The Stench of Perception and the Cacophony of Mediation

PETER APPELBAUM

In this course of instruction there were no concepts, doctrines, methods, script, figures, and only very few words The Master trained Knecht's senses far more than his intellect A great heritage of tradition and experience, the sum total of man's [*sic*] knowledge of nature at that era, had to be administered, employed, and even more, passed on A vast and dense system of experiences, observations, instincts, and habits of investigation was slowly and hazily laid bare to the boy. Scarcely any of it was put into concepts. Virtually all of it had to be grasped, learned, tested with the senses. (Hermann Hesse, 1969, p 42)

Throughout the field of meanings constituting science, one of the commonalities concerns the status of any object of our accounts to a 'real world,' no matter how complex and contradictory these worlds may be. Feminists, and others who have been most active as critics of the sciences and their claims or associated ideologies, have shied away from doctrines of scientific objectivity in part because of the suspicion that an 'object' of knowledge is a passive and inert thing. Accounts of such objects can seem to be either of a fixed and determined world reduced to resources for the instrumentalist projects of destructive Western societies, or they can be seen as masks for interests, usually dominating interests. (Donna Haraway, 1992, p 197)

Then suddenly he fixed me with his eyes

"And now, do you understand?"

"What?" I said

"What you've heard!"

"I don't know."

"Why?" I said, "I really think it's time we left." (Ralph Ellison, 1972, p 86)

Hesse, Haraway and Ellison nurture overlapping terrains of discourse for my reiterating experiences of mathematics, technology and professional development. Mutually constructive in all directions, the discursive categories of science/technology studies, sense-based epistemology as the vestige of the body in social action, mathematics curriculum and the power/knowledge implications of professional discourse form a nexus of disempowerment at issue in this essay. Ellison's climax establishes an initial summary statement for further inquiry:

"You see," he said turning to Mr Norton, "he has eyes and ears and a good distended African nose, but he fails to understand the simple facts of life. *Understand*. Understand? It's worse than that He registers with his senses but short-circuits his brain. Nothing has meaning. He takes it in but he doesn't digest it. Already he is - well, bless my soul! Behold! a walking zombie! Already he's learned to repress not only his emotions but his humanity. He's invisible, a walking personification of the Negative, the most perfect achievement of your dreams, sir! The mechanical man! (1972, p 86)

The invisible hero of Ellison's novel is the epitome of school success. In fact, it is his careful embrace of school learning that leads to this episode, the subsequent turmoil of interaction with the white man, and his excommunication from the world of school into the real-world of the senses and his authentic education. School had refined his senses as prosthetic attachments to a mechanized brain, the essence of the invisible man In an era of calls for education that achieves 'mathematical power' for all students (e.g NCTM, 1991), it is crucial that we examine the role of the senses and the use of perception in mathematics education Educators in the romantic tradition have lamented school mathematics as the overwhelming drill-and-practice construction of the mechanized human But the language of reform, the national standards documents of the eighties and subsequent state and provincial standards and curricula of the nineties elaborate, for North American policy at least, a contradictory and confusing terrain

Stench and cacophony

As policy is written, it constructs the nature of what it means to be a teacher (of mathematics): as a professional, a teacher needs to 'learn' the new policy and conform/adapt her or his practice such that it can be described in terms of the discourse of the policy Policy positions the professional as ignorant of 'best practice', devaluing the sort of learning emblematic of the boy in Hesse's apprenticeship narrative, an unarticulated, non-conceptual experience of the body. As a professor of education called upon to perform acts of professional development, I too am placed on this terrain in the midst of bewilderment. In general, I am extremely sympathetic to the reform efforts in mathematics education. Yet my experiences guide me, too, into a state of professional non-expertise as I am by my position in the configuration of policy and institutional practice constructed as an educator introducing a new prosthetic technology.

For me, the job is to introduce policy discourse as a new technology of vision (Haraway, 1992) As Galileo learned to use a telescope (Polanyi, 1958; Feyerabend, 1988), I and the teachers I work with use new prosthetic theories and the result is a similar collection of new metaphors and models. Far from understanding the objects of knowledge as passive and inert, my own practice assumes a volatile and aggressive mutation-organism, the experience of which transforms permanently those who interact with it. Likewise, teachers are asked to comprehend mathematics in the same fashion, as a tool through which students are unequivocally mutated into people who "see the world through mathematical eyes" (As an instance of how this ideology has come to permeate our whole discourse, Ritchart (1997) has this as its very title.)

