BRIAN GREER, SWAPNA MUKHOPADHAY, &
WOLFF-MICHAEL ROTH

CELEBRATING DIVERSITY, REALIZING[1] ALTERNATIVES

An Introduction

> Remember that our basic message is: We are allowed to think about alternatives. (Slavoj Žižek, speaking to the Occupy Wall Street protesters, October, 2011)

This book is about the celebration of diversity in all its human forms, specifically in relation to mathematics and mathematics education: culture, ethnicity, gender, forms of life, worldviews, cognition, language, value systems, perceptions of what education is *for*. All of which are reflections of the unavoidable (yet often denied) reality that mathematics education *is* politics.

There are obvious and direct manifestations of political involvement in education. Governments, through their bureaucracies, set policies and control curricula, testing, teacher education requirements, research bodies, and so on. They also, increasingly and with more and more guile, control the discourse – while no child is to be left behind (a deliberate echo of the ethos of the US Marines), a student who cannot jump through the hoops of algebra (the intense study of the last three letters of the alphabet) is now framed not just as stupid, but also as undeserving of educational and economic opportunities, and even as unpatriotic. For studying these processes in action, the National Mathematics Advisory Panel (NMAP) set up by George Bush constitutes an invaluable case study (Greer, 2012; Roth, 2008).

As one manifestation of the increasingly nationalistic rhetoric surrounding mathematics education, national egos are bound up with international comparative exercises such as PISA and TIMMS. Poor performance by the US in such "beauty contests" is exploitable for political leverage – to find scapegoats (whether the increasing cultural and linguistic diversity of the US population, or the teachers, students, parents), and to create the perception of crisis so that radical deformation can be pushed through. Students, teachers, and school communities (i.e., people) are invisible inside a black box that can be manipulated by external levers of tests, carrots and sticks (many more of the latter than the former), in the context of a set of hysterical demands, such that all children be at grade level in reading and mathematics by 2014. Meanwhile, back on planet Earth, the differences in test scores between the White majority and other ethnic groups – particularly African American, Latino/a, and Native American – stubbornly persist. Meanwhile, under

S. Mukhopadhyay & W.-M. Roth (eds.), Alternative Forms of Knowing (in) Mathematics, 1-8

President Obama's embrace of privatization, the public school system faces an existential threat (Ravitch, 2010).

Less obviously, there is an pervasive political influence in applications of mathematics in ways that impact most aspects of our lives, but are generally outside our control or even our awareness, that has been characterized and extensively analyzed as "mathematics in action" (e.g., Skovsmose, 2005). Mathematics education does little to prepare people to be aware of, and to deal with, this formatting of their lives by educating them about the nature of mathematical modeling (Greer & Mukhopadhyay, 2012). To the contrary, mathematics education largely provides training in simplistic argumentation (the mathematical concept of "function" corresponds to a single cause producing a single effect, which is a good model for essentially nothing, even in the physical sciences), blind faith in numbers and mathematical models, and slavishly following rules, the rationale for which is not questioned and that absolve people from making human judgments. It also encourages the attitude that simple technical solutions can be applied to complex human problems (including mathematics education). Both forms of thinking in fact belong together and are the pinnacles of metaphysical thinking that today expresses itself in technology gone wild (Heidegger, 2006).

The world is in a mess. Nearly a century ago, H. G. Wells (1920) commented that "human history becomes more and more a race between education and catastrophe" (p. 594). We need to ask what responsibilities we bear as mathematicians and mathematics educators for bringing this situation about and for trying to change it:

> It is clear that mathematics provides the foundation of the technological, industrial, military, economic and political systems and that in turn mathematics relies on these systems for the material bases of its continuing progress. It is important to question the role of mathematics and mathematics education in arriving at the present global predicaments of humankind. (D'Ambrosio, 2010, p. 51)

Whereas mathematics has been used in the creation of both "wonders" and "horrors" it is neither good nor bad in itself – at least when considered in a decontextualized manner.[2] Mathematicians have a particular responsibility to avoid contributing to the horrors, in particular through participation in the military-industrial-academic complex.[3]

Prominent in educational-political consciousness and media coverage, in the United States and elsewhere, is an ongoing hegemonic struggle that goes by the term "Math Wars"[4] that has intensified since the publication of *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989) but has a much longer history and clear parallels in other disciplines. At the risk of simplism, the difference lies between those who pre-eminently value fluent and error-free performance of decontextualized mathematical procedures and those who attach more importance to conceptual understanding. The former group comprises an unholy alliance of certain mathematicians, certain mathematics educators, many experimental psychologists who address mathematics education, the corporatocracy, politicians, and policy-makers. As an example of this coalition in action, they dominated any traces of progressivism among the mathematics educators on the National Mathematics Advisory Panel.

