Why Teach Mathematics to All Students?

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The title of this article is borrowed from a panel presentation at a recent conference. [1] At the close of our annual meeting, four members of the Canadian mathematics education community were invited to share their thoughts on the topic of why mathematics is taught.

My contributions to this discussion were similar to the arguments I made some years ago in an article in this journal (Davis, 1995), in which I attempted to bring enactivist thought (Varela, 1999; Varela, Thompson and Rosch, 1991) to bear on the question of why we teach mathematics. Through the session, though, some inadequacies with that thinking were highlighted. In particular, the seemingly innocuous phrase "to all students", tacked to the end of the question "Why teach mathematics?", occasioned considerable response at the conference around matters of changes to formal education over the past century, Western tendencies toward cultural imperialism and popular assumptions concerning a transcendent mathematics.

Further issues have been raised by Peter Huckstep (2000) in his recent contribution to the expanding debate around rationales for teaching mathematics. Among other matters, Huckstep argues that the utility of mathematics remains as viable a basis for teaching the subject as it ever was. He further suggests that other rationales which are more grounded in psychological and sociological discourses, while worthy of discussion, are not as compelling as those that are built on an acknowledgment of the usefulness of the subject matter.

While I agree with Huckstep on the former point, I think that I disagree on the latter. In any case, prompted by my conference presentation and Huckstep's discussion, I find that I am no longer comfortable with many aspects of my earlier article on the issue, and so I offer this account. With regard to that past piece, this one might be seen as part elaboration, part clarification and part abdication.

On posing a question

Gadamer (1990) suggests that most questions fall into one of three categories: the teacherly [2], the rhetorical and the hermeneutic.

The first of these, the teacherly, is distinguished from the others by virtue of its pre-determined response: that is, the answer to the teacherly question is already known to the asker. It is the mainstay of the television quiz show and the trivia board game - and these are almost the only places such questions are encountered outside the classroom. For Gadamer, teacherly questions are about interrogation, not about expanding conversations or enabling learning. As such, he argues, they are not really questions at all.

The second category of question, the rhetorical, differs from the teacherly mainly in the fact that it has no pre-determined answer. However, this quality does not mean that the rhetorical question is any more effective than the teacherly one at opening up a conversation. Whereas the teacherly question constrains possibilities by virtue of its pre-determined end, the rhetorical question shuts down possibilities because it is too open. No answer is expected. As such, the rhetorical question is not really a question either. Like the teacherly question, it is not oriented toward the development of deeper understandings.

For Gadamer, then, neither the teacherly nor the rhetorical question is a question at all - the former because the answer is known (in effect, it lacks a questioner), the latter because the answer is assumed unknowable (in effect, it lacks an answerer). That leaves the hermeneutic question.

Hermeneutics is the study of interpretation. It is concerned with the issues of what is believed and how it is that those beliefs were established. Hence, a hermeneutic question is an event of interpretation that is oriented by a desire to expand the sphere of the known. It is a manner of engagement that arrives as a confession of the inadequacy of one's current understandings, a suspicion of the partialities of one's knowings, a realization of the need for constant reinterpretation.

The tricky part of Gadamer's formulation is that the act of categorizing any given question is not a matter of placing it in a taxonomy, but of making sense of the motivations of the asker and the context of the asking. This point can be illustrated through the question addressed in this writing, "Why teach mathematics to all students?". One might meet this query in a teacherly or a rhetorical or a hermeneutic way. Each manner of engagement would prompt entirely different categories of concern - and, in consequence, each would attract a very different sort of response.

Indeed, this quality might be used as a tactic for collecting and contrasting many of the rationales for and critiques of mathematics education that are in popular circulation, which is what I have done here. This writing is structured as three separate engagements with the orienting question "Why teach mathematics to all students?". To foreground the differences among these modes of asking, I have inserted linguistic markers, in the form of a few added words, to each question. I ask why we *do*, why we *would* and why we *should* teach mathematics to all students.

The teacherly question: why do we teach mathematics to all students?

