DOCUMENT RESUME

ED 359 840 FL 800 662

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TITLE Removing Cultural Barriers to Numeracy.
PUB DATE Oct 92
NOTE 16p.; Plenary address at the National Conference of the Australian Council for Adult Literacy (Sydney, New South Wales, Australia, October 9-11, 1992).
PUB TYPE Speeches/Conference Papers (150) -- Viewpoints (Opinion/Position Papers, Essays, etc.) (120)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Cultural Awareness; *Cultural Context; Cultural Differences; English (Second Language); Ethnic Groups; Females; Foreign Countries; Literacy; Mathematics Anxiety; *Mathematics Instruction; *Mathematics Skills; Minority Groups; *Number Concepts; *Numeracy

ABSTRACT

A plenary address to an Australian conference on adult literacy focuses on cultural barriers to numeracy. Mathematics, and therefore numeracy, is considered as part of cultural knowledge. It is noted that over the last decade there has been a growing awareness of the cultural basis of mathematical knowledge and teachers can no longer assume that mathematics is culture-free and therefore value-free. Numeracy is defined as "the particular mathematical knowledge needed by every citizen to empower them for life in that society." It is shown that particular groups have experienced alienation from and conflict with mathematics as it is commonly taught. These groups include ethnic minority children in westernized societies, second language students, indigenous "minorities" in westernized societies, girls in many societies, western "colonial" students, fundamentalist religious groups, children from lower-class and lower-caste families, physically disadvantaged students, and rural students. It is suggested that the key is to first recognize the existence and legitimacy of different mathematical practices, and then search for similarities between them. All mathematical knowledge is analyzable into six main categories: counting, locating, measuring, designing, playing, and explaining. Each of these is described and discussed in terms of teaching and learning activities. Some general principles for numeracy teaching are presented (e.g., even if content is specified by a curriculum, the context for activities and tasks is open to choice by students and teachers). Contains 27 references. (Adjunct ERIC Clearinghouse on Literacy Education) (LB)

# REMOVING CULTURAL BARRIERS TO NUMERACY

Plenary address to 1992 National Conference of
Australian Council for Adult Literacy,
University of Sydney, 9 - 11 October, 1992.

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# REMOVING CULTURAL BARRIERS TO NUMERACY

**Alan J. Bishop**

I am particularly interested in numeracy teaching because

(a) it often involves adult learners, and there is not much research on adults learning mathematics

(b) those learners have frequently experienced failure and/or fear in earlier learning experiences in mathematics, and this presents interesting challenges for us

(c) it usually takes place in the context of non-formal education, which is a context that allows for more experimentation than the formal educational situation

(d) the learners often have some specific goals which they want to achieve, and which can therefore be a positive resource.

As a result of my own teaching experiences and in relation to those points, I firmly believe that

(a) all adult learners can get access to mathematical ideas, because they do mathematical activities all the time

(b) one can remove fear and failure in becoming numerate by emphasising strengths and existing competencies, rather than weaknesses and disabilities

(c) achieving success as a non-formal numeracy teacher is largely a matter of removing cultural and social barriers to learning

(d) progress is best made by building on the goal setting which the learners have already done, and the self-assessment which they inevitably do.

In this paper I propose to address these points in the context of considering mathematics, and therefore numeracy, as part of cultural knowledge. Over the last decade we have seen a growing awareness of the cultural basis of mathematical knowledge, and it is clear that teachers can no longer assume that mathematics is culture-free and therefore value-free.

For example, the mathematics which we teach values universal applicability as one of its qualities - that is, the mathematical principles and concepts are valid and can be applied everywhere. Angles in a triangle add up to 180° everywhere; 15 x 7 = 105 everywhere. However the paradox which we must confront is that this idea of universal applicability does not mean that this mathematics is value-free. Its very applicability is one of its values. The mathematics which is the foundation of our numeracy, derives from a certain cultural history and has developed certain values. A large part of my recent research effort has been devoted to trying to clarify just what the implications are for teaching, of the fact that mathematics is culturally-based and value-laden knowledge.

