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TRAVELS IN TROY WITH FREIRE

Technology as an Agent of Emancipation

INTRODUCTION[1]

Oswald de Andrade, in his "Anthropophagic Manifest" of 1928, proclaims that the Brazilian calendar should have been counted from the day in which, accordingly to the legend, anthropophagic natives ate the Sardinha bishop, whose Portuguese vessel was shipwrecked somewhere along the Brazilian coast. Andrade's manifesto, a landmark in Latin American modern literature, expresses poetically what has become a key characteristic of Brazil: cultural and intellectual anthropophagy – the process of appropriation and creative recombination of ideas, theories, products, and processes.

Paulo Freire was a remarkable instance of such anthropophagy. Bringing together existentialism, phenomenology, Marxist and Christian thought, critical pedagogy, and his own experience as educator, he generated a unique body of thought for its radicalism, humanism, literary style and depth.

Trying to understand Freire without comprehending his personal quest is, to say the least, incomplete. It is crucial to understand why Freire struggled so fervently against oppression and advocated emancipation. A visit to the poorer regions of the Northeast of Brazil, where he spent his youth and early career, would probably suffice: the abysmal life conditions and the extraordinarily unfair social structure of such regions are self-explanatory. Indeed, Freire's autobiographical books and essays (Freire, 2001; Freire & Macedo, 1996) reveal a man deeply traumatized by poverty, dehumanization, oppression, and economic exploitation.

Therefore, Freire's language and ideas present so radical a challenge for extant educational systems, that he is more often than not categorized as a utopian. But such an interpretation, by labelling Freirean pedagogy as an impossible dream, only perpetuates the very ills against which Freire was fighting. In fact, from his trenches, Freire was, above all, a man of praxis. His theory was not created in the traditional academic setting as an ivory-tower theoretical exercise, but conceived to change education in real settings. His work with adults at the University of Recife, SESI, Angicos, and numerous other locations and countries resulted in detailed roadmaps for adult educators to implement Freirean learning experiences.

Yet, whereas Freire was driven to impact the real-world, he never denied that "it is one thing to write down concepts in books, but it is another to embody them in praxis" (Freire, 1990). His words ring as true today as they did when he

[1] This chapter builds on and further extends my Masters' thesis at the Media Laboratory of the Massachusetts Institute of Technology (MIT), under the supervision of Dr. David Cavallo. More information is available at http://www.blikstein.com/paulo or paulo@blikstein.com.

first attempted to put into action his radical educational vision. "Dialogical education" and situating learning within students' lived experience have been vastly influential, but the implementation of these ideas has never been unchallenging (Freire, 1973, 1974, 1992). These difficulties of embodying Paulo Freire in everyday school has led numerous teachers and researchers to categorize him as the proponent of the ideal school which, although desirable, is ultimately unrealizable.

And yet, we submit, the Freirean dream could become a reality. The objective of this chapter is both to demonstrate a "proof of existence" that realizing the Freirean vision is possible even within the underprivileged settings that he was targeting and to reflect on some design principles that may be conducive to realizing his vision. This chapter is a reflection on the implementation of Freire-inspired frameworks, its obstacles and leverage points. I particularly focus on the role of technology in such initiatives, as an emancipatory tool for mobilizing change in schools and empowering students. I posit that the rapid penetration of computers into learning environments constitute an unprecedented opportunity to advance and disseminate a Freirean aesthetic (paraphrasing Valente, 1993) in schools. Digital technologies, such as computers, robotics, digital video, and digital photography, could play a central role in this process: they are protean machines (Papert, 1980) that enable diverse and innovative ways of working, expressing, and building. This chameleonesque adaptivity of computational media, I argue, enables the acknowledgement and embracing of epistemological diversity (Abrahamson, Berland, Shapiro, Unterman, & Wilensky, 2006; Turkle, 1991), engendering an environment in which students, finding their own voice, can concretize their ideas and projects with motivation and engagement.

Emerging from the educational interventions we discuss in this chapter is a design framework for implementing Freirean learning environments. Key to this framework are the following components. First, we identify a community-relevant generative theme. Second, we depart from the community's technological culture and expertise as a basis for introducing new technologies. Third, we deliberately use a mixed-media approach, in which high- and low-tech, on- and off-screen, and high- and low-cost expressive tools coexist for students' production of artifacts. Lastly, we question (or "displace") taken-for-granted school practices and mindsets, even those that are apparently irrelevant to teaching and learning.

I demonstrate this framework with data from a project conducted in 2001 at a public school in São Paulo, located in a low-income community. Focusing on participants' attitudes and usage of digital technologies, I track and analyze their intellectual and emotional engagement, learning trajectories, and the complexity of their projects, which ranged from computer-controlled robots to fiction movies. I conclude that such use of expressive technologies could be a powerful agent of emancipation, à la Paulo Freire, even, and perhaps especially, in economically underserved communities.

FREIRE'S GENERATIVE THEMES

Generative themes constitute perhaps the best-known of Freire's constructs. In The Pedagogy of the Oppressed (1974) and in Teachers as Cultural Workers (1998), Freire explains in detail his method for coding/decoding elements of local cultures toward creating generative themes together with members of these cultures. Two

of his key concepts are 'humanization' and concientização (critical consciousness), both of which stress the dichotomy between being immersed in one's reality (only being aware of your own needs) and emerging from this reality (being active in fulfilling those needs). He asserts that learners can go from the "consciousness of the real" to the "consciousness of the possible" as they perceive the "viable new alternatives" beyond the "limiting-situations" (Freire, 1974). In other words, one path to emancipation and humanization[2] is to perceive oneself as an active agent of change, and the world as a mutable entity – in Freire's poetic prose, "History is the time of possibility and not of determinism […] The future is not inexorable, the future is problematic." (Freire, 1992, p. 21).