The teacherly question springs from a position of authority While the motives for such questions might vary (e g. for evaluation, for classroom management, for practice, for a reminder, for a million dollars, etc), as can the sophistication of the query, the defining quality of the teacherly question is that there is a correct and known response: at least as far as the asker is concerned

So framed, the question, "Why *do we* teach mathematics to all students?" is one that seeks explanation, justification, rationale When encountered – as it so often is in policy statements, textbooks, curriculum documents, and so on – it is almost always answered in terms of history and/or pragmatics

On the historical side, for instance, it is popularly noted that school mathematics arose alongside (and largely in the service of) capitalism, industrialization, modern science and urbanization In fact, an obvious residue of these co-evolutions can be found in the 'problem sets' of virtually any middle-school mathematics textbook, focused as they are on such concerns as purchasing carpet, calculating sales tax and determining gear ratios Further traces of this history can be found in the increasingly outdated curriculum rationales that assume a need for basic competence in number-crunching and organization (and, more insidiously, for complacency in the face of repetitive and largely meaningless activity)

However, I am myself hesitant to elevate historical cause or coincidence to the level of rationale Such a move invites an uncritical attitude toward the project of culture-making (Bruner, 1986) in which educators are deeply involved We may be able to identify many historical 'causes' for the phenomenon of mathematics instruction, but such events should not be used to justify the perpetuation of anachronistic practices and emphases.

An important shift in popular rationales for mathematics instruction has come about in the last half-century, with the move toward mathematics education *for all* The need to justify universal instruction (and the concomitant necessity to redefine mathematical content for schools more in terms of the traits of well-rounded citizens than in terms of the capacities of good workers) has prompted a diversity of rationales

An interesting quality they share is the tendency to come in dyads, along with admonitions for maintaining careful balance For instance, the historically resilient desire for basic mathematical literacy now tends to be paired with the need to develop sound reasoning skills – or, more popularly, people see needs for both rote competence and for mathematical understanding, but each of these tends to be seen as coming at the expense of the other

Such concerns are, in turn, linked to social responsibility and its counterpoint, personal empowerment Correspondingly, the notion of 'mathematics literacy' has been broadened from its emphases on algorithm and nomenclature to include competencies in such areas as data management and mathematical communication

I could go on, but would prefer to direct interested readers to the rationale statements in the barrage of published materials that are squeezed onto teachers' bookshelves These assertions never vary much – and this lack of variance is probably why the question "Why teach mathematics to all students?" is usually met as a teacherly question In the mainstream, the answers are settled It is assumed that someone knows them and the question is only posed to ensure that workers are up to speed on the correct answers

This is no less true of the more cynical tributaries to that mainstream, although the responses that spring from these sites are sometimes markedly different The more critical among us, for example, assert that mathematics is a tool of cultural imperialism and personal subjugation, that conventional mathematics instruction is a societal bad habit, that many problematic grade-school practices are maintained in the interests of higher education (e.g, to sort students and to ensure adequate enrollments for an inflated mathematics professoriate), and so on Many persons engaged in these manners of critique have sought to reframe the project of mathematics teaching

Specifically, in the face of so much unconscious activity, there have been various efforts toward what Freire (1972, p 101) calls *conscientization* [3] As the arguments tend to go, mathematics has long been a tool of subjugation, but it can be turned into an instrument of empowerment. It can enable individuals to see through the inequities and exaggerations that are so often cloaked in a mathematized rhetoric In this line of thinking, school mathematics can also be turned onto itself: pursuing its study, rather than rebelling against all that it stands for, can provide access to all sorts of cultural capital

However, these more radical responses to the (teacherly) question of "Why teach math?" may not be so different as they appear While they clearly represent different ideological takes on the issue, their critiques are generally aimed at pedagogy, not at the project of school mathematics That is, they offer different rationales – ones that are delivered with a different passion, even urgency – but those rationales are often used in justification of strikingly similar models of school mathematics We are thus thrust into a left-versus-right, liberal-versus-conservative, personal-empowerment-versus-social-responsibility subterfuge whenever the issue of teaching mathematics is engaged

Whichever side is taken, however, the response seems to land in the same place

> Why *do we* teach mathematics to all students?
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> Because we have to: there are historical and cultural reasons that operate in the social and societal realms, albeit that most of these reasons are often all but forgotten Whatever the reason, though, knowledge of mathematics is necessary for every citizen of today's world It is useful

The rhetorical question: why would we teach mathematics to all students?

The tendency to frame discussions and debates of why mathematics is taught in terms of oppositional dyads might be interpreted as a sort of capitulation Collectively, we seem to be resigned to the thought that school mathematics is a permanent fixture – that is, this practice is not going away and, hence, the best we can do is tinker with it as it moves along. Such an attitude demands that we look at both sides of every issue in the hopes of fair and equitable compromises. There are no ultimate solutions, however.