However it is not just enough to consider culture, particularly because numeracy and mathematics are not the same thing. We also need to recognise that numeracy sits within a certain societal context, and has been established through certain social situations. There is therefore a certain particularity about numeracy, and my definition of numeracy is "the particular mathematical knowledge needed by every citizen to empower them for life in that society". Different societies will, demand different numeracies. What is important knowledge in one societal situation will not necessarily be important in another society.

In this paper, therfore, I shall be looking at numeracy as culturally-based and socially-situated knowledge, to see what this perspective offers for improving the quality of numeracy teaching. To make a start on this I want first of all to focus on those students who experience alienation from, and conflict with, mathematics as it is commonly taught. Some examples of particular groups for whom conflict with, and alienation from, school mathematics has been documented are:

- Ethnic minority children in Westernised societies

  Many of our text materials contain problem situations which assume knowledge of life in the dominant society. I recall teaching a young girl from Bangladesh who had just arrived in England and who was faced with some mathematics problems involving reading a map of Salisbury and terms like 'ring road'. The text and the context were both totally incomprehensible to her, and thus whatever mathematical ideas she was supposed to gain from this experience were completely denied her.

- Second language students

  I asked a group of adults to 'imagine' some numbers when I called them out, and we discussed what images they conjured up. After considerable animated discussion one woman said all she 'saw' were the words, but added "I've only just leant English and I'm sure if you were to say the numbers in Polish I'd see them differently". I don't know Polish but I did say some numbers in French, and suddenly we all 'saw' the words! Is it always like that for second language students?

- Indigenous 'minorities' in Westernised societies

  There is much documentation of the conflicts experienced by Aboriginal students, by native American students, by Maori students and by black African students in South Africa.

- Girls in many societies

  Interestingly, and despite widespread acknowledgement of the alienation felt by girls, not all girls in all situations feel under conflict, and it is therefore instructive to reflect on why that should be so.

- Western 'colonial' students

  Models of mathematics education have been transported wholesale to former colonies, and in most cases have been found to be inappropriate and alienating.

- Fundamental religious groups

  School mathematics tends still to be presented as if it is value-free, but in some Moslem societies and within certain fundamental Christian communities there is felt to be much conflict with their religious beliefs.

- Children from lower-class and lower-caste families

  John Ogbu (1978), an anthropological researcher in America, believes that 'caste' is a more appropriate term for some under-achieving social groups than 'class', on the basis that one's class is escapable whereas one's caste is not. He explains the school failure of many blacks, native Americans, and certain immigrant groups in terms of their belonging to an under-caste in American society.

- Physically disadvantaged students

  To be blind, or deaf, for example, causes learners to be alienated by many of our mathematical curricular and pedagogical approaches. Imagine how you might teach a deaf student the meaning of 'if' or 'because' or 'nevertheless'.

- Rural students

  In many societies the mathematics curriculum and teaching context is based on the dominant values and cultural norms usually associated with an urban and a middle or upper class, or caste, group.

The alienation can be felt very strongly in many third-world countries, but exists to some extent in all countries.

The documented conflicts and barriers vary, for different groups but seem to concern some or all of the following:

- language
- geometrical concepts
- calculation procedures
- symbolic representations
- logical reasoning
- attitudes, goals, and cognitive preferences
- values and beliefs

How then can we approach numeracy as a culturally-based and socially-situated form of knowledge, with a view to removing these barriers? The key is firstly, to recognise the existence, and legitimacy, of different mathematical practices. Secondly, we need to search for similarities between those different mathematical practices.

Different mathematical practices are being revealed by research which comes under the general heading of 'ethnomathematics' and this research has three different and distinct foci:

(a) mathematical knowledge in traditional societies (Anthropology) e.g. Ascher (1991), Zaslavsky (1973), Lean (1986), Harris (1991)

(b) mathematical developments in non-Western cultures (History) e.g. Ronan (1981), Joseph (1991), Gerdes (1992)

(c) the mathematical knowledge of different groups in society (Social psychology) e.g. Lave et al (1984), Saxe (1990), de Abreu and Carraher (1988).