Despite Freire's precision about the genesis and role of his generative themes, multiple interpretations abound. Originally, the themes were cultural or political topics of great concern or importance to learners, which were used in the context of his first experiences in adult education. They served the purpose of generating meaningful discussion amongst learners and educators, as well as identifying generative words. Nevertheless, not infrequently one would find printed textbooks with themes and guides for the teachers to conduct discussions. To propose a theme that purports to address a yet-to-be-determined community's problem trivializes and contradicts the dialogic character of the educational enterprise – it negates the Freirean call to enable a community to participate in taking control over their indigenous needs; It raises the educator to the realm of patron when s/he should be no more than a facilitator of emergent emancipation.

It seems, then, as though disseminating the Freirean vision of 'generative themes' faces the apparent paradox of dictating that which should be negotiated. Indeed, Samuel Perez Garcia warns about the danger of having the generative themes in the agenda of the intellectuals rather than emerging from the learners (García, 2001). Freire himself struggled to maintain the authenticity of the generative themes, in his early projects in Rio Grande do Norte. Freire eventually confronted this form of trivialization of his work by standing up against its manipulation, as Heinz-Peter Gerhardt reports:

> The authors of the textbook [...] chose a political direction with five generative words: people, vote, life, health and bread. Freire opposed himself firmly to teaching ready-made messages for the illiterate. Ready-made messages would produce domesticative effects, either coming from the left or right-wing. Both sides would accept doctrines without criticism, and manipulation would then take place." (Gerhardt, 2000)

It might not be surprising that practitioners have tried to fit Freire's method into known practices, such as the top-down decision of what students should learn (see also Tyack & Cuban (1995) on how schools "change the change before change changes the school"). Yet Freire proposed a far more radical approach, which could only be fully accomplished in immersive contact with the community and the learners. Yet such practice introduces a revolutionary transformation as to who decides what will be learned, as well as who has the authority to sanction such choice.

[2] Freire defines humanization as the process of *authentic liberation*, "people's ontological vocation", or becoming more fully human, struggling against oppressive manipulation and control (Freire, 1974)

Note, however, that Freire never proposed that the researcher should refrain from contributing with his/her own themes and ideas (the connecting themes, or temas da dobradiça), but made it clear that the proposition should emerge within a specific context, and embrace themes already identified by the learners as meaningful. Ana Maria de Araújo Freire further confirms the importance of learners' sense of ownership:

> When men and women perceive themselves as makers of culture, we can declare [as] taken […] the first step for them to feel the importance, the need and the possibility to learn reading and writing. They are already literate, politically speaking. (A. M. Freire, 1995)

To be actively engaged in reading and changing the world, one ought to have the necessary tools. The power of language is self-evident: it enables us to voice the problems around us, discuss solutions, interact, debate, and, hopefully, change. One level of perception of viable new alternatives is, thus, through language, reading, writing, discussing. Yet language, a focus of most Freirean projects, is not necessarily the only vehicle of change. Another means is for individuals to design devices, systems, or solutions, using knowledge from science and technology, and then use language to improve these devices through critical interaction with fellow designers. This Vygotskiian notion of learning through communicating as applied to the case of designing personally-meaningful devices has been articulated by another luminary of progressive education: Seymour Papert.

FREIRE MEETS PAPERT

Seymour Papert shares with Paulo Freire an enthusiasm for unleashing the latent learning potential of students by providing environments in which their passions and interests thrive. A mathematician by training, who then worked with Jean Piaget for many years and co-founded the MIT Artificial Intelligence Lab, Papert pioneered the use of digital technologies in education and created the best known computer language for children, LOGO (Papert, 1980). Yet Papert's reasons for advocating the use of computers in education are, perhaps, not what one might expect of a mathematician working at an institution most often associated with achievements in science, technology, and engineering. Far from being technocentric (Papert, 1985), some of his motivations are very similar to Freire's. Papert's theory, Constructionism, builds upon Piaget's Constructivism and claims that the construction of knowledge happens remarkably well when students build and publicly share objects. In Papert's own words,

> "Construction that takes place 'in the head' often happens especially felicitously when it is supported by construction of a more public sort "in the world" – a sand castle or a cake, a Lego house or a corporation, a computer program, a poem, or a theory of the universe. Part of what I mean by 'in the world' is that the product can be shown, discussed, examined, probed, and admired. […] It attaches special importance to the role of constructions in the world as a support for those in the head, thereby becoming less of a purely mentalist doctrine." (1993, p.142)

Papert advocates technology in schools not as a way to optimize traditional education, but, rather, as an emancipatory set of tools that would put the most powerful construction materials in the hands of children. These protean machines would enable students to design, engineer, and construct, and would cater to a variety of forms of working, expressing, and building. This chameleonesque adaptivity which technology embeds permits the acknowledgement and embracing of different learning styles and epistemologies, engendering a convivial environment in which students can concretize their ideas and projects with intense personal engagement. In a typical Constructionist learning environment, there is rarely a fixed curriculum. Children use technology to build projects, and teachers act as facilitators of the process.

Nevertheless, the Papertian promise of technology has yet to penetrate the educational mainstream. For the most part, schools have adopted computers as tools to empower extant curricular subtexts – i.e., as information devices or teaching machines. But as Freire repeatedly claimed, choosing a curriculum is an intrinsically political act – his analysis of popular literacy booklets revealed how, by means of choice of words, they contained a hidden curriculum of internalizing oppression, making economic exploitation a fact of nature, claiming political participation undesirable, and ignoring the local culture, context, and knowledge (Freire, 1974, 1992).