NCTM represents what we could call the "enlightened mainstream." For example, in a section of *Principles and Standards* (NCTM, 1989) that has since undergone sustained criticism, it declared in favor of giving increased attention to number sense, meaning of fractions and decimals, use of calculators for complex computation, actual measuring, problem-solving strategies, and justification of thinking (selected from a list of 37 recommendations), and decreased attention to isolated treatment of division facts, paper-and-pencil fraction computation, use of clue words to determine which operation to use [in word problems], and rote memorization of rules (selected from 18 recommendations) (NCTM, 1989, pp. 20–21).

NCTM also proclaims a strong commitment to equity, but, upon examination, this seems to mean essentially that non-majority students should have access to unexamined mathematics education, not that it be examined in relation to its relevance to, and value for, such students – as Piaget might have put it, assimilation without accommodation. Within the statement of the Equity Principle (NCTM, 1989) the section headed "Equity requires accommodating differences to help everyone learn mathematics" in no way addresses the nature of the mathematics to be learned. We need to "[make] problematic the *there* in *How do we get There*?" (Martin, 2003, p. 18). The very considerable body of writing on equity and mathematics education is fundamentally flawed because of its internal gaze, mostly ignoring the systemic problems in capitalistic society (Roth, 2008).[5]

Likewise, it is necessary to deconstruct the superficially appealing (and intentionally so) slogan "Mathematics for all" (Martin, 2003) which underlies a project predominantly aimed at economic competitiveness – to whose benefit? (Gutstein, 2009). In official rhetoric, mathematics and science education are seen as essential to the competitive accumulation of human capital, which is really about how people can be exploited by the wealth-making class. The Nobel laureate in economics, Amartya Sen, has proposed an alternative that he terms "human capability" by which he means "[focusing] on the ability of human beings to lead lives they have reason to value and to enhance the substantive choices they have" (Sen, 1997, p. 35).

In general, mathematics education suffers from the same morbidity as education as a whole, in which the forces for the status quo have the upper hand. Thus, "[t]he more educational research finds out, the less educational policy changes, as it plays up to the powerful who tend to desire the reproduction of the status quo rather than to bring about changes of life conditions that lead to differences that make a difference" (Roth, 2008, p. 371). Critical surveyors of the scene (Pais, 2012) comment on the apparent lack of progress; little accumulates. As an example, the treatment of fractions may be taken as paradigmatic of the failure of research in mathematics education to accumulate wisdom that can be cashed at the educational bank, except insofar as it underpins many career trajectories. How many studies of children struggling with fractions can be done? How much more do we now know about teaching/learning fractions than we did 10, 20, 30 … years ago? Many totally functional adults "who could never do mathematics" first hit "the wall" with fractions. Why don't we ask why carpenters and others, when measuring length, use fractions of an inch such as ½, ¼, $^{1}/_{8}$ (Roth, 2008) so that, for example, the question of finding least common denominators does not arise?

How often does anyone in mathematics education ask a fundamental question such as why do people need to know how to compute with fractions? Division of a fraction by a fraction is notoriously difficult to illustrate in a meaningful context, as is illustrated by an example in the Common Core Standards for Mathematics for sixth grade[6]. Under the heading "Apply and extend previous understandings of multiplication and division to divide fractions by fractions" we find the example: "How many $^{3}/_{4}$-cup servings are in $^{2}/_{3}$ of a cup of yogurt?" And the reader might ask herself/himself: Why should I now (or a young student) be able to compute $^{3}/_{7}$ + $^{13}/_{19}$? Note that we are *not* saying there are no justifications for the need to have this ability, but rather that we should articulate more carefully what those reasons are, *and talk to the students about them*.

