them might be achieved and particularly what priority each should be given. For example: Does a

strategy of teaching through application to real situations, prevent some of the 'big ideas' of mathematics being appreciated? Does it matter? And if it does matter, then what are the important "big ideas" that should be emphasized? 'How can we best model or 'scaffold' 'numerate thinking' and is it the same as 'mathematical thinking'?

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The model as framework

It is possible to use a model of this sort as a developmental or planning framework: to ask questions such as: 'What sort of teaching practices flow from this model? What sort of curriculum? What sort of assessment? Our recent project examined assessment implications. It is also possible to use the model as a framework for reflection. I will look at some of these below.

What sort of assessment flows from this model?

The model has led us to describe, and develop further, a variety of assessment strategies. For example, at lower levels, we use assessment through observation of real or simulated practical activities so that low literacy levels will not get in the way of realistic numeracy performance. At higher levels, we use a combination of written responses to realistic tasks connected to students' lives and interests, and records of teacher observations of practical tasks involving real artefacts and measuring equipment.

Tasks we have discussed for assessment purposes include:

- tasks which use realistic artefacts, such as supermarket items, cooking equipment, real maps, timetables calendars, clocks...
- tasks which are openended, allowing students to achieve success at a range of levels;
- tasks negotiated between the teacher and the student, around student's interests.

These assessment strategies are far removed from short answer tests and rote-learned processes applied to sets of abstract exercises, especially if these are centrally dictated by distant government officials.

What sort of curriculum flows from this model?

Having spent a great deal of time considering these aspects of teaching over the last year, I have given this some priority on my current agenda. However, I am aware of the likely feelings of teachers when these ideas are put before them. "How will I fit all that into the short time I am given to cover the curriculum?"

In Australia we have worked hard to counteract the 'limited vision' of numeracy as number calculations, broadening it to focus on a range of practical functions: from measurement and design to data analysis; from money manipulation to navigation. There is a focus on whole tasks, on applications relevant to the various real worlds of our students, the 'social discourses' that are part of our students' lives. The most commonly used curriculum, the 'Certificates of General Education for Adults' (CGEA) (ACFE, 1996) is based on this approach. Learning outcomes such as: 'Can use and interpret whole numbers (including large numbers), simple fractions, decimals and percentages **to make decisions about money and time in familiar situations'** are used to keep this functional approach uppermost (see Ciancone & Tout, 2000). Also, as requested by teachers during the curriculum consultation phase, we have included details of the mathematical skills that would be likely to be incorporated in these outcomes at the four levels of the curriculum framework. In doing this we have covered all or most strands of formal mathematics: 'space and shape,' 'measurement,' 'chance and data,' not just 'number.' Most teachers are happy with the approach of our CGEA curriculum document and say that it has led them to broaden the scope of their numeracy teaching (Marr, et. al., 1998).

On the other hand, teachers are also saying that it is difficult to cover the curriculum, given the funding limitations on the time available for teaching. There is a risk that lack of time, together with stringent reporting requirements, might pressure teachers away from spending time on the development of the whole person in relation to numeracy and reduce the curriculum to a checklist of skills to be demonstrated.

If we want to ensure that teachers can spend time scaffolding a logical, mathematical approach to tasks (using the 'Task Process Cycle') , or facilitating 'awareness' of learning and developing autonomy in our students, then we may have to make some hard decisions.

Do we have to stop worrying about the broad range of numeracy outcomes and encourage students to work towards those they will find most rewarding or relevant 'applications'? Do we focus on the outcomes that will encourage their 'personal connections', and through these build their 'confidence' and numeracy identity? If this is the way forward it opens up a number of other dilemmas.

How would the students make meaningful choices about their areas of interest if we did not introduce them to the range of possibilities? For example, some students' reason to be in the class is to change their identity in relation to the discourse of the school mathematics classroom, that is, to be able to finally succeed with the things they failed at school. Would we then be doomed to teaching fractions and long division forever?

Sometimes the curriculum is the external motivator to broaden students' outlook or expose them to new, interesting and important aspects of numeracy.

How does individual negotiation about content and applications fit in with other important aspects of classroom teaching methodology? For example, observation and past practice have alerted me to the importance of facilitating connections between students in adult numeracy classes. I strive to encourage learning 'noise', in order to develop social rapport in the classroom, to lessen anxiety about the mathematics and to forge cooperative working relationships between the students (Baynham, 1996; Beach, 1992; Benn, 1999) [see also Marr, 2000]. These strategies create an atmosphere as far removed from the traditional, anxious and silent mathematics classroom as possible. To me that means a mixture of games, cooperative activities to explore concepts and to build related mathematical language, as well as some individual, calculation-based tasks. I wonder how my techniques will fit with more individual negotiation of meaningful whole tasks in diverse content areas. Does it come down to a clash between numeracy and mathematics teaching?

The model as a framework for reflection

Our Holistic Model of Competence, can, and probably should be, critiqued, since the arbitrary nature of boundaries and naming are perhaps more useful at the stage of analysis than after their inception. But if it can be accepted for the moment, it may be a useful framework for reflection on current curriculum, teaching and assessment practices.

Hopefully practitioners, practitioner-researchers and curriculum writers can pause to look through objective eyes at their current educational circumstances, and ask themselves:

"Which of the seven components of the model are more likely to be developed through my current situation?"

Situation' is a deliberately broad term. It could apply to the curriculum, the program in which we work, or our own classroom practices. The model can be a useful tool for reflecting at all of these levels. For example, if the curriculum is still being largely influenced by school mathematics thinking, then the 'skills and knowledge' component is likely to be given a great deal of emphasis. You might then consider whether students make 'personal connections' in any real-world sense and whether 'application and transfer' is given space in the teaching. Literacy teaching has moved beyond merely teaching fragmented skills such as grammar and spelling, towards a real-task approach. Can such a fragmented approach remain acceptable for numeracy?

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On the other hand, if the teaching is predominantly influenced by literacy/ numeracy philosophies, then 'application' is likely to be a paramount classroom concern. You might then consider whether this assists 'personal connections': whether the situations for application are chosen by the teacher, the students or the worksheets. (Do contexts outside students' experiences help or hinder their learning of new skills?) It might also be interesting to find out if students actually feel they are developing mathematical 'skills and knowledge' through the process. Does their confidence usually increase and what are the contributing factors?

These are just some examples of the questions generated by the model. I expect that you will come to the Summer Institute with lots more.

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1. Further details of this project and a fuller description of the model can be found in the working draft of Marr, B & Helme, S. (2002). Towards a Model of Holistic Numeracy Competence. - by email beth.marr@rimt.edu.au.
2. The skills of 'Using mathematical techniques' and 'Problem solving' are acknowledged as desirable generic skills to be fostered in all Australian Vocational Education and Training curriculum documents.