Similarly, the traditional use of technology in schools contains its own hidden curriculum. It surreptitiously fosters students who are consumers of software and not constructors; adapt to the machine and not reinvent it; and accept the computer as a black box which only specialists can understand, program, or repair. For the most part, these passive uses of technologies include unidirectional access to information (the computer as an electronic library), communicate with other people (the computer as a telephone), and propagate information to others (the computer as a blackboard or newspaper). Not surprisingly, therefore, the new digital technologies are commonly called ICT (Information and Communication Technologies). In sum, a Papertian-cum-Freirean perspective – injecting into a critique of education a subversive political agenda – might position computers, for the most, as commonly recruited by 'the system' to inculcate in future consumers the learned passivity that supports capitalism by perpetuating its inherent iniquities. Yet, the most revolutionary aspect of the computer, at least from a Constructionist perspective (Papert, 1991), is not to use it as an information machine, but as a universal construction environment.

The LOGO programming language was the first attempt in education to demonstrate that the computer is not only an information and communication device, but also an expressive tool for construction and self expression. In the early nineties, Papert's and his disciples at the MIT Media Laboratory extended the powerful ideas of Logo to the physical world by making robotics accessible to children through the Lego Mindstorms kit and the Cricket (Martin, 1993; Resnick, 1991). In the nineties, parallel multi-agent simulation, then only available in advanced research labs, was also made available for young learners (Wilensky & Resnick, 1995, 1999). More recently, new developments are also being made in putting cutting-edge hardware and software in the hands of children to conduct advanced scientific explorations (Blikstein & Wilensky, 2006), create electronic jewellery (Sylvan, 2005), design participatory simulations and games (Wilensky & Stroup, 1999), program videogames (Millner & Resnick, 2005; Sipitakiat,

Blikstein, & Cavallo, 2004), create interactive textiles (Buechley, 2006), program virtual robotic systems (Berland & Wilensky, 2006) and explore Environmental Science and Geographical Information Systems (Edelson, 2000).

Therefore, even though at first blush critical pedagogy might appear at odds with technology, what with technology's "imperialistic" connotations, a closer analysis reveals that a Constructionist use of technology is essentially compatible with Freire's emancipation and even Ivan Illich's ferocious criticism (Illich, 1971).

Indeed, Cavallo's pioneering (Cavallo, 2000a) work in rural Thailand attempted to demonstrate this compatibility, suggesting the benefits of conflating indigenous knowledge, innovative learning formulations and digital technologies. Even in remote and neglected regions, he detected a sophisticated culture of building and repurposing internal-combustion engines for use in agriculture, boats, and transportation, which contradicted the widespread assumption that such populations lacked the necessary cognitive foundations to learn about or use modern technologies. Cavallo conducted workshops in which participants were invited to design solutions for salient community problems using digital technologies. His results

> [demonstrate] a significant gain in accomplishment among a population that had not previously exhibited such competence in educational institutions. This work demonstrates how to build on and enhance local knowledge [and] liberate their local knowledge from its specific situated embodiment […] The key point here is that the constructionist use of computational technology leveraged this ability and helped people apply their knowledge to new and varied situations […] The knowledge did not remain limited to the particular technology such as combustion engines, but rather they could use the malleable computer technology as a tool for understanding other domains. (Cavallo, 2000a, p. 780)

Other theorists have also been advancing the discussion about the prospects of indigenous (or local) knowledge (Ladson-Billings, 1995; Lee, 2003; Moll, Amanti, Neff, & González, 1992). If Freire and his disciples are correct, schools should value that kind of knowledge instead of the official curriculum, as a way to simultaneously tap into students' existing representations and make the content relevant to their lives. Yet some degree of knowledge of modern science and technology is important for emancipation. Fortunately, theorists such as Raymond Morrow (this volume) are working on reconciling such contradictory directions into a promising framework (cultural hybridity):

> "[…] modern science and technology […] remains the necessary authoritative reference point [...] [but] rather than still being tied to a monolithic Cartesian-Newtonian epistemological perspective, academic disciplines have increasingly developed a more plural, inclusive, and contextual understanding of knowledge, one that creates the basis for the kind of authentic dialogue with indigenous knowledge envisioned by Freire. (Morrow, 2005)

The intersection between Freire and Papert, thus, constitutes a fertile and promising ground for research and implementation of innovative learning environments (Cavallo, 2000b). Freire's focus on humanism and Papert's emphasis

on the creation of personally meaningful artifacts are highly complementary. I conjecture that constructive, expressive technology makes it possible to further Freire's agenda of emancipation, perhaps as powerfully as with language and literacy. In the next section, I will present case studies of implementations of such environments.

CASE STUDIES

When Fernando José de Almeida, a well-known Brazilian educator, was appointed as Secretary of Education of São Paulo in 2000, hopes for innovation across the school system were high. I was then a graduate student at the Future of Learning group at the MIT Media Laboratory, and we identified an excellent opportunity to collaborate and revisit some of the successful strategies used when Paulo Freire himself was Secretary of Education.

On August 2001, after many months of dialogue, we were set to have a proof-of-concept three-week after-school workshop in the Campos Salles school in Heliópolis, the biggest shantytown in São Paulo. The goal was to show what could be accomplished in a typical public school using technology in a Freirean/Constructionist fashion. The results of this workshop were very positive and enable the conception of a larger project with the Secretary of Education, which encompassed as many as 30 schools throughout São Paulo (Cavallo et al., 2004)[3]. These subsequent workshops were typically conducted as after-school activities, yet a number of them have ended up as part of regular school work.

This section, which describes the Heliópolis workshop, is structured as a running narrative that follows the succession of implementations, and this narrative is parsed into meaningful episodes, each presenting a design dilemma and each illustrating an emergent design principle. Within this rich narrative hide the details of a design that appeared to work. This is a design that in principle cannot be easily summarized – the very nature of the design is in attention to emergence. These principles will be further discussed in the Discussion section.

THE HELIÓPOLIS WORKSHOP

The Heliópolis workshop was conducted so as to demonstrate what might be accomplished by students with technology in a Freirean-inspired environment. The vision was for students to build projects of their choice, using a wide range of media and technologies: computers, robotics, still pictures, video, and arts materials. In the Freirean spirit, we were to begin by identifying with our participants generative themes that would actuate, motivate, and sustain the project work.