There are alternative approaches to the study of the conceptual field of multiplicative structures that are grounded in students' experience. The phenomenology of fractions and the diversity of situations that they model are extremely complex, a complexity typically ignored in standard pedagogies (Freudenthal, 1983). Culturally based approaches are possible, as illustrated at many points in this book. The position taken in this book, and by the emerging groups of practitioners, researchers, and activists who self-identify as critical mathematics educators, goes well beyond that of "the enlightened mainstream" in insisting on the historical, social, cultural, and political situatedness of mathematics education, and the diversity that characterizes mathematical practices as much as any other human activity. Arguably the most pervasive and damaging aspect of mathematics education as it is typically practiced in schools is the lack of relevance and connection to students' lived experience. One mathematics educator who had lived through four very different political regimes in Palestine commented on this state of affairs in this way:

> What is startling about the math curriculum is – with the exception of some changes at the technical level – how stubborn and unchanging it has remained under the four completely different realities in which I have lived, studied, and taught; how insensitive and unresponsive it has been to the drastic changes that were taking place in the immediate environment! When something like this is noticed, it is only natural to ask whether this is due to the fact that math is neutral or that it is actually dead! (Fasheh, 1997, p. 24)

Mathematics education as a research field predominantly shows a similar insensitivity to the circumstances in which students live. This is apparent in the following reflection on a visit to a school in a South African township where the physical learning obstacles were obvious:

> How is it that the research in mathematics education has not noticed this hole in the roof? … Black children are simply treated completely differently, and their future has been spoiled by the apartheid regime. To ignore this fact is a political act. (Skovsmose, 2005, p. 20)

The same willful ignoring is apparent in educational research in the US on children living in poverty (Berliner, 2006). On the basis of extensive data analysis, the author concludes that "the most powerful policy for improving our nation's school achievement is a reduction in family and youth poverty" (p. 949).

In sketching a program for critical mathematics education research, one fundamental form of diversity that demands greater attention is the variety of sites for learning mathematics (Skovsmose, 2012). Skovsmose points out that the discourse of the field has been dominated by what he calls the "prototype mathematics classroom," an idealization that ignores the global diversity of circumstances in which people learn mathematics in schools.[7]

For critical mathematics educators, equity is not a matter of merely "giving" people access to unreconstructed mathematics education, but rather a matter of valorizing the diversity of mathematical practices that are intimately bound up with forms of life. Particularizing the declaration that "the intellectual activity of those without power is always characterized as non-intellectual" (Freire & Macedo, 1987, p. 122), the position that we seek to undermine is that the mathematical activity of those without power is always characterized as non-mathematical.

In positive vein, it is increasingly possible to point to manifestations of cultural resilience and resistance, and assertions of agency and identity, of which the ethnomathematics program is an important part. To adapt Spivak's famous phrase, the subaltern can speak mathematics. An essential form of this resistance comes in the form of alternative practices. As illustrated by several of the contributions to this book, serious attempts are being made to integrate knowledge of cultural mathematical practices into school mathematics, not as a peripheral activity, and with no implication of inferiority (Pinxten & François, 2011), illustrating another form of diversity, namely the variety of educational possibilities (Skovsmose, 2012). Serious work is being done to actualize Freirean principles of emancipatory education and advance social justice through mathematics education (Gutstein, 2006). Indeed, in that Gutstein and his students work around generative themes that come from their lived experience and the political reality of their milieu, this work could be considered a manifestation of ethnomathematics, in its wider sense, being integrated into mathematics education.

Meaningful integration of culturally based knowledge into school mathematics inevitably creates a strong tension. Acknowledging that "an understanding of [academic] mathematics and a world-language such as English … [represent] access to communication, further educational opportunities, employment, and development' (Barton, 2008, pp. 167–168), the author points to the dilemma of what and how to teach mathematics to students who "learn mathematics in a distinct cultural-linguistic context – how can they study an international subject while retaining the integrity of a minority world view?" (p. 142).

A possible way out of this dilemma already has been proposed (Pinxten & François, 2011). These authors embrace a characterization of ethnomathematics as "the generic category of all mathematical practices, with academic mathematics as a particular case" (p. 264). They also invoke the Freirean principle of the oppressed learning the language of the oppressor, hence that "everyone is entitled to 'access' to academic mathematics because it is the best position from which you can criticize the Master discourse" (p. 264).[8] On these foundations, they propose a concept of "multimathemacy" that reconciles the honoring of alternative forms of mathematical knowledge and practices with pursuing academic mathematics as a choice of the student, and taking into account his or her circumstances.

