PREFACE

Mathematics, Numeracy, and Democracy

In a retrospective account, the historian Lawrence Cremin cites rising rates of literacy as one of the most significant long-term achievements of American education. As a whole, Cremin argues, Americans were a more literate population at the end of the twentieth century than at its beginning or at any time earlier, and he attributes this outcome directly to increased public access to education. When evaluating the evidence, however, Cremin cautions against defining literacy as no more than rudimentary technical skills in reading, writing, and computing. Indeed, Cremin himself goes much further than this, saying that "if literacy [in the twentieth century] did involve the achievement of a technical skill, its meaning also depended on what an individual did with that technical skill, on how it was used, on what sort of material, with what frequency, and to what ends" (Cremin, 1988).

If we adopt Cremin's conception, literacy obviously becomes a complex rather than a simple matter. From this point of view, we regard it not merely as a measurable amount of technical skill, but also as a judgment about the nature and quality of an interaction between a person with that skill and a particular social or environmental situation. This implies, in turn, that literacy can have no permanent meaning, no definition forever fixed and constant across all times and places. As we know well, social and environmental situations change, often because of human intervention, and thus what counts as literacy very likely will vary at least somewhat in different historical periods and from one cultural setting to another. This is a recognition that Cremin's mentor, John

Dewey, unceasingly urged upon educators and the American public generally. Under modern American conditions, Dewey said, change repeatedly outruns continuity, and thus the need to reframe the meaning of literacy must continue apace through a process that "can never be ended." Such, he observed, "is the need of a human nature and of a society that are themselves in process of constant change" (Dewey, 1931).

For both Dewey and Cremin, the matter becomes even more complex when we ask what literacy means in a society dedicated to democratic ideals and informed by an ethos of individual freedom. In democratic settings, Cremin says, it is important to distinguish between what he calls "inert" and "liberating" literacy. As Cremin defines these terms, the former is that level of verbal and numerate skill required to comprehend instructions, perform routine procedures, and complete tasks in a rote manner. From a social perspective, this is that measure of literacy we might expect to find applied in a cultural setting in which tradition prevails and customs are securely in place, and where opportunities for freedom, choice, and innovation are limited. To speak of literacy as "liberating," however, assumes a much more challenging standard by which individuals command both the enabling skills needed to search out information and the power of mind necessary to critique it, reflect upon it, and apply it in making decisions. It is only this more expansive and demanding meaning of literacy, or what Dewey calls "popular enlightenment," that can inform and animate a vital democracy. Indeed, Dewey reminds us, a successful democracy is conceivable only when and where individuals are able to "think for themselves," "judge independently," and discriminate between good and bad information.

Turning to the present, the considerations raised by Dewey and Cremin bear directly on the issues addressed in this book. Currently, to be sure, the optimism that colors their views has been replaced by an attitude of concern, or even foreboding, in some quarters. Indeed, many no longer believe that literacy is as prevalent in American society as it once was. Of these, the most outspoken contend that literacy rates are on the decline in this country and that the long-standing historical trend lauded by Cremin is in serious danger of being reversed. As further cause for alarm, they assert, there is evidence that American students do poorly on tests of literacy skills when compared with the performance of students from many other nations—thus raising the specter of global

competitive disadvantage along with that of social dysfunction at home (Hirsch, 1996).

Others question these dark claims and say that there is no good evidence to support them, but few, if any, dispute that we can and should do better in making efforts to nurture literacy throughout society. This consensus has helped move literacy to the top of the national social agenda, and it now appears highly probable that both of the major political parties will present ambitious new proposals aimed at strengthening literacy through education, testing, and other means. Whatever the wisdom of these plans, however, we can be sure that each will invoke the belief still deeply held by most Americans that literacy is a great enabler—that, as Dewey said, it is the necessary prerequisite for access to "a life of widened freedom" and the competence needed for each and every individual to have the opportunity to be all he or she is capable of becoming.