In both cases, the stuff of knowledge is a prosthetic enhancement of vision. The primary model of knowing is that of seeing with one's eyes, and the dominant metaphor for understanding is vision Mathematics and policy are like ultramega-ray lenses surgically affixed to the eyes. The metaphor is inscribed in practice by the celebration in professional development of technology itself as the privileged focus of sanctioned and acclaimed 'new knowledge'. The context of inscription is that of technology as 'superior', the improved being enhanced beyond simplistic 'nature' or savagery (Appelbaum, 1999) Hence prosthetic technology is an enculturation into a long Western tradition of colonialism, racism and dehumanization (Adas, 1989).

Highlighted in this essay is my work as a featured speaker for a conference of teacher-leaders in technology in mathematics, as a participant in a funded institute for the development of web-based curricula, and my employment by school districts to introduce technology (usually defined as 'computers') and the internet (usually considered a separate item from 'technology' in requests for professional development programs).

Each of these experiences highlights for me the contradiction of the previous paragraph: that technology is simultaneously an aggressive agent of mutation and a mere prosthesis of vision I have since found it necessary to examine my position itself as potentially in conflict with my politics of knowledge: can I construct alternative metaphors for the tasks of my profession and avoid the problematic job of mutation terrorist or prosthetic surgeon?

The discourse of epistemology has not helped me greatly. There have been of course numerous, remarkable attempts to offer alternatives to a Platonic notion of authentic vision as true knowledge Most, however, remain within a hegemony of perception as essential to the comprehension of knowing and coming to know Sartre's (1969) form of existentialism offers touch as a powerful challenge. We reach out into the world and feel those things we know; and the object *makes* us feel as we touch We must direct our intention toward what we touch, but once we do we are the object of experience, not the thing we touch. The magic of touch indeed has its enactment in mathematics education, primarily through the pedagogical use of manipulatives.

However, Sartre's project is undermined in the majority of manipulative-based experiences While the materials are claimed to embody a model of a mathematical concept, students need to be taught how to 'feel' the concept. As Michael Polanyi described Gallileo's telescope as the icon of 'tacit knowledge' learned prior to the experience of seeing with a telescope, students must be acculturated to the way of touching mathematics through manipulatives Often they are simultaneously taught how to 'see' the concept in the material from a distance as well, thus returning the epistemology of touch into an epistemology of dominant sight supported by touch

The most accessible discussions for me of the ear and listening as the model and metaphor of knowing and coming to know are to be found in recent feminist theory (Belenky *et al.*, 1986), and, within mathematics education, in the exquisite work of both Julian Weissglass (1990, 1994) and Brent Davis (1996) This approach, which emphasizes the interactionist quality of listening to another person, is particularly pertinent to current reform efforts regarding the increase of mathematical communication in the classroom. As Davis notes, we tend to stand back in order to see, and to move nearer in order to hear

> Correspondingly, there is an element of discomfort associated with being watched, but we generally want to be listened to - in part, at least, because of the interaction afforded by listening (p 37)

Furthermore, participation as a 'listener' or the 'listened to' has a different quality from that of the 'watcher' and the 'watched':

> In particular, because we are unable to shut off our hearing with the ease that we can close off our seeing, attempts to not hear often result in being compelled to listen more attentively. (p. 37)

Yet, as Davis notes, a person's range of possible action, as described with the aid of listening as a metaphor, is determined by his or her structure: in an interaction with another person, how he or she acts is not primarily a function of the other person's actions (as in presumed transmission models of communication and teaching), but a consequence of his or her own structural dynamic The ear within and part of the body is perturbed by the environment, but it is the structure of the living being that determines the changes that occur in it (p. 10). Interaction, then, is not 'instruction'; its effects are not determined by the interaction, but rather changes result from the interaction, determined by the structure of the disturbed system.

Significant in the work of Weissglass and Davis is their emphasis on listening as a form of 'embodied action' as opposed to a technique of hearing Weissglass presents a taxonomy of listening forms that he designates as partially pedagogic; his alternative, dubbed 'constructivist', encourages the talker to reflect on the meaning of events and ideas, to express and work through feelings that are interfering with clear thinking, to construct new meanings and to make decisions.

Davis (p. 53) similarly constructs a framework of three comparative modes of listening differentiated by their features of attending to the one 'listened to'.

- *Evaluative listening* is the dominant mode of the detached teacher who rarely deviates from intended plans and judges contributions as right or wrong. More authentic forms of enactive listening are the responsibility of the learner.

- *Interpretive listening* requires a teacher to reach out rather than take in; listening becomes the development of compassion, increasing the capacity of the listener to be aware of and responsive to the interrelatedness and commonality across human beings.