These research developments are showing us quite clearly the enormous range of mathematical knowledge and practices which exists in the world and which is usually ignored in educational contexts. (As an aside you might care to ask yourselves, does this mean that there is one mathematics appearing in different manifestations and symbolisations, or are there different mathematics being practised which have certain similarities?)

We will consider some examples of this range now, but I will do this by using the categories of <u>similarity</u> which I believe exist. It is these categories which I believe are the key to removing cultural barriers.

It appears from our research that all mathematical knowledge which has been documented in different societies is analysable into six main categories: counting, locating, measuring, designing, playing, explaining. All groups which have ever been studied and documented so far appear to do all of these activities, and together (I argue) these human activities create the knowledge we call mathematics.

As these categories are described, and discussed in more detail below, it is important for readers to be thinking of how to develop teaching and learning activities around these categories, and in particular how to do this with reference to any students' particular societal contexts:

Counting — This is to do with answering the question "How many?", with inventing ways to describe numbers, recording them and calculating with them. Fingers, part of the body, stones, sticks, and string are just some of the objects which are used as 'counters'. The range is enormous - for example Lean (1986) now at Deakin University has documented more than 1500 counting systems in Melanesia, Micronesia and Polynesia.

Joseph (1991) also indicates the range of calculation methods and algorithms used by different cultural groups.

Many interesting classroom activities can be generated by comparing counting and calculating procedures used by different learners.

Locating This activity concerns finding one's way around, navigating, orienting yourself and describing where things are in relation to one another. Compass directions, stars, the sun, wind, maps, are used by people all over the world to find their way and position themselves. Many geometrical ideas come from this activity, and students who perhaps have difficulty with number activities can often feel more comfortable with spatial and geometric ones.

Measuring "How much?" is a question asked and answered everywhere. Whether it is amounts of cloth, food, land or money which people value, measuring is a skill we all need to develop. Parts of the body, pots, baskets, string, beads, coins have all been used as well as writing and drawing amounts on paper or cloth.

An interesting class activity can be to discuss different ways of measuring. For example in a certain part of Papua New Guinea, the people compare their rectangular gardens' size by adding the length and the width, rather than by multiplying them. In North East Brazil the sugar-cane farmers compare the sizes of their four-sided fields by averaging the lengths of opposite sides and multiplying the two answers together. Both methods appear to work satisfactorily in the local context.

Designing Shapes are very important in all societies and these arise from designing objects to serve different purposes. The objects can be small and mundane, like a spoon, or large and symbolically important like a church. Mathematically we are interested in the shapes and the designs which are used, together with their different properties. For example, in Mozambique some of the housebuilders lay out the rectangular base for the house by using four equal lengths of rope all tied together at one end. How then do they make a rectangle?

**Playing** Everyone plays and everyone takes playing seriously! Not all play is important from a mathematical viewpoint but puzzles, paradoxes, rules of games, strategies for winning, guessing, and gambling are all important in the development of mathematical thinking. For teaching also, don't forget the more aesthetic contributions which certain dances and music can make to mathematics education.

**Explaining** Understanding why things happen the way they do is a universal human quest. In mathematics the interest is in why number patterns happen, why geometric shapes go together, why one result leads to another, why some of the natural world seems to follow mathematical laws, and in the process of trying to symbolise answers to these kinds of 'why' questions. A proof is one kind of symbolic answer, and there are many others, depending on what else is assumed to be true.

Given then that these six activities are in some sense universal, how can we make use of them to improve numeracy teaching? The most important point is that it is very possible to find many connections with the world of the students we are teaching. They all do these six activities in their everyday lives. Whether our students are home-makers coping with managing households, adults working in a variety of occupations, or unemployed or physically handicapped youngsters, you will find as a teacher that you can make contact with mathematical ideas in their world through these six categories. It is very important to emphasise that this is also true for all adults who come from a non-Western cultural background or whose first language is not English.