This manner of assertion often prompts different takes on the issue of why we teach mathematics, away from efforts to specify purpose and toward more reflective examinations of the phenomenon. That is, the question, "Why teach mathematics to all students?" is sometimes taken as a rhetorical one - in essence, as exceeding response but nonetheless worthy of consideration. Perhaps there is more to school mathematics than is captured by popular debate, involving matters and details that surpass our analytic abilities.

Phrased differently, I would seek to elaborate Huckstep's (2000, p. 8) assertion that motivations for certain activities belong to one of two categories: either extrinsic to the activity (i.e. it is useful) or intrinsic (i.e. it is carried out for its own sake). An argument can be made that much - and perhaps most - of human activity is *neither* intrinsically nor extrinsically motivated. As Varela (1999) explains,

> we must impress on ourselves how much of our lives is spent in skilled behavior - working, moving, talking, eating - and how little is spent in deliberate, intentional analysis. Yet it is this latter category that we notice. It is this latter category which has been the focus of philosophers and scientists alike. (p. 23)

In somewhat different terms, humans are capable of such non-intentional activity as aimless play and mindless habit - both of which tend to be assigned purpose if and when they are noticed. But the truth of the matter is that after-the-fact justifications cannot fully explain why we do most of what we do. Our lives are filled with intentionless activities. But the fact that they are intentionless does not mean that they do not embody particular knowings.

An understanding of school mathematics demands that such possibilities be considered. This assertion, to be clear, is tantamount to the suggestion that we humans are not primarily reasoning beings. Nor, for that matter, are we conscious of much that we do. [4]

It strikes me that this suspicion is at the root of the public school student's question, "Why are we doing this?", so often posed in the middle of mathematics lessons. Unfortunately, such inquiries tend to be heard in teacherly terms, and so the responses tend to be matter-of-fact, for the most part seeking to deflect discussion to some other time (e.g. "You'll need this someday") or some other place (e.g. "It's in the curriculum"). However, the fact that such answers are rarely satisfying - either to the interrogator or to the respondent - should give us pause.

It may be that these persistent questions are rhetorical in nature. Perhaps our children are onto us, aware that mathematics instruction is in a rut. As a middle-school teacher, I never really had a sense that the students who were brave or angry enough to ask were actually expecting an answer. Or, at least, they seemed to have abandoned the hope of receiving a satisfactory answer. "Why are we doing this?" was, in effect, one way of announcing that they were aware that the teaching of mathematics, along with most of modern schooling, was being carried along by a momentum so great (and that it had cut a swath so wide), that it reduced all involved to quiet complacency as they immersed themselves in its less-than-mindful activity.

"Why *would we* teach mathematics to all students?", then, operates on the collective level in much the same way that "Why would I do/think this?" operates for anyone who is dealing with a habit or obsession that has lost much of its original meaning. In brief, ours is a culture that is obsessed with and utterly reliant upon mathematics. Perhaps, even, 'obsession' and 'reliance' are not strong enough. It might be more appropriate to describe the situation in terms of 'addiction'.

For example, in terms of symptoms, consider the way that mathematics courses through the veins of virtually all cultural activity. Try, for example, to find one item in the daily newspaper where some mathematized notion is not explicitly invoked - let alone the more subtle uses of comparison, logical assertion and linear narrative that are so privileged in Western mathematized culture - and set aside the pervasive presence of electronic and other technologies, so utterly reliant on mathematized technologies, that make it possible for the items to be collected by the newspaper and for the newspaper to be brought to us. Mathematics is so present as to be like the air around us. And when a problem that demands explanation arises, which discipline are we collectively most inclined to reach for?

This cultural proclivity is often given the label of 'scientism', that uncritical acceptance of modern science that has underpinned efforts to impose analytic methods onto phenomena that exceed their reach. 'Scientism', though, labels the symptom, not the underlying problem. As developed in much of recent (non-analytic) philosophy, it is likely more appropriate to frame the situation in terms of 'mathism', or as what Lakoff and Núñez (2000, pp. 339-340) describe as the "Romance of Mathematics". As they develop it, in this romance mathematics is seen as an objective feature of this universe. As such, it is independent of culture - and, for that matter, it transcends humanity. In this interpretative frame, those who have devoted their lives to the study of mathematics slip into roles that are not entirely unlike those assumed by priests and mystics of other societies. They are seen to mediate humanity's relationship to a different, more real reality.