- *Hermeneutic listening* is messier in problematizing any differentiation between the 'listener' and the one 'listened to'; participants are involved in a project of interrogating taken-for-granted assumptions and prejudices that frame perceptions and actions. Hermeneutic listening promotes "participation in the unfolding of possibilities through collective action".

I want to suggest that reform efforts tend to undermine potential hermeneutic listening when they promote increased student talk as a tool for assessment, a recent focus of much professional development (NCTM, 1994, 1995). Workshops on alternative assessment practices or on, for example, performance assessment with technology (Appelbaum and Kaplan, 1996) thus train teachers in the use of surveillance of students via evaluative listening. Greater pedagogical potential might be found in practices that create students as listeners and those listened to in one of the other two modes.

Collaborative group work has this potential when not used for assessment surveillance and when listening skills are actually facilitated in the classroom, so that participants can begin to engage effectively in forms of interpretive and hermeneutic listening. One possibility suggested by Karen Gallas (1995) for science as 'science talks' could be adapted as 'mathematics talks' in schools. Math talks might be held once per week or more frequently. A person poses a question and class members together talk and listen to each other toward a comprehension of the question and potential responses to it.

The relevance of a listening orientation for professional development can be found in Davis' point that the unfolding, enacted curriculum makes no attempt at optimization.

> Instead, the listening teacher works with the contingencies of the particular classroom setting. It is founded on the realizations that no learning outcome can be prescribed, no active setting can be controlled. But neither must we forego attempts to influence (or fail to acknowledge our influence upon) what might come about. The key to teaching, in this conception, is to present a space for action and then to be present to participate in – and through this participation, to shape – the joint project that emerges. (1996, p. 271)

In other words, a workshop designed to introduce new technology to teachers will have surprisingly little impact on workshop participants *unless* it speaks to the teachers' needs for enabling such enactive spaces within the peculiarities of their own styles of interaction and the particular circumstances of their classroom. Moreover, such a workshop runs the danger of placing participants in the role of one-being-evaluated via evaluative listening if it must conform to expectations constructed by policy or district guidelines. I find myself repeatedly placed in such a position, in which participants bring expectations of evaluative listening to a workshop that I foresee as hopefully hermeneutic, at least interpretive, but never evaluative. Here lies one example of how I am positioned by practice in a role that is doomed to failure if my aim is to engage in a project of unfolding possibilities.

More challenging to current institutional expectations, and in need of further investigation, are the nose and the tongue as models and scenting and tasting as metaphors. In one manner the counterpart to listening and the optimistic notion of hermeneutic conversation, smell, for Nietzsche:

> sniffs out the cowardice of hypocrisy and decadence that lurk in those most-secret places into which neither eye nor mind can penetrate. (quoted in LeGuerer, 1992, p. 185)

Instinct, not reason, has "the flair to scent out falsehood as falsehood" and reveal a facade of interpretive or hermeneutic listening as corrupted by evaluative aims. The links between smell and wisdom, mental penetration and sympathy, make it the sense of the psychologist, guided by instinct, whose action consists not of reason but of 'scenting out' (LeGuerer, 1992).

Nietzsche, Freud, Marcuse and Serres raise the crucial counterpart to mathematics as a technology of seeing or listening in noting the pleasure and intimacy that is repressed by the domination of sight and hearing over smell and taste. Mathematics as abstraction technology does not abandon the idea of a person as a body in a caricature of prosthesis attached to a reasoning brain (the 'invisible man'), nor does it deny the notion of a person as indeed a perceiving being. Instead, Serres recognizes, the particular technology constructed by mathematics as experienced in school breaks the body down into parts: the seeing and listening are favored over the tasting and scenting. The result is a perpetual lurking suspicion of the instigator of this bodily decomposition – the teacher – simultaneous with a harmful repression of pleasure and personal participation through the splitting of one's bodily perception of the world.

It is in this respect that school mathematics reveals its stench. As the discipline most elaborately constructed as a process of 'truth' dominated by seeing and listening, it perpetuates in Nietzschean terms an environment of nauseating effluvia effervescent of the shady den in which such ideals are cooked up, ideals that stink to high heaven of falsehood, obliging so many students to hold their noses. Implications of the metaphor include following it further and constructing mathematics as a search for pleasure, and as a realm for scenting out the delightful fragrance as well as the foul stench of hypocrisy.

In Stephen Brown's (1984, 1993) study of problem posing and de-posing lurks potential tastes toward this sort of psychoanalytic use of mathematics therapeutically to reclaim the sense of oneself as a moral acting being.