Some important implications come from this fundamental point:

(1) It shows how narrow some approaches to numeracy teaching can be and have been and also how limiting it will be to define numeracy too narrowly. I would personally wish to see numeracy teaching including all six activities rather than, for example, just 'counting', which is the case in many situations. The six activities aren't necessarily all 'on the curriculum' but they do offer ways into mathematical ideas from the learner's own perspective. Thus it may not be required to teach 'playing', but 'playing' and games offer an important route into many mathematical ideas.

(2) No cultural groups develop all mathematical activities to the same degree - so be aware of relative strengths, which can be built upon. For example, Western mathematical language is full of logical connectives. English and other Indo-European languages are so replete with logic words in general, that we almost seem to be obsessed with logic, argument, and rational argument. It needs therefore to be a priority in any numeracy and literacy course particularly for any NESB students.

(3) You may well find many differences in relation to these activities between the students in your classes. Don't be dismayed! The assumption of learner homogeneity is one of the most powerful barriers

to individual learner progress. Learner heterogeneity should be an advantage and a benefit to any teacher, rather than a problem. The more alike the students are, the more the teacher herself has to bring in relevant counter-examples, contrasts, comparisons etc. Contrastive mathematical backgrounds among the students can be a powerful resource in classrooms.

(4) Societies differ in the extent to which they value these different activities. This point reinforces the earlier observation that numeracy is socially-situated knowledge with its own particularities in any one society.

Some other general principles for numeracy teaching which can be deduced from this perspective are the following:

* Even if content is specified by a curriculum, the context for activities and tasks is open to choice by teacher and students. The teaching group is the actual joint creator of the knowledge environment within which the learning takes place, and that can be specifically negotiated by each particular teaching group.

* It is important to localise the numeracy activities, by using relevant local numerical and geometric information, and by acquiring and using local 'realia'. I am using the idea of localising to emphasise familiarity and therefore meaningfulness. The abstract and generalised problems found in most mathematics textbooks make assumptions about students' general knowledge of the society represented by the books. Those assumptions are often unwarranted and constitute strong barriers to learning.

* More small group working should be encouraged to reduce the fear which many still have of mathematical activities. Mathematics is still for many adults a subject which they believe you have to do by yourself. This is clearly not the case, and pedagogical ideas which are used in language and literacy classes for example are equally useful in numeracy classes, for all the same reasons.

* Encourage students to work mathematically in whatever language they wish to use. Recognise bilingualism to be of positive value rather than a problem. Groups can be discussing in a language with which the teacher need not necessarily be familiar. That doesn't seem to me to be a problem provided at some stage the students must present their ideas and results to the teacher and the class in the accepted language.

  An old adage says "you count, you swear, and you dream, in your first language". Whether that is true or not, the fact is that bilingual learners are usually much more aware of language aspects of numeracy and mathematics than monolingual learners, because they have to be. Any problems bilingual learners have in classrooms are usually caused by the dominant monolingual speakers - either the teacher or the other students.

* Focus your attention, and the classes activities on students' strengths and preferences, rather than on deficiencies and weaknesses. This is clearly a message which underlies all the previous points. The deficit model of teaching and learning numeracy has been found to be inadequate because of its tendency to see learners in an inadequate and therefore negative and inferior light. It also places them in a dependent mode, which is also unhealthy in both the short and the long term. Ultimately they will need to survive without the teacher and be an independent and contributing member of society. The best way a

teacher can help is by building on the students' strengths, not denying them, and by removing whatever cultural barriers seem to be in the way of the students using their strengths maximally.

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## Further information

My professional background includes working in the field of mathematics education for many years, both as a teacher at several different levels, and as a researcher. My teaching and my research interests are closely related. I have taught physically handicapped children and adults, young people from ethnic minority groups in U.K., extra-curricular mathematics classes with gifted, black youngsters in USA, teachers and young people in Uganda, Iran and Papua New Guinea. I have been curious about how to make mathematical ideas accessible to all learners and that has taken me into some intriguing areas of research and into some very challenging teaching situations.

I am now Professor of Education at Monash University, having moved here from Cambridge University, England, where I was lecturer in charge of mathematics education for 23 years.

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