I mean to be descriptive not provocative here. In evidence of these assertions, consider some of the remarks made by one of this era's high priests, Stephen Hawking. In a survey of the conceptual implications of a highly mathematical piece of work, he ends his discussion with a simple question: "What place, then, for a creator?" (1988, p. 141).

Here the romance of mathematics pushes aside the romance of religion in a rhetorical gesture that is delivered with the force of fundamentalist pronouncements from past ages. To re-emphasize, it is mathematics (and not science) that gives weight to the statement. Mathematics dictates the criteria for and the structure of such claims (and science obeys them), just as in other times and places different cultural myths have provided. To shift the metaphor from the felt to the seen, for the most part these structures and criteria are invisible to us, accepted simply as the way things are. To borrow from Marx, mathematicized rhetoric has provided the masses with a new opiate.

This silent and invisible addiction has, over the past few centuries, supported a false security and a sense of great superiority - even invulnerability - in Western knowledge. Such troubling self-assurance as much derives from as it engenders particular partialities. [5] For example, to extend the addiction analogy, mathematics supports such self-perpetuating compulsions as the drives toward complete certainty, totalized knowledge and constant growth In turn, a fervent evangelicalism arises, one that is often manifest as well-intentioned but nonetheless power-seeking efforts at cultural domination. In the process, mathematics enables a range of self-destructive activities while blinding users to the (ever more pressing) consequences of such activities. The primary question in this mathematics-permeated world is the knowledge-obsessed "Can we do it?", rather than the wisdom-oriented "Should we do it?".

To wring just one bit more from the analogy, our cultural addiction to mathematics is perhaps most evident in the telltale sign that, in spite of abundant evidence to the contrary (in, for example, the overburdening of planetary systems through mathematics-enabled technologies), there is a persistent denial that there is a problem. And, what is perhaps more troubling, if and when the mathematical establishment is grudgingly willing to acknowledge a problem, there is an ironical tendency to see mathematized thought as the route to its resolution and not at all responsible for its conception.

The point here is not that mathematics is bad, nor that Western society is uniquely guilty of narrow perspectives It is, rather, that singular epistemic (or religious, or philosophical) frames cannot encompass the spectrum of possible human lives As Rorty (2000) puts it, a specific frame is:

> a projection of some particular choice among those possibilities, a working out of one particular fantasy, a picture of human existence drawn from one particular perspective (p. 14)

I am, as everyone is, caught up in this fantasy, even as I attempt to consider the complex question "Why *would we* teach mathematics to all students?" It is a query that is not really about what it seems to be asking It is one way of expressing a suspicion of forces unseen and a frustration at the veils and the dust that prevent any hope of a truly satisfying answer. Such is the role of the rhetorical question. It is in many ways an admission of resignation, even defeat. And it is this that I would dare to suggest is woven through a twelve-year-old's frustrated demands to know why she has to do whatever she is being asked to in math class.

To recap, perhaps the most honest answer to the question "Why *would we* teach mathematics to all students?" is that we cannot help but do so. It is bound in our collective character; it is part of our systemic being It is not simply something we do, but something we are. Indeed, we can scarcely imagine not doing/being so. To suggest otherwise - and, for the most part, even to suggest that the habit be altered - is to reveal oneself as either naive or deliberately provocative.

On this count, there is a problem with the question that orients this writing. To pose a question that begins with *why* is in some ways to suggest that we have a choice in the matter.

We do not Even when not made an explicit topic of instruction, our mathematics is knitted through the structures of our being(s), and perhaps most readily apparent in our habits of perception The linearities, rectangularities, crisp distinctions, tidy orders, etc. of our living spaces, narratives, interactions, hopes, etc hint that our mathematics is one of the most pervasive and powerful of human technologies [6] and, hence, one of the most pervasive and powerful constraints on Western conceptualization.

> Why *would we* teach mathematics to all students?
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> Because we have to: we are creatures of habit who are caught up in complex flows of events that are dependent on but not determined by what we do - and, in terms of what we Westerners do, mathematics is at the core of the explanatory fantasy that is currently preferred to organize and structure experience

The hermeneutic question: why should we teach mathematics to all students?