Mathematics is, for Brown, transformed out of a technique that links means and ends, a tool for 'solving it', into a collection of psychoanalytic activity through which one understands oneself and mathematics in new ways. My own description of sight and listening privileged over taste and smell, the splitting that occurs as a psychoanalytic crisis, could be understood in Brown's early work as a persistent by-passing of activity that incorporates abstractions 'out there' in such a way that we begin to gain power over it and feel that we possess it in some important sense

Brown calls for a mathematics education grounded in making observations of a phenomenon, drawing implications from these (assumed valid) observations, using the phenomenon to imagine alternatives to it, negating some of the hypotheses and posing new problems He later claims:

> If we persist in by-passing this activity [by which I understand the continued splitting of sight and listening over taste and smell], we desensitize ourselves to the point that we no longer 'taste' the uniqueness among phenomena, and though they may be able to gain answers to questions, they become very much insensitive to what it means for something to be a problem and have even less of an understanding of what it means to have solved something. (1993, p 271)

This 'insensitivity' is another dimension of the splitting crisis. Mathematical knowledge includes a meta-knowledge of how one 'does' the mathematics. One's relationship to mathematics and one's understanding of how this influences the mathematical conclusions that are drawn/reached become important considerations in and out of school Other than this work by Brown, the field is ripe for greater comprehension of the plight of the student. As Søren Kierkkegaard reflected:

> One sticks one's finger into the soil to tell by the smell what land one is on. I stick my finger into existence – it smells of nothing Where am I? Who am I? How did I come to be here? What is this thing called world? How did I come into the world? Why was I not consulted? [...] and if I am compelled to take part in it, where is the Director? I would like to see him! (quoted in LeGuerer, 1992, p 197)

Technology and mediating process

I am arguing for a changing interpretation of mathematics, technology and professional development, one that does not reproduce the splitting crisis. One way through might be to establish a sort of integrated perception epistemology that does not privilege some constellation of the senses over another This would maintain mathematics as an object of reflection. My description of work by Stephen Brown indicates one potential perspective Weissglass (1994) offers a compatible process of professional development intended to help teachers with 'the crisis of reintegration' (p. 73) through constructivist listening to one another in dyads.

I want to suggest, however, that it is possible to avoid the conceptual collapse of perception and learning altogether, by finding an alternative to mathematics as a body of knowledge similar in some ways to what Brown proposes, one which also avoids the reification of mathematics as a thing to which people relate or with which people do something. If mathematics is understood as a feature of cultural practice and thus as a characteristic of professional action (Appelbaum, 1995), we can enter professional development in terms of mathematics as a mediating process rather than as a technology. Nevertheless, it is still heavily presumed today – and policy and practice continue to so construct – that mathematical observations:

> directly connect the rational mind with objective nature. [Only now] the possibility of such a connection is not derived from an *a priori* pre-established harmony, but is based on technical success (p. 280)

The presumption is enacted in practice by a commonsense discourse captured well by Nel Noddings (1985) when she writes about effective pedagogical encounters for students:

> the key seems to be that they *get to do things that they want to do* with their newly learned conventions [...] people like to use the skills that they acquire *toward their own ends*. (p. 124)

Alan Bishop (1988) goes as far as to posit mathematics as a:

> pan-cultural phenomenon [...] a symbolic technology, developed through engaging in various [integrated] environmental activities (p 59)

one which can be classified as counting, locating, measuring, designing, playing and explaining. Intersecting this cultural context is the institutional feature of curriculum work as the creation of pre-packaged 'lessons' that have often been described as mutating the teacher into an instrument of pedagogy. Thus, it is crucial to recognize the persistence of mathematics as an object of object-relations within the discourse of mathematics education and professional development

A promising transformative embrace of this discourse has been presented by Keitel, Klotzmann and Skovsmose (1993). Rather than doubting mathematics as a technology, they suggest claiming it as such for democratic aims in a highly technological society, thus echoing sociologically what Brown has suggested psychologically. For educational tasks, they make a distinction between different types of know-ledge based on the object of the knowledge They go beyond knowledge as perception by enclosing such knowledge within the empiricist doctrine – that all knowledge would have to be of the same nature, which in turn presumes that all sorts of knowledge have to do with the same sort of objects: sense-data

Another extended realm of mathematics as knowledge, out of which they derive curricular possibilities, is that of the model and its relationships as the object of knowledge. Out of these objects they form levels of 'reflective knowledge' grounded in questions such as "How is the development of the system influenced by basic interests and intentions?" or "How is the structure of argument influenced by the complexity of the mathematical model?"