This attention to literacy is very welcome and much needed, but arriving at sensible approaches to the educational issues involved will require asking what we mean when we speak of a literate person. Looking forward, what should be our conception of literacy and what are our standards for its achievement at the advent of a new century? In a time of uncertainty about educational achievement, such as now exists, there can be a disposition to answer this question by hearkening back to the ideas and standards of some previous era. Because they are easier to pin down, these convictions of an earlier time may seem to provide an element of constancy in the midst of shifting conditions. But, as Dewey insists, how can thinking about literacy look back, and in effect stand still or even regress, when "society itself is changing under our very eyes"? In practice, would not this result in *mis*education that fails to take account of the very forces propelling change that we most need to understand and guide?

Today, this question is particularly pressing with regard to numeracy—the analogue to reading and writing in the triumvirate of competencies that, conjoined and working in unison, make up the traditional core of literacy. Few would disagree that, with the arrival of the computer age, the environing conditions that must be addressed in arriving at a definition of numeracy are undergoing rapid and often bewildering change. Increasingly, as the contributors to this book note, we live in a society "awash in numbers" and "drenched with data." Throughout most of history, human beings had to make do with sparse

and incomplete information about the world because typically data were difficult to obtain and insufficient to the task. Now, however, the flood of available information produced by powerful computers and their many applications threatens to become an overwhelming deluge. Working nonstop and with extraordinary speed, computers meticulously and relentlessly note details about the world around them and carefully record these details. As a result, they create data in increasing amounts every time a purchase is made, a poll is taken, a disease is diagnosed, or a satellite passes over a section of terrain. In consequence, one observer notes, whereas until very recently information about the world has been scarce and hard to come by, "today we are drowning in data, and there is unimaginably more on the way" (Bailey, 1996).

The implications of this new situation can be either very good or very bad. At present, they are some of both. For those competent and comfortable in thinking with numbers, the opportunities that come with the new conditions can be liberating. Not only specialists but now everyone can obtain and consider data about the risks of medication, voting patterns in a locality, projections for the federal budget surplus, and an almost endless array of other concerns. Potentially, if put to good use, this unprecedented access to numerical information promises to place more power in the hands of individuals and serve as a stimulus to democratic discourse and civic decision making. Indeed, as a recent study illustrates, the availability of numbers now reaches into "every nook and cranny of American life," making it no exaggeration to say that, in consequence, numerical thinking has become essential to "the discourse of public life" (Caplow et al., 2001). It follows, however, that if individuals lack the ability to think numerically they cannot participate fully in civic life, thereby bringing into question the very basis of government of, by, and for the people.

Moreover, the consequences of what John Allen Paulos named "innumeracy" (Paulos, 1988) can be profoundly disabling in every sphere of human endeavor—whether it be in home and private life, work and career, or public and professional pursuits. Stating the case in dramatic terms, Lynn Steen warns that "an innumerate citizen today is as vulnerable as the illiterate peasant of Gutenberg's time" (Steen, 1997). Any such possibility of regress to pre-Enlightenment conditions would be deeply troubling under any circumstances and most certainly is unacceptable in a

democracy. But how can we address the danger? What actions should we take? To begin, what exactly is quantitative literacy in today's world? How do we define and describe it in such a way that steps can be taken to foster it? In search of answers, the National Council on Education and the Disciplines (NCED) put these questions to a Quantitative Literacy Design Team formed for the purpose of inquiring into the meaning of numeracy in contemporary society. Led by Steen, the Design Team chose to cast its reply in the form of the case statement now made available for the first time in this book. As readers will see, the result is a rounded and thoroughgoing consideration of that way of thinking about the world we have come to call numeracy.

That said, however, the case statement does not seek to end debate about the meaning of numeracy. On the contrary, it aspires instead to be a starting point for a much needed wider conversation. Most certainly, this conversation must be carried forward first and foremost in school and college settings. If asked, faculty and administrators at most schools and colleges today probably would say that they intend to produce numerate graduates, although they might use different vocabularies to describe this aim. At the same time, however, if we look closely it is difficult to identify very many academic institutions at which extensive consideration has been given to the meaning of this outcome or to how students pursue and achieve it. We believe that the case statement can be a helpful point of departure for just such a consideration, and, with this in mind, NCED invited 12 respondents to comment on the views expressed by the Design Team. Like the members of the Design Team, each of the respondents brings a wealth of experience and insight to quantitative issues. Their responses make up the second half of this publication, and each adds to and carries forward the conversation from a different perspective. Together with the case statement, they provide an excellent beginning for a national discussion of the increasingly important links among mathematics, numeracy, and democracy in the changing world of the twenty-first century.