[3] This project, called "The City That We Want", was coordinated by my former advisor, Dr. David Cavallo, and had the collaboration of many partners, such as Profa. Dra. Roseli de Deus Lopes and her team from the University of São Paulo, Rodrigo Lara Mesquita at the Agência Estado, as well as Edith Ackermann, Arnan Sipitakiat and Anindita Basu from the MIT Media Lab.

Figure 1 – Two views of the Heliópolis shantytown

In 2001, due to rain shortage and lack of infrastructure investment, Brazil experienced a massive crisis in the electric energy system. Once blackouts became common, the government issued a new law mandating households to save 20% of their energy bill. The everyday life of most Brazilians was deeply altered by the law, and the population was resorting to all sorts of creative solutions to save energy. The crisis, being an everyday concern for all the population, appeared to be a good generative theme for this workshop. I was satisfied that by having identified a theme that was important locally (the energy crisis), students would work on projects close to their reality and interests. I did research on the topic and generated a set of possible ideas, such as building galvanometers, timer devices, waters heaters, energy generators, and robots to control lights. I also wanted to work with our participants on modeling and understanding the energy consumption of a household, trying to identify the critical devices, their energy requirements, and engineering alternative, more energy-efficient devices. Our resources were 13 days of work, Lego robotics kits, sensors, motors, solar panels, video cameras, digital cameras, and arts materials.

On the first day of the workshop, however, everything turned upside-down.

As we met for the first time and I started explaining the theme, I noticed some puzzled faces. Finally, one of participants interrupted me and politely said that the majority of the households in Heliópolis had illegal energy connections (gatos, in Portuguese), and therefore neither energy meters nor bills. It did not make any sense for them to save 20% of energy if they did not even had a meter. My generative theme floundered, but the student went on: with the energy crisis, the utility company became more rigorous with the electricity payments, disconnecting many legally connected households, which could not afford the energy bill anymore. Desperate, they would get themselves an illegal connection. The transformers, being designed to handle the legal number of connected households, were then much more likely to malfunction – causing disastrous fires or power outages. Therefore, the energy crisis for most families was a matter not of saving energy, but of safety and survival. My expectations were thus demolished and with them the grandiose energy-saving projects I had anticipated. Fortunately a whole new range of ideas opened up for the group.

Energy was, indeed, relevant for the students, but in a different way: Students were concerned with safety, but aware that families simply did not have the means to pay the energy bill in case they were to be suddenly made legal. One

group, then, set up to create a newspaper and a video-documentary raising awareness about the danger of illegal connections. Their main goal was to teach the population how to make safe, yet illegal, energy connections.

Figure 2 – Students' documentation of the dangerous illegal energy connections, which they hoped to transform through an educational panphlet to teach the population to make safe illegal connections.

This experience underscores the meaning of negotiating in real time and in locus for truly authentic generative themes – such that could not have originated in any textbook; themes that are time- and people-specific. Within the same city, in neighborhoods only a few kilometers away, the consequences of the energy crisis were radically different. Moreover, many of the project-based initiatives I observed in schools across Brazil had themes chosen in advance by teachers who often lived in other parts of town and came from a different socio-economic stratus. Similarly, text books claiming to include useful generative themes are often authored by curriculum designers completely removed from the contexts in which these themes are to be employed. As a result, many project-based teaching interventions enforce upon learners activities that are irrelevant to their interests and culture.

WHO CONTROLS THE EQUIPMENT?

On the first days of the workshop, students acquainted themselves with the new resources and planned their projects. All the students were initially enthralled by the Lego parts, digital cameras, and video cameras. Most students had never touched such equipment, and so I anticipated that the students would find this access to the equipment highly appealing. I was, again, wrong. Even though students seemed excited, some were afraid to use the equipment, and these anxieties were only further stoked by some teachers.

There were historical reasons for such behavior. Access to computers in schools is often regarded as an administrative issue, addressed with strict usage rules and constant supervision. The high cost of the equipment and maintenance (especially in developing countries) amplifies the concern of damaging these machines. As I would later confirm during my fieldwork, in many schools the computer room was even more regimented than regular classrooms. Signs on the walls, firm rules and multiple locks on the doors were just some of the manifestations of it. In some computer labs, students had even to sit on their hands during the initial explanation of the activity, not only for (questionable) reasons of classroom management.

I was not aware of that scenario when the workshop started. My experience in previous workshops taught me that, in such situations, children are overcautious with equipment even without vigilance, and I was willing to take the

risk of allowing a completely free access to every tool we had. Therefore, Lego parts, arts materials, electronics materials and my own notebook computer were scattered all over the floor. Two cameras were freely available for students to take pictures or record video. There was no sign-up sheet or strict rules. At first, teachers were very concerned with the system. One of them told me that "We should not leave the equipment loose in the hands of the students […] they will mess it up, we should have a scheduling mechanism to organize this". Students were also concerned. Before touching any piece of equipment, they would ask about its price. Despite being in awe of all the new artifacts, their concern was clearly associated to the perceptible high cost of the materials. They mentioned, for instance, that their parents would have to work for months to replace a robotics kit or a video camera. Despite the pressure of teachers, I did not implement any controlling mechanism. After a few days, my expectations were confirmed, but teachers were surprised: not only did students self-organize peacefully to share the cameras among the different groups, but also by the end of the workshop nothing was damaged.

During the wrap-up interviews with the participants, I asked students to list their three favorite aspects of the workshop. The results revealed an astonishing figure: 70% mentioned "trust" as their first choice. I followed up by asking students to interpret this finding; the students explained that they felt trusted by me because I let them freely use the equipment, especially my personal notebook which I left on the floor (see Figure 3).