The first level of *mathematical work*, according to Keitel, Klotzmann and Skovsmose, presumes a true-false ideology and corresponds to much of what we witness in current school curricula The second level directs students and teachers to ask about right method: are there other algorithms? Which are valued for our need?

The third level emphasizes the *appropriateness* and *reliability* of the mathematics for its context. This level raises the particularly technological aspect of mathematics by investigating specifically the relationship between means and ends. The fourth level requires participants to interrogate the *appropriateness of formalizing* the problem for solution; a mathematical/technological approach is not always wise and participants would consider this issue as a form of reflective mathematics.

On the fifth level the curriculum studies *implications* of pursuing special formal means; it asks how particular algorithms affect our perceptions of (a part of) reality, and how we conceive mathematical tools when we use them universally Thus, the role of mathematics in society becomes a component of reflective mathematical knowledge Finally, the sixth level examines *reflective thinking* itself as an evaluative process, comparing levels 1 and 2 as essential mathematical tools, levels 3 and 4 as the relationship between means and ends, and level 5 as the global impact of using formal techniques On this final level, reflective evaluation as a process is noted as a tool itself and as such becomes an object of reflection.

Another approach builds on the history of early adoption of computers in schools. Responding to increasing demands for large sums of money to be spent on a computer for each child in the classroom, or the scheduling bureaucracy associated with computer labs, educators began to call for one or a few computers in each classroom The idea was that the computer would shift from an object of knowledge and celebration toward a tool that facilitates educational experiences. An analogy was drawn to a piano in a kindergarten: each student is not assigned to their own piano; instead, one piano in the room enables a variety of possible activities across the curriculum (Goodman, 1984).

Adding another layer to the analogy, we can posit mathematics as a technology, similar to the early computers. Now, extending this analogy, we imagine a curriculum that does not affix a mathematical prosthesis onto each cyberchild, but instead takes advantage of mathematics as a technology that enables a range of educational activities across the curriculum. Facility with mathematics as an instrument might foster a variety of individual and group activities throughout the educational spectrum.

The above two examples accept mathematics as a technology and adapt it toward particular pedagogical ends. A parallel response I want to encourage for consideration in policy and professional development suggests that mathematics as a technology is not simultaneously a body of knowledge but a mediating process. Michael Otte (1993) writes:

> The social conditions of mathematics as well as its character change with its relations to technology and according to changes in the technological condition. Mathematics is a reflection about the technical means of human activity These claims slightly perturb as well as readjust the traditional view according to which mathematics has evolved alongside empirical natural science. If, as is traditionally the case, the methods of physics or science in general is characterized as mathematical and experimental, it is often overlooked that the experiment is also mathematical because of its dependence on technology. Our conception of reality and, in particular, our relationship to nature in the broadest sense are never direct, but are mediated by the general process of mathematization and technicalization, which is polarized itself, because mathematics is not identical with technology. (p 281)

It is in this respect that we can observe students interacting with a computer and note, as did Laborde (1993) in her study of the status of drawings and figures, that students have a tendency toward analyses that are 'perceptually dominated'. Mathematics as a mediating process develops technologies of perception. Yet mathematics as curriculum is much 'more' than this, in that it is a form of mediating 'literacy' as well. Mathematics might be written about here as a liminal terrain, always between, never an object but a conduit or a fog, a nexus of intersecting nodes, a border that shifts when we try to sketch a map, like a border that runs down the middle of a river.

Within the tension constructed by a juxtaposition of a person (teacher or student) and mathematics – as if they could be distinct locations – is placed the confounding decoy of 'technology' as defining relationships between the two Theories of the relation that set up technology as the relation displace the question of technology onto an ahistorical, purely textual figure of a student; or they shift the power basis of technology beyond difference of mechanization or technique onto a diffusion of pleasures; or they shift the power basis onto a multifaceted web of interconnected nodes and circuits, constructing a student freed from self-representation and constraints of identity; or these theories displace 'reality' along *with* an ideology of perception, onto a diffuse, decentered, possibly deconstructed student, naming the very process of displacement 'becoming an educated person'.