Perhaps, then, our efforts to answer the question should begin by breaking with the fantasy that prompts it - which is *not* to say that we should give up on mathematics, but that we might seek to interrogate the common sensibility that supports and is supported by modern mathematics. This common sensibility, this collective fantasy, is that our civilization (and, as part of this civilization, our knowledge) has a developmental structure

An alternative fantasy might be that we do not (and cannot) know where we are going, that we are not converging onto a totalized knowledge of the universe, and that unambiguous linearized accounts of how we got here are convenient fictions. And, just as classic mathematics has played such a key role in the myth of a fully knowable universe, recent disciplinary developments may help to structure a perhaps-more-contextually-appropriate myth.

Over the past few centuries, the contributions of mathematics (and the mathematized sciences) to Western habits of perception have been dramatic. From the subatomic to the supergalactic, a range of phenomena have become perceptible mainly because mathematics has helped to predict their existence and, as such, has prompted us to look for them. Such is the key element to perception: expectation We perceive mostly what we expect to perceive. Indeed, it has been suggested that perhaps only one millionth of the perceptual possibilities that impinge on our senses actually manage to bubble to the surface of consciousness. That means that most of what reaches consciousness is already interpreted, already selected by habits of perception, already fitted into the frames of expectation. [7]

It is thus not surprising that we would locate mathematics at the core of public schooling All formal education begins with one group's desire to have another group perceive things in the same way. And mathematics is a primary enabler of current perceptual habits.

Discussions of the question "Why *should we* teach mathematics to all students?", then, belong in the realms of obligation and mindfulness, in the spaces of the ethical and the moral These are domains that, in terms of the manners in which mathematics teaching is usually rationalized, are not always visited – a tendency that is in keeping with the privilege afforded the acquisition of knowledge over the development of wisdom.

Such avoidance certainly has much to do with the character of modern mathematics As a domain of inquiry, mathematics has for centuries failed to consider its place in the moral and ethical fabrics of human existence. In fact, following the Platonic separation of the worldly from the ideal, mathematics has most often been cast as detached from, even superior to, such worries It cloaks itself in a rhetoric of ideality and certainty, occasionally justifying its pursuits by touching the soil of utility. However, such acts seem to come with (at least tacit) qualifications that mathematics should not be held responsible for its applications and misapplications.

Even when discussions get past this troublesome separation of knowing from doing – that is, when matters of moral import are allowed to surface – there almost always continues to be an assumption of an inherent purity of formal knowledge. It follows that the project of mathematical inquiry tends to be cast in terms of goodness, with some acknowledgment given to the baser concerns of usefulness and cultural need. And the fact that discussions rarely go further doubtlessly contributes to the unproblematized history of imposing mathematics not only onto our children but also onto the children in other cultures.

But it is rare that discussions of mathematical study are framed in terms of its complicity in a range of crises that extend (at least) from the microbial to the planetary Even less is it discussed for its potential to support mindful awareness of such matters.

At the moment and site of this writing (early summer 2000, in rural southern Ontario), for example, citizens of the nearby town of Walkerton are reeling from a deadly outbreak of a toxin-producing strain of *E. coli* which somehow infiltrated the civic water system. The precise causes are yet to be determined, but record rainfalls, cattle faeces from industrial farms and government cutbacks have been implicated While journalists race to assign blame and politicians scramble to evade it, I find myself increasingly unsettled at the co-implicated products of the scientific, industrial and capitalist revolutions.

Woven through these movements is the enabling technology of mathematics. In each case, in fact, mathematics is more than an enabler. It is core to particular habits of perception, to a world-view. These revolutions have driven and supported mathematics for centuries, so much so that it is not difficult to argue that the crisis at Walkerton has more to do with mathematics than with anyone or anything else in particular.

To make the point more directly, in terms of the day-to-day life of a typical citizen of the Western world, mathematics has become part of the thrum of existence, an inextricable aspect of humanity. Represented to the masses as a more-or-less finished set of procedures, mathematics plays a vast and shaping role in the collective unconscious – common sense – the 'way things are' Consider such pervasive phenomena as straight roads through undulating terrains, stripped forest ecosystems replenished with single species, the conception of time as linear and uniform, and on and on. Such phenomena betray a conception of the universe as subject to a singular, linearizable interpretation. As Varela (1999) puts it, our Western world is characterized by:

> [the] tendency to find our way toward the rarefied atmosphere of the general and the formal, the logical and the well-defined, the represented and the foreseen. (p. 6)

In other words, it tends to a conception of the universe as essentially Euclidean. This usually transparent world-view served as the 'neutral' backdrop of anthropologists' studies of other cultures until only recently, when it was finally noticed that their reports were more expressions of their own cultures than of the cultures they thought they were describing In the past few decades, there has been an emergent recognition that different world-views are just that: different. Not wrong or primitive or naive: different.