Figure 3 – Students using the facilitator's notebook computer (left), and building on the computer room floor

An apparently expensive computer lying on the floor, available for all to use, turned out to be a meaningful demonstration of trust and, thus, a source of empowerment. The freedom to use the equipment, and in particular the unintentional placement of my notebook on the floor constituted a fundamental displacement from the traditional learning scheme. It was also an example of how an external intervention can both reveal and challenge behaviors taken for granted within a culture. Such a design decision (how to manage access to equipment), which appears to be a minor detail within all the considerations of a teacher or school administrator, turned out to have a major impact on students' affect toward the activity. For an attentive reader of Freire or Foucault (Foucault, 1977), this should not come as a surprise: the manifestations of oppression and power are not necessarily overt. Similarly, manifestations of trust are not always explicit. The

unrestricted access to equipment was a design decision, but placing my computer on the floor was a mere accident. While I did not anticipate students to attribute so much importance to that fact, this event is illuminating. There was, after all, a power divide. Used to the rigid computer room rules, children perceived the computer on the floor a message of trust. Repeatedly, as I observed, they had dealt with teachers and administrators who kept Freire only at the discourse level, keeping the praxis very traditional. Dialogical education, requiring the establishment of a true conversation between learner and teacher, cannot survive if discourse and practice are not compatible to the eyes of children.

BUILDING UPON FAMILIAR PRACTICES

Control was not the only issue relevant to the equipment. Students and teachers were very concerned with the equipment's monetary value. The students became uneasy once they learned that the robotics kits were equivalent to one or two months' worth of their families' income, and teachers were shocked to realize that the kit was worth their entire monthly salary. I realized that in such underserved localities, technology is a foreign and rare artifact - an extravagancy consumed by the upper classes. With an average monthly income of just a few hundred dollars, households in Heliopólis did not have computers or sophisticated electronic equipment. In addition, many of the students' parents had lost their jobs to technology. Children were seduced to play with the Lego but were afraid to break it or become attached to objects that would soon be whisked back out of their reach. This sense of foreignness was a barrier for students' engagement. How does one go about introducing technologies in such a challenging context?

While I was still wondering how I might demystify the foreignness of technology and engage students in its exploration, a surprising development took place. While some groups stayed at school working on Lego or making photo-novels, another group started to make a documentary about the illegal energy connections. As a result, we often left the school precincts and went to the community; I visited their houses, small stores, snack places, car repair garages, and the community radio station. By talking and interviewing people, I started to understand that the technological culture in that community had a very particular character. Car mechanics would use all sorts of improvised solutions to keep cars running at a minimum cost. In their homes, people would never discard a broken appliance without trying to fix it in all possible ways. If fixing was impossible, they would repurpose the broken device in creative ways. The community radio station, also, was put together with equipment from different sources, many of which were broken or incompatible and had to be fixed.

In the same sense that David Cavallo identified an "engine culture" in rural Thailand (Cavallo, 2000b), I identified in Heliópolis a repurposing culture. Cavallo's emergent design methodology, which draws heavily on Freire's theory, identifies how indigenous knowledge can be utilized to design technology-enabled learning environments that benefit from familiar practices. Cavallo states that:

> Rather than being deficient, there is tremendous knowledge, experience and expertise indigenous to Thai culture that provides a firm base upon which to build and leverage new knowledge. We believe this to be universal and not merely limited to Thailand (Cavallo, 2000b, p. 201)

Indeed, one of Brazil's most-known cultural practices is the so-called jeitinho brasileiro ("the Brazilian way out"), a practice of creatively solving problems using what is at hand, improvising ideas, instead of waiting for the ideal or formal solution. This implies repurposing, de-, and re-construction of objects as well as customary utilization of recycled and found materials. The repurposing culture was not found exclusively at Heliópolis – nevertheless, due to the harsh economic situation, it was especially apparent there.

The repurposing culture, thus, suggested an appropriate way for introducing technologies to the students. Freire repeatedly warned against romanticized or paternalistic approaches to the local culture, by which the learners are unchallengeable beaux salvages.

> The educator should be immersed in the historic and concrete experience of the students, but never in a paternalistic way by which he starts to speak for them more than truly listening to them. […] maintaining the oppressed chained to the conditions that were romanticized so that the educator keeps being necessary […] [or] a romantic hero" (Freire, 1974, p. 59).

Rather than erring, thus, in my role as an educator, I sought ways to mobilize the community's cognitive evolution – to be an agent of change, a catalyst. The challenge of introducing technology as an agent of change for an underserved population was now honed as the challenge of grafting the technology onto the indigenous context of repurposing. The perfect opportunity to use the local repurposing expertise materialized when one of the groups needed one extra Lego motor, yet all the motors were being used in others projects. On the following day, I brought a broken tape recorder to the school and proposed to disassemble it for parts. The group quickly armed itself with screwdrivers and pliers and soon had a perfectly operational motor to use in the project. In addition, they had to build an adapter to make the salvaged motor work with the Lego gears (see Figure 4, right), so, in fact, the task ended up being even more complex than it would have been just using ready-made materials.

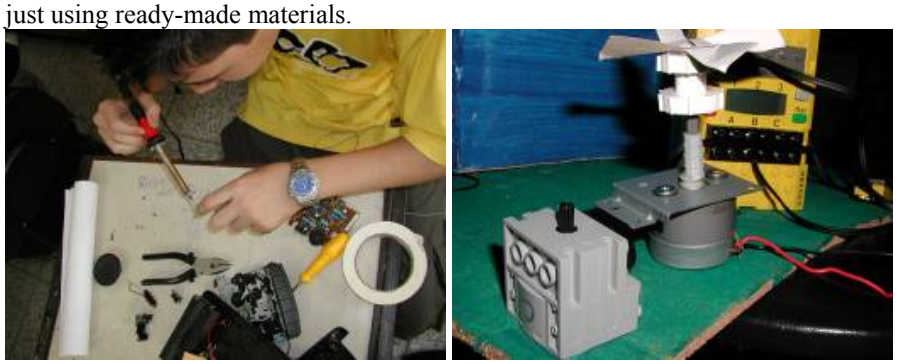

Figure 4 - A student disassembles the tape recorder (left), the expensive Lego motor, and the motor salvaged from the tape recorder (right)