In other words, it is only by denying technology as a component of the mathematicity of a cultural being, and hence by denying the historical context of mathematics wielded as technology by cultural beings, and the subsequent subjugation to mathematization through technology, that a philosopher can see in an 'educated person' the privileged cache of 'the future of society'. Someone 'with mathematics' as a technology is nothing more than Michael Adas' (1989) technology-ideologue of Western Dominance

We should then ask, if we are to deconstruct mathematics as a technology, and if this deconstruction effects our reconstruction, as educational project, in which terms and in whose interests the deconstruction is being effected. The 'problem' here has much in common with the general project of a view from 'elsewhere'. Parallel to feminist theory, technology as a relationship corresponds to gender as a relation between male and female In cultural theory mathematics is threatened with construction as the 'other' to the person

A lesson that could be taken from the psychoanalytic perspective on mathematics and the emblematic student or teacher is the disappointing outcome of denying dependency on the mathematics. A one-sided autonomy that denies its dependency characteristically leads, ironically, to domination. The absolute assertion of independence requires processing and controlling the needed object. As Alan Block (1997) writes in his discussion of psychoanalytic object relations theory, we must focus, not on the materials that pass as knowledge, but on what is experienced with that material. The psychoanalyst's ideas, Block suggests, should become the:

> provision of objects that can be used [...] to evoke repressed memories, to collect split thoughts, or to facilitate new self states. It is the [...] use of such objects that determines whether an idea becomes an insight. (p. 70)

All the teacher's knowledge is only potential knowledge, an object for the student. Weissglass (1994, p. 73) quotes Peter Marris:

> No one can resolve the crisis of reintegration on behalf of another. Every attempt to pre-empt conflict, argument, protest by rational planning, can only be abortive: however reasonable the proposed changes, the process of implementing them must still allow the impulse of rejection to play itself out. When those who have power to manipulate changes act as if they have only to explain, and, when their explanations are not at once accepted, shrug off opposition as ignorance or prejudice, they express a profound contempt for the meaning of lives other than their own.

In Brown's terms, we:

> must balance a commitment to truth as expressed within a body of knowledge or emerging knowledge, with an attitude of concern for how that knowledge sheds light in an idiosyncratic way on the emergence of a self. (1993, p. 274)

Echoing Polanyi's tacit knowledge, Block also helps us recognize *finally* that perception is not the beginning of knowledge (p. 39).

The meaning of perception is not in the act of perceiving, but in the idea of the construction of the percept, of knowing to look and then finding what we look for. Barraged with this cacophony of mathematics as a mediating process, can we find a view from nowhere, and hence from elsewhere?

> Computers have only been present in any substantial numbers in classrooms for less than two decades, but the choices have been present since their introduction. They are, in essence, choices about knowledge, about skilling or deskilling, closure or openness, calculation or modelling [...] they structure the relationships individuals will need to have with the principles which underlie their design. Does it suffice for students to be consumers of programs, to learn to punch in answers or vary parameters in models which have been built by software developers? Or will they need to gain insight into how the programs are built, what it means to build a mathematical model, how the construction of algorithms provides a rich source of metaphors and knowledge on which to develop mathematical understandings? Will students merely need to know how to run other people's programs, or will they need to reconstruct them for themselves in order to read and interpret the output creatively? (Noss, 1998, p. 7)

As Teresa de Lauretis (1987, p. 25) has written, if that view is nowhere to be seen, not given in a single text, not recognizable as a representation, it is not that we have not succeeded in producing it. It is possible that what we have produced is not recognizable (to us precisely) as a representation that could be perceived. She borrowed the term 'space-off' from film theory in expressing the space of feminist theories of gender: the space not visible in the frame but inferable from what the frame makes visible. She noted that classic commercial film erases the space-off within a narration.

But avant-garde cinema has shown the space-off to exist concurrently and alongside the represented space; this is done by remarking its absence in the frame or in the succession of frames, showing it to include not only the camera (the point of articulation and perspective from which the image is constructed), but also the spectator (the point at which the image is received, reconstructed and re-produced in/as subjectivity).

Similarly, we could claim the 'space-off' of technology as framing the relationships of mathematics in and out of schools. 'Technology' is noted as an ideological representation that characterizes the subject of this essay, a movement back and forth between the representation of technology (as a tool of perception) and what the representation leaves out, or makes unrepresentable. The space-off is the elsewhere of hegemonic discourses.

It is not that other discourses do not exist or that pedagogies based on them could not be found. Indeed, students can and do experience a relationship with mathematics as a socially mediating process that leads to something other than the disempowering, mechanizing zombification of the *Invisible Man*. Rather, the discourse for such pedagogy is not to be found in policy, standards, or professional development, but 'elsewhere' in the space-off spaces between and around these locations. For example, in the few moments before and after a professional development workshop when a genuine discussion pops up between the director and a few participants.

Brown (1993) alludes to this when he writes of his own suggestions for mathematics education:

> Make no mistake about it. Our strategies [...] are revolutionary ones for those whose major concern in curriculum is to hand over a hermetically sealed body of knowledge. (p. 271)

The space-offs for Brown are the stuttering pauses of the curriculum that occur when one forgoes observations connected to the original goal of a problem; one scents out - is inspired, and breathes in - new goals. "Los[ing] sight of the original problem" (p. 271), students and teachers in a problem posing classroom converge with the psychoanalytic mathematics discussed earlier and allow school to bracket out the curriculum in favor of a study of the self. In writing of some possible types of activities, Brown suggests they are means of making something imposed from outside one's own.