There is a dawning realization that this diversity is vital – an insight that is now commonly expressed in terms of the tremendous loss of knowledge that accompanies the extinction of a language. As Wade Davis (2000) describes, a language:

> is not simply vocabulary and grammar; it's a flash of the human spirit, the vehicle by which the soul of a culture comes into the material realm. Each language represents a unique intellectual and spiritual achievement. (p A15)

Just as bio-diversity is critical to the complex ecology of the planet, so it seems cultural diversity is essential to human knowing

Ironically, though, despite the obvious cultural and linguistic aspects in the emergence of mathematics (see Lakoff and Núñez, 2000), the subject matter has maintained a certain transcendence in popular conception. True, there have been those who have argued that mathematics is as much a cultural expression as literature, music or drama, but the idea has not really become popular. However, there are hints of a change. Our mathematized assumptions are starting to be rendered more visible – and mathematics itself seems to be in large part responsible for this happening Developments in new geometries and alternative logics – which, notably, have been popularized by best-selling books on the topics – have contributed to a growing realization that the mathematics presented in schools is not simply a fragment of the whole, but a biased fragment that is aligned with a predominantly by modernist and Western world-view.

This is neither the time nor the place to go into detail. But I will offer one quick example: in a recent issue of a local newspaper, a full page was devoted to the display and interpretation of several fractal-like patterns that had been woven into or drawn onto artifacts from other cultures, including cultures that have long been considered mathematically impoverished. Suddenly, these artifacts are understood to be representing insights that are not just interesting, but that lay outside the purview of Western minds until recently

Such events should compel us to ask "What else are we not seeing?", not just in terms of other societies, but, more importantly, with regard to the more-than-human world [8] And that is a question that should make us constantly suspicious of the habits of mind that frame our current perceptions. In terms of the central concern of this writing, we need to be suspicious of our mathematics, especially at this historical moment. We need to suspect that domain which, at least since Descartes proclaimed it as the sole route to unimpeachable truth, has been popularly regarded as the cornerstone of solid knowledge rather than an impediment to mindful participation in the universe.

So, why study mathematics?

Our circumstances seem to compel a different perspective on the relationship between human knowledge (that is, the established but mutable patterns of human activity) and the more-than-human world. In place of a conception of knowledge as something 'out there' lying in vast pools awaiting discovery, we might take up:

> the conviction that the proper units of knowledge are primarily *concrete*, embodied, incorporated, lived. (Varela, 1999, p. 7, *his emphasis*)

This is a conviction that rejects classical Western metaphysics and, in the process, shifts understandings of what it means to be educated. As Varela points out, the overall concern:

> is not to determine how some perceiver-independent world is to be recovered; it is, rather, to determine the common principles of lawful linkages between sensory and motor systems that explain how action can be *perceptually guided* in a *perceiver-dependent* world. (p. 13, *his emphasis*)

Faced, for example, with environmental events that continuously and dramatically illustrate the participatory nature of our activities, it seems that it is time for a more humble, tentative and attentive conception of truth. In terms of the contribution of mathematics, I would argue that we need to become more aware of how perceptions, forms, beliefs, activities, and so on are profoundly mathematized - and that can only happen by knowing something about mathematics.

More bluntly, if humanity, as a species, is to survive, we need to learn new habits of perceiving the world And that will not happen unless we are better aware of what has been allowed to slip into transparency. We owe it to the world (and to ourselves, as part of the world) to make an effort to restore a little of the hope and the wonder that were lost when Enlightenment thinkers condemned imagination and dismissed wisdom with the imposition of deductive argument onto all claims to truth. To return to the analogy between personal addiction and our cultural obsession with mathematics, what is involved here is taking that first critical step toward recovery from an addiction: admitting that we have a problem

Such assertions take us out of the 'epistemology only' frame announced by Descartes, maintained by analytic philosophy and enacted in our schools. It pushes the discussion back to the realm of *being* . . existence . enchantment . . spirituality - the ontological It is a realization that matters of knowing and doing are always and already matters of being

> Why *should we* teach mathematics to all students?
>
> Because we have to: there are moral and ethical imperatives that operate in the human and in the more-than-human realms.

