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Mathematical Literacy

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ABSTRACT

This chapter investigates different perspectives on mathematical literacy that vary with the values and rationales of the stakeholders who promote it. The central argument is that it is not possible to promote a conception of mathematical literacy without at the same time – implicitly or explicitly – promoting a particular social practice. It is argued that mathematical literacy focussing on citizenship also refers to the possibility of critically evaluating aspects of the surrounding culture – a culture that is more or less colonised by practices that involve mathematics. Thus the ability to understand and to evaluate these practices should form a component of mathematical literacy.

1. INTRODUCTION

There is an expanding body of literature referring to the terms ‘numeracy’ and ‘mathematical literacy’, although sometimes these terms are used only as a synonym for mathematical knowledge. On the other hand, much of the literature does not refer specifically to ‘mathematical literacy’, but is relevant because of its concern with issues such as the goals of mathematics education, mathematics for all, the public image of mathematics, or with the role of mathematical knowledge for scientific and technological literacy. Accordingly, the references given in this chapter are neither comprehensive nor restricted to the discussion of numeracy or mathematical literacy.

Section 2 of this chapter briefly deals with the development of the terms ‘numeracy’ and ‘mathematical literacy’. One main part of this chapter is divided into five subsections. It provides a critical account of different perspectives on mathematical literacy. The central argument is that it is not possible to promote a conception of mathematical literacy without at the same time – implicitly or explicitly – promoting a particular social practice. Section 3.1, *Mathematical Literacy for Developing Human Capital* considers attempts of developing a cross-cultural definition of mathematical literacy for the purpose of generating measurable standards. Section 3.2, *Mathematical Literacy for Cultural Identity* reviews literature on ethnomathematics with respect to its implications for conceptualising mathematical literacy. Section 3.3, *Mathematical Literacy for Social Change*

deals with a conception of mathematical literacy that promotes the use of mathematical knowledge for analysing critical features of societal reality within a process of pursuing a different reality. Section 3.4, *Mathematical Literacy for Environmental Awareness* considers the possibilities of linking mathematical literacy not only to an individual's capacity to solve personal and local problems, but also to global environmental concerns. Section 3.5, *Mathematical Literacy for Evaluating Mathematics* schematically develops a conception of mathematical literacy that reflects the view of the author more than the previous sections. It is argued that mathematical literacy focussing on citizenship should refer to the aim of critically evaluating aspects of the surrounding culture – a culture that is more or less colonised by practices that involve mathematics. Thus the ability to understand and to evaluate these practices should form a component of mathematical literacy.

2. FROM NUMERACY TO MATHEMATICAL LITERACY

It is indisputable that in today's society the ability to deal with numbers and to interpret quantitative information is an important component of literacy in addition to speaking, writing and reading. At the same time, however, it is difficult to say what the distinct meanings of 'numeracy' and 'mathematical literacy' are.

There are a number of perspectives on numeracy or mathematical literacy that vary with respect to the culture and the context of the stakeholders who promote it. It may be seen as the ability to use basic computational and geometrical skills in everyday contexts, as the knowledge and understanding of fundamental mathematical notions, as the ability to develop sophisticated mathematical models, or as the capacity for understanding and evaluating another's use of numbers and mathematical models. These different interpretations reflect different rationales and values of proponents, such as the desire to standardise and measure the output of formal mathematics education, popularise academic mathematics, vocationalise general mathematics education, or educate critical citizens.

According to the 1959 edition of the Webster's Collegiate Dictionary, in which the term appears for the first time, 'numerate' means "marked by the capacity for quantitative thought and expression". This definition reflects the meaning of numeracy from the Crowther Report (DES, 1959); this report was concerned with the education of students in the 15–18 age group. Being 'numerate', meant to have a rather sophisticated understanding of mathematics and science (see Brown et al., 1998). Noss (1997) observes a narrowing of meaning in the Cockcroft Report (DES/WO, 1982) towards the ability to perform basic arithmetic operations and to decode information given in the form of graphical representations. He sees this narrow, number-based interpretation which excludes important ideas of mathematics (e.g., geometry, algebra and proof) as linked to the culture of utility.

'Innumeracy' and 'mathematical illiteracy' became more familiar terms in 1988 when John A. Paulos published his book 'Innumeracy. Mathematical Illiteracy and Its Consequences', a national best-seller in the USA. He shows many authentic examples of innumeracy and develops a conception of 'numeracy' as being able to understand better the quantitative aspects of one's environment. Relatively simple number facts and some elementary ideas from probability and statistics are used for estimating, for understanding large numbers by linking them to concrete examples of things, for building relationships between quantities, and for evaluating chances. However, looking at the quantitative aspects of our environment does not automatically make us see something of interest.

The volume 'On the Shoulders of Giants: New Approaches to Numeracy' (Steen, 1990), developed under the auspices of the 1989 Mathematical Sciences Education Board Curriculum Committee, provides an example of a different interpretation of numeracy that is informed by the practice of mathematics in research and in science. It starts with deep mathematical ideas, such as dimension, quantity, uncertainty, shape and change and shows a vision of the richness of mathematics as the language of patterns. This interpretation of numeracy does not primarily stress the idea of critically evaluating another's use and misuse of data and numbers, an ability that should be seen as a central ingredient of a 'liberating literacy' (Cremin, 1988).

Definitions of numeracy commonly include 'number sense' and 'symbol sense', which are asserted a mediating role between symbolic (numeric or algebraic) representations and their interpretations. Number sense refers to informal aspects of quantitative reasoning, such as the knowledge of situation-specific quantities, common sense in employing numbers as measures, and the ability to make order-of-magnitude approximations (McIntosh, Reys, & Reys, 1992). Symbol sense includes being comfortable in using and interpreting algebraic expressions, an ability that relies upon generating numeric, graphic or computer representations of algebraic expressions (Fey, 1990; Arcavi, 1994).

The National Council on Education and the Disciplines (Steen, 2001) prefers to speak of 'quantitative literacy' in stressing the importance of inquiring into the meaning of numeracy in a society that keeps increasing the use of numbers and quantitative information. Nevertheless, the term 'numeracy' is still widely used in adult mathematics education programs, even if the interpretation goes far beyond the mere functional use of numerical and technical skills to process, communicate, and interpret numerical information (Benn, 1997; Gal, 2000; FitzSimons et al., 1996).

'Mathematical literacy' and 'numeracy' cannot be literally translated into many languages so their meanings have to be paraphrased. In German, for example, there is not even a common word for 'literacy', but only for 'illiteracy'. 'Numeracy', however, connotes numbers and calculations with numbers. Hence in this chapter the term 'mathematical literacy' is used intentionally to focus attention on its connection to mathematics and to being literate. Thus it refers metaphorically to a mathematically educated and well-informed individual.