Rather than reintegrate mathematics as a technology in this way, however, I prefer his parallel 'spice': that these activities are a way of inhaling and consuming an 'abstraction' in such a way that it becomes a part of oneself, potentially nourishing and potentially mutational That a spice can be an irritant is relevant as well. My dilemma is that professional development as a cultural and institutional practice is set up as a technological solution and thus prevents an on-going experience of this sort, redefining 'professional' from an ethical position into a narrowed percept, parallel and distinct; in psychoanalytic terms, to a whole integrated form of experience, or in epistemological terms a broader range of knowing that includes those forms characterized metaphorically by taste and smell.

The reduction of a mediating process to a technology of relation is a type of surgical denasalization If professional development has any hope for a different structuring of experience, it must therefore enter a realm of activity that does not avoid scenting out and tasting of possibility in favor of a distribution of new-fangled gadgets guaranteed to satisfy the new audio-visual needs they create The same old pedagogical dilemmas can no longer be sidestepped.

Moreover, the space of mathematics as mediating process is not defined by its difference from some 'evil' dominating discourses The (at least) two spaces are not in opposition or placed in a sort of competitive relation themselves; they coexist concurrently and in contradiction, simultaneously in harmony, counterpoint and cacophony. To inhabit both spaces is to live a contradictory tension This is, indeed, the condition of education: the critiquing quality of its theory, and the positivity of its practice.

Weissglass' (1994) point is that professional development has been dominated by discussion and action groups to the exclusion of support groups. Group goals are to exchange information, thoughts and opinions about issues in education, or to take action on procedures or policy. Professional development increasingly needs to develop trust among educators, and to help each participant personally think through issues, work through feelings, and set goals; support for personal and professional growth is to be distinguished from challenging policy

What this highlights, I propose, is the very social and cultural nature of mathematics as a mediating process in the on-going construction of teachers (of mathematics), students (of mathematics), student/teachers and teacher/students, and 'professional' development, contrary to the prevalent view espoused in contemporary discourse on professional development as an autonomous and isolated experience:

> Professional development takes many forms, but true professional development, in the sense of resulting in meaningful and long-lasting qualitative change in a teacher's thinking and approaches to educating, is an autonomous activity chosen by a teacher in search of better ways of knowing and teaching mathematics Professional development activities that are externally mandated or coerced by a power hierarchy are false because they do not result in development as a qualitative change. Externally imposed professional development activities, although well-intentioned, are doomed to failure, like other passing educational fads on the junk heap of discarded simplistic solutions to complex problems. In short, one cannot 'empower' another professionally. (Castle and Aichele, 1994, p 3)

This commonsense discourse shares with the psychoanalytic approach of reintegration an abdication of responsibility on the part of the 'professional' hired to 'perform professional development' A more provocative form of professional development would ask a group to talk about how it came about that people assume professional development in mathematics education is an individualized activity Such a discussion has the potential to raise mathematics as a technology of the self (Foucault, 1988), as implicated in the formation of how participants represent themselves to themselves. As an entry into the stench of perception and the cacophony of mediation, professional development may be a fragrant inspiration.

References

Adas, M (1989) *Machines as the Measure of Man: Science, Technology, and the Ideologies of Western Dominance*, Ithaca, NY, Cornell University Press.

Appelbaum, P (1995) *Popular Culture, Educational Discourse and Mathematics*, Albany, NY, State University of New York Press.

Appelbaum, P. (1999) 'Cyborg selves: Saturday morning magic and magical reality', in Daspit, T. and Weaver, J. (eds), *Popular Culture and Critical Pedagogy*, New York, NY, Peter Lang, pp 83-116

Appelbaum, P. and Kaplan, R. G. (1996) 'Performance assessment with technology', Presentation for the annual meeting of the Association of Mathematics Teachers of New Jersey, New Brunswick, NJ.

Belenky, M., Clinchy, B., Goldberger, N. and Tarule, J. (1986) *Women's Ways of Knowing: the Development of Self, Voice and Mind*, New York, NY, Basic Books.

Bishop, A (1988) *Mathematical Enculturation: a Cultural Perspective on Mathematics Education*, Boston, MA, Kluwer Academic Press.