The wrong question: why teach mathematics to all students?

I have already indicated that there are sometimes problems with questions that begin with *why* Most obviously, such questions can project a sense that there is a choice - that if the answers were known, they might awaken participants to various possibilities for action That just does not seem to be the case in this instance.

A subtler problem with the question "Why teach mathematics to all students?" is that it focuses the spotlight of attention on rationales for teaching and, in the process, pushes the much more contentious issue of the nature of mathematics into the shadows. In so doing, it compels discussants to assume that they agree on the terms of the discussion - that they are talking about the same thing when they use the term 'mathematics'.

Such was certainly the case when the panel, mentioned in the opening paragraph, took the stage We talked about why we *do*, *would* and *should* teach mathematics, but no one took on the issue of what it is we think we are teaching when we claim to be teaching mathematics And we did not address the matter because our collective attentions were deflected onto the secondary matter of *why* (which assumes a *what*) As I review my own thoughts on the matter in this writing, in fact, it is with some surprise that I notice a persistent slippage away from 'rationales for' and into 'topics of' instruction - from the *why* to the *what*.

Huckstep (2000) provides a similar example of the way a certain focus can eclipse a bigger issue As he points out, discussions of why mathematics is taught inevitably fall back on assertions (sometimes veiled) of the utility of the subject matter. In fact, he quite appropriately reveals my own earlier efforts to address the issue to be developed around this strategy of argumentation. It is, nonetheless, a strategy that I was (and am) trying to avoid, for reasons that were well expressed by Dewey:

> The conviction persists, though history shows it to be a hallucination, that all the questions that the human mind has asked are questions that can be answered in terms of the alternatives that the questions themselves present. But, in fact, intellectual progress usually occurs through sheer abandonment of questions together with both of the alternatives they assume, an abandonment that results from their decreasing vitalism and a change of urgent interest. *We do not solve them, we get over them* (cited in Deacon, 1997, p 11, *my emphasis*)

What I am asserting, then, is that we need to get over the question "Why teach math?" and replace it with a more temporally appropriate obsession, namely becoming more mindful of what is happening in the name of mathematics education

So, what exactly are we teaching when we claim to be teaching mathematics? To be sure, it is vastly more than such mechanical competencies as adding fractions and differentiating functions And, also to be sure, this question is much more difficult to mistake as being teacherly or rhetorical in nature. It is a complex question, but a hint of a response is suggested by the fact that, in English, 'rational' and 'sane' are almost synonymous.

It is thus that the intuitive leap, a sense of awe, a feeling of enchantment, these and other moments of being are cast as irrational (and, hence, in some ways insane) within our schools. There is little space in the conventional normative and normalizing classroom for wonder, for sustained engagement, for obsession, for playful bodies But we do not seem willing to teach, or even to talk about, the very qualities that animate most mathematicians' life-work. In fact, it is not hard to make the case that *precisely the opposite* is being taught of mathematics: certainty instead of wonder, detachment instead of engagement, touring instead of dwelling, observing instead of obsessing, scripted performances instead of playful acts.

It is not easy to justify the classroom emphases on the former members of these sorts of dyads: at least, not any more. Modern curricula are, for the most part, devoid of any sense of the fact that mathematics is one of we Westerners' principal means of interpretation – that is, of mapping categories of experience onto one another

In the previous sentence, I gave an important part of my current answer to the question of the nature of mathematics: it is a system of interpretation (or, perhaps more appropriately, *they are systems* of interpretation). Tangled in this statement is a rejection of the ongoing debate over whether mathematics is created or discovered, a rejection that follows Dewey's observation, above. I join with Lakoff and Núñez in asserting that 'what human mathematics is' is *not* a mathematical or philosophical question, but one that should be addressed through an interdisciplinary study of mind, brain and their relation. Put differently, it is a question of the complex coupling of biology and phenomenology.