The idea spread quickly, and soon other students were using found materials to build their projects. By the end of our two weeks in Heliópolis, most students had switched to using found/broken electronics materials instead of Lego pieces to build their projects – they appeared more proud assembling project from parts they

found by themselves than from ready-made Lego blocks. Indeed, using found materials was more complex a task than using the Lego parts, because the latter were designed to fit perfectly, whereas the former required ingenuity. This practice, thus, enabled students to apply a familiar way of working (the Brazilian jeitinho, the tinkering/repurposing culture) to demystify technology – technology was no longer an expensive foreign tool. In addition, by disassembling electronic devices, students could see inside those previously inscrutable machines, understand how they work, and get exemplars of mechanisms for their own projects, 'glassboxing' the technology behind those devices.

The repurposing-based pedagogical approach to the use of technology was so successful that, for all subsequent workshops, we abandoned Lego altogether as construction material. Participants were invited to bring and disassemble broken and found equipment and materials (sucata, in Portuguese), and integrate them into their projects. Moreover, I provided cheap, customized kits of locally purchased/found electronic and mechanical construction components, and Arnan Sipitakiat developed an open-source robotics interface board, the GoGo Board, which students themselves could assemble (Sipitakiat et al., 2004).

Figure 5 – In later workshops, Lego and commercial materials were abandoned and we used only found/recycled material: Teachers disassembling broken electronics for parts (top left), students scavenging a broken computer monitor (top right), teachers showing "sucata" they are about to dive into (bottom left), and a student solders his own robotics board, the GoGo board, under adult supervision for safety purposes (bottom right)

Introducing found materials was another example of displacement: we departed from familiar ways of working (using and repurposing found materials) but added

new elements (robotics, motors, sensors, and computers) significant enough to make people work in new ways, appropriating a new set of tools within their existing practices. In particular, computer technology was a valued technology, inside and outside Heliópolis. Their local practice of repurposing materials, although technically quite sophisticated, was not valued outside their community, being often regarded as a custom of underprivileged populations. By introducing computational technologies based on that existing repurposing culture, not only participants were empowered by the realization that one of their everyday practices was indeed sophisticated and technological, but made their projects, artifacts, and newly learned skills valued by the outside world.

A MICRO-EMERGENT APPROACH

Initially, some students, and especially the girls, were not excited by robotics or computers. Indeed, the relatively lower engagement of girls in technology-related school activities is a common research topic (A. M. Cavallo, 2003; Turkle, 1991). As a facilitator, the girls' reluctance presented me with a dilemma. On one hand, I wanted all students to enjoy a novel learning experience. On the other hand, forcing these reluctant students would violate a crucial principle of the workshop: not forcing upon students a 'technology curriculum', allowing them to choose their own projects and tools.

Freire and Freirean educators faced this dilemma in many occasions. He critiqued the demagogic teacher who renounces his/her role as educator (Freire, 1987) and also the portrayal of learning as a purely entertaining activity, in which students can never feel challenged or frustrated:

> It is important that the child realize, from the beginning, that studying is difficult and demanding, but is pleasant from the beginning. Certain new pedagogies exacerbate the fun, the affectiveness, at the expense of cognition. (Freire, 1993, pp. 89-90)

Rather than elucidating the dilemma, the above quote restates it: how can learning be "pleasant from the beginning" and "difficult and demanding" at the same time? This is, perhaps, the crucial paradox of most Freirean or democratic pedagogies. Between the 'anything-goes' classroom and the traditional scheme, could there be an academically productive and politically legitimate compromise? Richard Gibson notes that

> Freire is only infrequently precise in his theoretical writings about just what it is that a liberating educator is--other than one who offers freedom and rigor--toward what end? Indeed, his obscurity is frequently noted. […] Actually, Freire is quite directive. He refers to an 'inductive moment' when 'the liberating educator cannot wait for the students to initiate their own forward progress into an idea or understanding, and the teacher must do it'. (Gibson, 1994)

This dilemma extends well beyond Freire. José Cukier has extensively studied the psychopathologies originating from school (Cukier, 1996), and warns against the demagogical and charismatic educator, who focuses only on the affective link with the students, through seduction, neglecting the educational goal and the content. Paul Zoch argues against the overburdening of teachers for preparing personalized

learning experiences, while students "[are] not expected to overcome situations not of [their] liking" (Zoch, 2004, p. 71). Cavallo (2002) reminds that the over-charismatic teacher undermines the autonomy of the learner, as learning becomes associated with being taught by the charismatic as opposed to something that the learner does and controls. Fernando Almeida (2001) describes how school fosters 'split-personalities' in students, by having them learn to assume different personalities all along the day, from the obedient to the outspoken, from the quiet to the participative. Between the two extremes, the traditional authoritarian teacher and the charismatic leader, would there be space for less pathological transactions? Far from providing a definite answer to this question, the multiplicity of expressive tools is an invaluable aide for the educator to find that space. The story of Marisa and Gina[4], two 6th graders participating in the workshop, is illuminating. They were not excited about robotics, but were very fond of the arts. They wanted to spend the workshop painting, benefiting from the uncommon availability of materials, space, and time. Renata, a 14-year old 8th grader, loved singing and music, but was not particularly found of computers. She also had a particular interest in religion. How does one integrate students' diverse and seemingly "unacademic" passions and interests into the workshop? How does one direct this powerful creative energy toward an educational goal?

One effective tool is Cavallo's applied epistemological anthropology, which consists in "unearthing the meaning learners attribute". In so doing, he states, it is essential that learners build objects of their own interest: the more freedom of expression students experience, the more faithful to their own constitution will the expression be, thus enabling a better design and implement of the learning environments (Cavallo, 2000a). Consequently, these seemingly unacademic passions are not impediments for student learning, but, conversely, wide-open windows into learners' epistemologies, and remarkable opportunities for engagement into 'academic' work, without having to recur to imposing schemes.