An overarching theme that we suggest the reader should be attuned to when reading the book is that of humanization (a consistent theme in the work of Paulo Freire).[9] Mathematics and mathematics education continue to be dehumanizing in many respects, including the following:

– A pervasive thread in mathematics-as-a-discipline, historically, has been the search for the Holy Grail of absolute certainty and precision. Even though results of Gödel and others have shown this to be an illusion, there is still a powerful desire to perfect a formal architecture of mathematics – which really becomes pernicious when the attempt is made to force mathematics education into that mold.
– There is no essential reason why mathematics-as-a-school-subject should be taught in a fashion that inflicts psychological damage on students, but that is, too often, the case. Taking such positions as that there is only one right answer (untrue as soon as mathematics is applied to reality) or only one right way to carry out a computation or express a proof (totally untrue) affords authoritarianism.
– Mathematics is often presented as existing independently of the people who do it, and independent of their bodies, senses, desires, emotions, and aesthetics – everything that makes a person flesh and blood. Thus, "mathematicians … have increasingly chosen to flee from nature by devising theories unrelated to anything we can see or feel" (Mandelbrot, 1983, p. 1).
– In terms of mathematics education as a research domain, we can simply point to research that reduces people to values on a few variables (the methodological straitjacket that forces everything to be a factor so that statistical rituals can be performed) or scores on (generally ill-conceived) tests. Likewise, when carrying out interviews, the pervasive image of brains as containers of knowledge from which dumps can be made (the ever-present brain-as-computer metaphor).

To (re)humanize mathematics and mathematics education it is necessary to:

– Connect with students' lived experience, their bodies, their immediate experiences, their emotions, needs, and desires. Which implies activity with hands and eyes, interacting directly with our physical and social worlds, not just through symbolic mediations on pages and computer screens.
– Celebrate mathematics as a pan-cultural activity, acknowledging the whole of humanity and its diversity.

– Understand that mathematics, like any human activity, is inherently social. Education is, fundamentally, about interpersonal relations between students and teachers.

Let us also make clear that we do not reject the glories of mathematics as intellectual achievements of humankind – giving appropriate acknowledgment to the contributions of all cultures by deconstructing the Eurocentric narrative of the history of academic mathematics – just as much as literature, music, or art (which are also pan-cultural activities).[10] Although mathematicians and teachers often appear to go to extraordinary lengths to disguise the fact, mathematics is creative and aesthetically deep. Learning mathematics in school, instead of too often being a form of intellectual child abuse, should be an intellectually exhilarating experience.

To return to how we began, we *are* allowed to think about alternatives; the world *can* be other than what is the case.

NOTES

1 "Realizing" is deliberately ambiguous, as it can mean both "becoming aware of" and "making happen."

2 The essence of a thing does not reveal itself when subject to the theoretical gaze that isolates it from everything else; rather, the essence reveals itself in practical use (Heidegger, 1927/1977). In praxis, mathematics is part and parcel of politics and therefore inherently bound up with value.

3 Giroux (2007, pp. 14–15) points out that this was the original formulation in the retirement speech of President Eisenhower in which he warned of the dangers of the military-industrial complex.

4 This is a pernicious metaphor for several reasons. It diminishes suffering in actual wars, potentiates symbolic violence by invoking nationalism, and encourages the media to frame the discussion as a confrontation between extremes.

5 This crucial point has been argued very forcefully in a very penetrating critique of research on equity within mathematics education (Pais, 2012).

6 www.corestandards.org/assets/CCSSI_Math%20Standards.pdf (p. 42)

7 A parallel point can be made about research in psychology being most often restricted to middle-class groups from the richer part of the world (where students are available and obedient) yet still claiming that its results constitute scientific truths (Pinxten & François, 2011).

8 The civil rights activist Bob Moses, who now works in mathematics education, characterizes such access as a civil right.

9 Not addressed in this book, yet a matter of extreme importance, is the generally impoverished nature, from our point of view, of mathematics education at the university level.

10 It is worth noting that many mathematicians have urged that alternative epistemologies, such as Navajo conceptions of space, could be a rich source for suggesting innovative extensions to academic mathematics.