Block, A (1997) *I'm Only Bleeding: Education as the Practice of Violence against Children*, New York, NY, Peter Lang

Brown, S I (1984) 'The logic of problem generation: from morality and solving to de-posing and rebellion', *For the Learning of Mathematics* **4**(1), 9-20.

Brown, S I (1993) 'Mathematics and humanistic themes: sum considerations', in Brown, S. I. and Walter, M (eds), *Problem Posing: Reflections and Applications*, Hillsdale, NJ, Lawrence Erlbaum, pp 249-280. (This is a reprint of an article with the same title from *Educational Theory* **23**(3), Summer 1974, 191-214.)

Castle, K and Aichele, D. (1994) 'Professional development and teacher autonomy', in Aichele, D and Coxford, A. (eds), *Professional Development for Teachers of Mathematics*, 1994 Yearbook, Reston, VA, National Council of Teachers of Mathematics, pp 1-8

Davis, B. (1996) *Teaching Mathematics: Towards a Sound Alternative*, New York, NY, Garland

Ellison, R (1972) *The Invisible Man*, New York, NY, Vintage Books.

Feyerabend, P (1988) *Against Method*, London, Verso.

Foucault, M (1988) 'Technologies of the self', in Martin, L, Guttman, H and Hutton, P. (eds), *Technologies of the Self: a Seminar with Michel Foucault*, Amherst, MA, University of Massachusetts Press

Gallas, K (1995) *Talking Their Way into Science: Hearing Children's Questions and Theories Responding with Curricula*, New York, NY, Teachers College Press

Goodman, F (1984) 'The computer as plaything', Simulation and Games **15**(1), 65-73

Haraway, D. (1992) 'Situated knowledges: the science question in feminism and the privilege of partial perspective', in Haraway, D , *Simians, Cyborgs, and Women: the Reinvention of Nature*, New York, NY, Routledge, pp 183-202

Hesse, H (1969) *The Glass Bead Game: Magister Ludi*, New York, NY, Rinehart and Winston.

Keitel, C , Klotzmann, E and Skovsmose, O (1993) 'Beyond the tunnel vision: analyzing the relationship between mathematics, society and technology', in Keitel, C. and Ruthven, K (eds), *Learning from Computers: Mathematics Education and Technology*, New York, NY, Springer-Verlag, pp 243-279

Laborde, C (1993) 'The computer as part of the learning environment: the case of geometry', in Keitel, C and Ruthven, K (eds), *Learning from Computers Mathematics Education and Technology*, New York, NY, Springer-Verlag, pp 48-67

LeGuerer, A (1992) *Scent: the Essential and Mysterious Powers of Smell*, New York, NY, Kodansha International

de Lauretis, T (1987) *Technologies of Gender. Essays on Theory Film and Fiction*, Bloomington, IN, Indiana University Press

Marris, P. (1986) *Loss and Change*, London, Routledge and Kegan Paul

NCTM (1991) *Professional Development Standards for Teaching Mathematics*, Reston, VA, National Council of Teachers of Mathematics

NCTM (1994) *Professional Development for Teachers of Mathematics. 1994 Yearbook*, Reston, VA, National Council of Teachers of Mathematics

NCTM (1995) *Assessment Standards for School Mathematics*, Reston, VA, National Council of Teachers of Mathematics

Noddings, N (1985) 'Formal modes of knowing', in Eisner, E (ed), *Learning and Teaching the Ways of Knowing*, Chicago, IL, University of Chicago Press, pp 116-132

Noss, R (1998) 'New numeracies for a technological culture , *For the Learning of Mathematics* **18**(2), 2-12

Otte, M (1993) 'Towards a social theory of mathematical knowledge', in Keitel, C and Ruthven, K (eds), *Learning from Computers: Mathematics Education and Technology*, New York, NY, Springer-Verlag, pp 280-306.

Polanyi, M. (1958) *Personal Knowledge: Towards a Post-Critical Philosophy*, Chicago, IL, University of Chicago Press

Ritchart, R (1997) *Through Mathematical Eyes: Exploring Functional Relationships in Math and Science*, Portsmouth, NH, Heinemann

Sartre, J.-P. (1969) *Being and Nothingness; an Essay on Phenomenological Ontology*, New York, NY, Washington Square Press

Weissglass, J (1990) 'Constructivist listening for empowerment and change', *Educational Forum* **54**(4), 351-70

Weissglass, J (1994) 'Changing mathematics teaching means changing ourselves: implications for professional development', in Aichele, D and Coxford, A (eds), *Professional Development for Teachers of Mathematics. 1994 Yearbook*, Reston, VA, National Council of Teachers of Mathematics, pp 67-78