Outside of school, students develop talents, passions, ideas and different ways to learn. In a traditional, "single-medium" activity, very common in schools and after-school environments, Marisa and Gina would not have opportunities to engage their arts passion and would most likely disengage from the technology theme. Even more dangerously, we could observe a perverse "stratification" of group work: high-achieving students end up doing the more sophisticated work, and lower achieving students do the menial jobs (Abrahamson & Wilensky, 2005). Therefore, to embrace passion and epistemological pluralism (Turkle, 1991), the environment should offer multiple entry-points and expressive media (Blikstein, 2002). In such mixed-media[5] learning environments (Abrahamson, Blikstein, Lamberty, & Wilensky, 2005) more students are likely to find paths into personally meaningful engagement in group activities.

Consequently, getting to know the students outside of the classroom was all but fundamental. A few days into the workshop, after I perceived this to be a key to its success, I set up to interact with them as much as I could, in the same sense that, in a classical Freirean environment, a researcher should get to know the

[4] For anonymity, all the names of the children were changed.

[5] The term 'mixed media' is distinct from 'multimedia,' which has come to mean audiovisual artifacts, such as presentations, interactive CD-ROMs, or websites that are prepared with dedicated computer applications.

community's practices and values. We had lunch together several times, took field trips, discussed the projects, or just chatted before and after the workshop sessions. Within the context of the workshop, once students had initially committed themselves to some level of participation, I had some 'license' to contrive situations that were 'contextually authentic'. Departing from my knowledge of the students' interests, I tried to suggest these 'contextually authentic' situations for them to feel valuable to themselves and to the group, generating group and self-esteem.

Thus, my decision about Marisa and Gina was not to direct them immediately toward technological constructions. The two girls were not only allowed but also encouraged to work with art. They first painted a number of pictures that were hung on the lab's walls (see Figure 6). Then they began exploring clay and made small human figures and miniature furniture. Next, they built a cardboard house, painted its walls beautifully, and put all the furniture inside (Figure 6). The girls were extremely happy with their house, and so was everyone else. I still had a concern: their house had nothing technological: no robotics or programming. Those technologies, which could potentially open up many possibilities that conventional material do not allow, were entirely absent from the girls' project. I was tempted to suggest some ideas about how to integrate robotics into the house, but that was concerned lest such a suggestion would come across as a badly disguised imposition. Instead, I occasionally pointed students to other colleagues who were doing potentially synergic projects. There were potential complementarities "in the air," and I wanted students to learn to identify those.

When Marisa and Gina saw some friends using the digital camera to tell stories, they got excited about producing a claymation of the life inside their house. With some help from their friends, they learned how to use the digital camera and the computer software, and worked for hours on this new project.

Figure 6: Marisa poses beside her paintings on the wall (left) and the clay furniture of the toy-house's bedroom (right)

Concurrently, two eighth-graders, Ester and Maria, were searching for an idea for their first robotics projects. They had done some minor constructions, and therefore had some know-how, but were looking for a larger project. I suggested that they look around for ideas, talk to friends, and see what others were doing. Observing that Marisa and Gina had already completed a beautiful house, they asked them to team up to make it a "smart house." Using the robotics kit, for almost a week, the four girls added energy-saving lights, an automatic retractable roof and a

temperature controlled ceiling fan for the hot summer days. The fruitful collaboration between the "architect-girls" and the "engineers-girls" is one example of the synergy generated in such environments.

Figure 7 - Marisa and Gina proudly pose with their "low-tech" house (left), which was transformed by Ester and Maria into a smart, high-tech house (right).

Other students exhibited yet different interests and passions. Renata, the 8th grader who loved music and singing, did not know what to build at first. She would spend the day mostly alone, writing poetry. I suggested her to become the disk jockey of the workshop, selecting and playing different CDs everyday. After much resistance, she even agreed to sing for her friends. The shy and artistic Renata was starting to find her place. After a few days, and observing her friends' projects, she felt more secure and decided to build something more concrete. After long conversations with me, during which she revealed a deep religious belief, she decided to undertake the building of the Praying Tower, a complex moving Lego structure that would mimic the movement of the hands of devoted prayers.

Daniela, an 8th-grader, was very shy for the first two days. She would roam across the room observing the work of other groups, but never engaging for more than ten minutes. Realizing that she was not finding a suitable entry point, I suggested she take the video camera and make small TV reports about her colleagues' projects. After just two days in her new job, Daniela's command of the camera was impressive. After a while, though, being a cameraperson who documents other people's work, was not enough for Daniela. She began to plot more ambitious projects, and together with several other students wrote and directed two short documentaries: one about the life of the families who lived near an open-air sewage, and another about the local radio station.

Inspired by Daniela's successful documentary projects, other students, including Marisa and Gina (the "architects" of the smart house), became engrossed in the idea of producing fiction movies. Over the following four days, split into two groups, they wrote and produced two 5-minute movies: one medieval love story about an unhappy king's daughter and her forbidden love ("The Royal Family") and a "vendetta" story of a boyfriend who dared to date two best friends at the same time ("The Spanked Boyfriend").

Figure 8. Two moviemaking projects: students filming "The Royal Family" and producing a documentary about poor families who lived by the open-air sewage.

Yet another synergy involved the moviemaking crew: after a long filming day, these students presented their footage to the rest of the group. Moriz, who had remained at the school, working on his robotics project, saw the big pipes that carried the sewage (see Figure 8, lower right) and devised the idea of generating electrical energy from these currents, which could be used to light up the home. To explore his idea, Moriz built a model consisting of a small generator with a DC motor, plastic, cork, and wood. He attached this model to a capacitor and realized joyfully that the energy could be stored in it, and that, thus, his invention might in fact be viable. Caio, who had spent the previous day experimenting with energy-saving devices, solar panels and capacitors, was thrilled to help him (see Figure 9). Guilherme had yet another idea: to build a car that would automatically avoid flooded areas, which are very common during the rainy season.