As Lakoff and Núñez seek to demonstrate, the beginnings of human mathematical competencies may be found in innate but limited capacities (e g. to subitize and compare) and physical experiences (e g. of moving through space or collecting objects together). Such embodied knowings are then elaborated into further-reaching competencies through various means of reading experiences against one another. Lakoff and Núñez provide evidence that these means of elaboration have much in common with the strategies for developing and extending language, and include analogy, metaphor and metonymy

As a privileged system of interpretation, mathematics is a core technology in Westerners' structures for *discarding* information across ranges of experience. Our mathematics helps us to decide which bits of information will matter and which oceans of detail will be ignored. In so doing, mathematics and other technologies have enabled us to parlay rather severe physiological constraints into seemingly god-like capacities. In the process, however, we tend to forget both what is being thrown away and the once-deliberate mechanisms that enable such discarding

So that is a huge part of what we are learning in mathematics class: a means to filter experience, to select what will and will not be allowed to impinge on consciousness. Yet, if one were to trust the current literature, one might get the impression that mathematics education is mostly concerned with assisting learners to factor quadratics and to master other competencies that are rarely (and, for many, never) invoked outside of mathematics class.

It is my own conviction that it is time to shift our attentions in school mathematics away from the current emphasis on concept competency and toward anthropological interpretation. It would seem to be time to involve learners in examinations of the pervasiveness of mathematical technologies – not only those hard technological artifacts, but the technologies of conception that are knitted through perception

To be clear, such a project is about not only what we know and believe, but also who we are It is a matter of self-knowledge – a statement that should not be read as an *inward* turn. Quite the contrary, this statement represents a rejection of the common-sense assumption that identity resides in the individual We are biological and social creatures who at birth are thrown into an already interpreted world. Throughout one's life, one categorizes oneself as an 'us' at least as much as a 'me', depending on where attentions are focused at any given moment. Most of the time, in fact, we float somewhere between personal and collective identifications, able to represent group opinion while exercising whatever personal choice is permitted within extant interpretative possibilities

This formulation amounts to a rejection of the Cartesian ego as the fundamental particle of knowing, doing and being – along with analytic philosophy's project of metaphysics (and, with that, much of the ground of modern schooling). It points away from attempts to recover a believed-to-be-independent reality, and toward a more deliberate participation in the unfolding of a universe. Here, self-knowledge is not an introspective project, but a mindful engagement with the issues of where and how the lines are drawn between the *me* and the *not-me*, between the *us* and the *not-us*, and so on

As distant as such issues might seem from a lesson on, say, the addition of integers, they are all about school mathematics. To make sense of this claim, though, there is a need for a different conception of what teaching mathematics is all about Such a conception would involve, for example, an awareness of the nested bodies - biologic, social, epistemic, and so on – that shape and that are shaped by such projects Within this frame, by way of immediate and practical implication, the question that orients the mathematics teacher's action shifts from "How can I best explain this concept?" to "What sorts of experiences might this concept be used to interpret?" This manner of thinking pulls mathematics out of the realm of transcendent knowledge and into the space of embodied knowing.

Perhaps such a shift, away from seeing school mathematics mainly in terms of lists of concepts and toward seeing mathematics as a humanity within a more-than-human universe, might help to transform the project into one where we do not have to work so hard to justify whatever it is we are doing when we claim to be teaching mathematics

Notes

[1] The session was organized and chaired by Elaine Simmt The panel consisted of A J (Sandy) Dawson, Bernard Hodgson, Nadine Bednarz and myself It was part of the 23rd Annual Meeting of the Canadian Mathematics Education Study Group (Montréal, 2000, May 30).

[2] The actual term used by Gadamer (in translation) is 'pedagogic' For reasons discussed elsewhere (Davis, 1996, p 301), I prefer to use 'teacherly'.

[3] In the English translation of Freire's book, the Portuguese term *conscienctização* is used

[4] This point is actually this crux of the essay, but cannot be appropriately developed here. I would direct interested readers to reviews of the literature that are offered by Dennett (1991), Lakoff and Johnson (1999), Lakoff and Núñez (2000) and Norretranders (1998) Along with colleagues (see Davis, Sumara and Luce-Kapler, 2000), I have used some of this literature to frame a broader discussion of teacher education and schooling.

[5] 'Partial', here, is used to point *both* to the biases that are implicit in a mathematized world-view and to the fragmentary nature of such a world-view.

[6] 'Technology' is used here in its original sense of those activities and artifacts that are used to structure human experience: see Heidegger (1977)

[7] See Norretranders (1998) for a summary of the extensive research on these matters

[8] The term 'more-than-human' is borrowed from David Abram (1996) He develops it as an alternative to the more popular terms 'non-human' or 'natural' In contrast to such terms, 'more-than-human' does not separate humanity from the rest of the universe

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