REFERENCES

Barton, B. (2008). *The language of mathematics: Telling mathematical tales*. New York: Springer.

Berliner, D. C. (2006). Our impoverished view of educational reform. *Teachers College Record*, *108*, 949–995.

D'Ambrosio, U. (2010). Mathematics education and survival with dignity. In H. Alro, O. Ravn & P. Valero (Eds.), *Critical mathematics education: Past, present, and future* (pp. 51–63). Rotterdam, The Netherlands: Sense Publishers.

Fasheh, M. (1997). Is mathematics in the classroom neutral – or dead? *For the Learning of Mathematics*, *17*(2), 24–27.
Freire, P., & Macedo, D. (1987). *Literacy: Reading the word and the world*. South Hadley, MA: Bergen & Garvey.
Freudenthal, H. (1983). *Didactical phenomenology of mathematical structures*. Dordrecht, The Netherlands: Kluwer.
Giroux, H. A. (2007). *The university in chains: Confronting the military-industrial-academic complex*. Boulder, CO: Paradigm.
Greer, B. (2012). The USA Mathematics Advisory Panel: A case study. In O. Skovsmose & B. Greer (Eds.), *Opening the cage: Critique and politics of mathematics education* (pp. 107–124). Rotterdam, The Netherlands: Sense Publishers.
Greer, B., & Mukhopadhyay, S. (2012). The hegemony of mathematics. In O. Skovsmose & B. Greer (Eds.), *Opening the cage: Critique and politics of mathematics education* (pp. 229–248). Rotterdam, The Netherlands: Sense Publishers.
Gutstein, E. (2006). *Reading and writing the world with mathematics: Toward a pedagogy for social justice*. New York: Routledge.
Gutstein, E. (2009). The politics of mathematics education in the US: Dominant and counter agendas. In B. Greer, S. Mukhopadhyay, S. Nelson-Barber, & A. P. Powell (Eds.), *Culturally responsive mathematics education* (pp. 137-164). New York, NY: Routledge.
Heidegger, M. (1977). *Sein und Zeit* [Being and time]. Tübingen, Germany: Max Niemeyer.
Heidegger, M. (2006). *Gesamtausgabe. I. Abteilung: Veröffentlichte Schriften 1910–1976. Band 11: Identität und Differenz.* Frankfurt/M, Germany: Vittorio Klostermann.
Mandelbrot, B. B. (1983). *The fractal geometry of nature* [updated and augmented]. New York, NY: Freeman.
Martin, D. B. (2003). Hidden assumptions and unaddressed questions in *Mathematics for All* rhetoric. *The Mathematics Educator*, *13*(2), 7–21.
National Council of Teachers of Mathematics (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.
Pais, A. (2012). A critical approach to equity. In O. Skovsmose & B. Greer (Eds.), *Opening the cage: Critique and politics of mathematics education* (pp. 49–91). Rotterdam, The Netherlands: Sense Publishers.
Pinxten, R., & Francois, K. (2011). Politics in an Indian canyon? Some thoughts on the implications of ethnomathematics. *Educational Studies in Mathematics*, *78*(2), 261–273.
Ravitch, D. (2010). *The death and life of the great American school system: How testing and choice are undermining education*. New York, NY: Basic Books.
Roth, W-M. (2008). Mathematical cognition and the Final Report of the National Mathematics Advisory Panel: A critical, cultural-historical activity theoretic analysis. *The Montana Mathematics Enthusiast*, *5*(2&3), 371–386.
Sen, A. (1997). Human capital and human capability. In S. Fukuda-Parr & A K. Shiva Kumar (Eds.). *Readings in human development: Concepts, measures and policies for a developmental paradigm* (pp. 35–37). Oxford: Oxford University Press.
Skovsmose, O. (2005). *Travelling through education: Uncertainty, mathematics, responsibility*. Rotterdam, The Netherlands: Sense Publishers.
Skovsmose, O. (2012). Towards a critical mathematics education research programme? In O. Skovsmose & B. Greer (Eds.), *Opening the cage: Critique and politics of mathematics education* (pp. 343–368). Rotterdam, The Netherlands: Sense Publishers.
Wells, H. G. (1920). *Outline of history*. New York, NY: Macmillan.