We hasten to add, however, that this conversation is not for educators alone. In every way possible, the public must be encouraged to join the discussion. As Steen points out in the epilogue to this book, many commonly held assumptions about the relationship of mathematics and quantitative literacy impede understanding and are therefore much in

need of reexamination. It may seem only common sense, Steen says, that a rigorous education in mathematics along traditional lines should lead to a high degree of achievement in quantitative literacy. Contrary to this popular belief, however, only a small part of the education needed to attain control over numbers can be found in the typical mathematics curriculum. That is because skills in complex counting and data analysis, like many other aspects of numeracy described in the case statement, rarely find a place in the standard calculus-oriented mathematics progression. Once basic arithmetic is left behind early in a student's education, the mathematics curriculum moves on to more abstract concepts that are most applicable for future work in a limited number of technical professions. Only to a limited extent do students engage in the kind of quantitative work needed in the great variety of contexts and settings that they will encounter in life.

An important theme of this volume, then, is that efforts to intensify attention to the traditional mathematics curriculum do not necessarily lead to increased competency with quantitative data and numbers. While perhaps surprising to many in the public, this conclusion follows from a simple recognition—that is, unlike mathematics, numeracy does not so much lead upward in an ascending pursuit of abstraction as it moves outward toward an ever richer engagement with life's diverse contexts and situations. When a professional mathematician is most fully at work, Keith Devlin writes, the process becomes so abstract and inward that "the mathematician must completely shut out the outside world" (Devlin, 2000). The numerate individual, by contrast, seeks out the world and uses quantitative skills to come to grips with its varied settings and concrete particularity.

This is not to say, of course, that mathematics and numeracy have little to do with one another in a balanced education. There is a sense, in fact, in which numeracy should be thought of as the extension of mathematics into other subjects in which, too often, the quantitative aspects of life are ignored altogether. This kind of compartmentalization, however, is rarely possible in the world outside. In life, numbers are everywhere and cannot be segregated into one subject and left out of others as often happens when we build our academic cubbyholes. Indeed, if the need for quantitative competence is now pervasive in American life in the many ways this volume indicates, it seems only common sense that the responsibility for

fostering quantitative literacy should be spread broadly across the curriculum. This book is a step toward bringing attention to the compelling arguments for arriving at this conclusion and, as it should follow, to making quantitative thought much more than an affair of the mathematics classroom alone.

Readers, therefore, should not come to this book expecting only to hear arguments about at what age students should begin to learn algebra or whether all should aspire to study calculus. Though not unimportant issues, there is something missing in these debates when we consider them in light of the quantitative demands of contemporary life. In fact, it may be the most significant question that is not being asked. One way to approach the debate is to assume the traditional mathematics curriculum and ask how more students can succeed in it. Another way is to consider the quantitative challenges that arise day in and day out in American life and ask what kind of education would lead to the fully liberating literacy that Dewey and Cremin say we must seek in a democracy. While neither is the one right and only approach, this book takes the latter course, and, in so doing, the contributors hope to launch a conversation that is widespread, rich, and productive of new thinking about the educational outcomes we most want for students.

The making of a book is a cooperative undertaking. Readers will find ample evidence of this in the list of contributors. Among the many others who helped, very special thanks must go to Lynn Steen, who guided the project from start to finish. Our thanks also go to Diane Foster, whose superb editorial skills and all-around good sense entered into every decision made from the time the idea of a book first came into our minds. When the book was in draft, Susan Ganter's close reading of each and every contribution resulted in many improvements, and Dorothy Downie made sure that we attended to details large and small as she so often has done in the past. Finally, Mary Catherine Snyder will know what I mean in mentioning that she saved the day more than once.

In closing, let me also thank Bob Weisbuch and the staff of The Woodrow Wilson National Fellowship Foundation for providing the supportive work environment in which a book of this kind could be

produced. The book itself was made possible by financial assistance provided by the Pew Charitable Trusts, and I am very pleased to have this opportunity to thank the Trusts for the support given to the National Council on Education and the Disciplines.

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