Figure 9 - Caio researching solar energy and energy-saving devices, and Guilherme with his flood-safe car.

TEACHER'S INVOLVEMENT OR, "KIDS ARE JUST HAVING FUN."

A theme of our Heliopólis narrative has been that the prefabricated floundered, while the serendipitous prevailed. Our role as educators was not to enforce a precise implementation of a scripted design but to facilitate student interactions with each other and with the available resources and to proffer any counseling we could once students were engaged in their personal projects. Edith Ackermann would say that

> "…wherever 'diversity' reigns, centralized planning, or mere transmission of traditional values won't work. Instead, auto-determination and negotiation – i.e. self-expression and exchanges – are needed". (Ackermann, 2001)

Evidently, this type of approach diverges from the prevailing mindset in most schools, and indeed, this pedagogy generated anxious reactions from some local practitioners. In discussions with them, I identified a number of theories and mental models which blatantly conflicted with the workshop's approach: "You should focus on just one thing," "Children will break the equipment," "Without a specific plan, they will not do anything," "Some students were given the chance to participate and are not working the way we expected them to," and "Kids are just having fun". The epistemological status of the teachers' comments is revealing. It is not only compatible with the traditional school paradigm, but also with the way parents regard school. Cavallo reports that in Thailand parents complained about one workshop that he conducted, saying that the children were only having fun and thus could not possibly be learning (Cavallo, 2000b). The underlying theory of mind is apparently that "playing around" and learning are literally incommensurate. The epistemological belief of the teachers is that there must be concrete goals, plans to get there, and orderly sequences of knowledge construction. The 'conceptual building blocks theory' – that "you cannot learn 'x' without learning 'y' first" was prevalent – and probably reflects a pedagogical legacy of how these teachers were trained and learned what they know.

Despite their initial skepticism, most of those teachers were "converted" by the end of the workshops, particularly Sueli, a Portuguese teacher also responsible for the computer room. On the first days, she would go around inspecting the groups and (literally) pointing her finger at the "lazy" students who were "just going around

taking pictures." Some students fought with each other, as a result of the tense climate that had been established by Sueli's behavior. I asked Sueli whether she would sit with students and try and help them in their projects. She told me she knew nothing about robotics and thus did not feel she could possibly be of any assistance. I insisted, and she accepted the challenge, temporarily relinquishing her "supervising" role. Because Sueli did not know anything about robotics, she indeed had to sit with students, but in the capacity of 'learner' rather than 'teacher.' Yet, as the environment and content were equally foreign to students and teacher, Sueli was not embarrassed to admit to students her ignorance on some technical issues. Being in such uncharted territory was a liberating experience for her. Free from the obligation of being the "sage on the stage" or the discipline enforcer, after seven days, Sueli was a different person, spending almost all of her time sitting on the floor helping (and being helped by) students. The computer lab was in complete chaos, with students, computers, cameras and scrap materials scattered all over it – another displacement in and of itself – and Sueli could not be happier.

Figure 10 – Sueli (leftmost picture, wearing glasses) and other teachers sitting on the computer lab's floor, helping students in their projects.

Apparently, not only Sueli was pleased with this displacement. In a post-interview, a student of her reported:

> Last year, one boy was playing with a ball, his tennis shoe went off from his foot, and hit a bulb. Everyone that was around went to the Principal office. It was not fair. This time, when we blew the bulbs, the teacher helped us find other ones so that we could keep working.

But students themselves were initially anxious operating in an environment where they lacked precise directions. In their post-interviews, the majority mentioned "being lost" in the beginning:

> Gina: In the beginning, I didn't know what to do. I saw a lot of things here, I didn't know where to start. Now, at the end, I have a lot of ideas, but I can't make anything anymore, because it's over… In the beginning I was lost, but then there was the idea of making the house, we put one little thing from here, one little thing from there… even on this last week we had things to do…

> Maria: At first I thought I was not going to get familiar with all these instruments… It's so much stuff…. But then I began to like it, and I learned to use all of those things, the photo camera, everything… In the beginning I didn't know what this course was about, I didn't know what I was supposed to do, and then I began to let myself in it more and more… loosing up…
>
> Marisa: In the beginning, I didn't know how to start. I have never worked with Lego, but then, me, Marcelo and Simone, we started to make things, learn, to learn new things…

From my observations and their testimonies, it was apparent that students went through a significant transformation, from being lost to gradually finding their way through the new materials, environment, and methods of working and collaborating. They had never touched a digital camera or built with Lego before, and most did not have a computer at home. Their testimonies do not suggest, as teachers had warned me, that the apparently free environment would generate an irresponsible and inconsequential spirit of childish mischievousness. The environment of the workshop did not inspire an "anything goes" attitude – students' transformation, as they reported, had occurred due to serious work and engagement in a project, and not due to random inconsequential explorations with cameras or Legos.

There were other kinds of transformations -- some very subtle, but no less revealing. Lucio was a relatively shy 7th grader. He built two robotics projects, participated in the documentary about the illegal energy connections and in a fiction movie. One day, he came to the workshop with his mother. He was wearing pleaded pants and a long-sleeve shirt, instead of his customary school uniform (see Figure 11). His mother asked to have a conversation with me – fortunately, she was not pulling him out of the workshop, on the contrary. She told me that her son had become extroverted lately, talking about his school activities, whereas previously he would never discuss school at home. Lucio had asked her to dress him up to come to the workshop, because "it was something very important."

Figure 11 – Lucio before and after: school uniform and t-shirts on the first days (left), pants and shirts thereafter (right)

DISCUSSION

In the previous sections, I presented and discussed selected episodes from a workshop in a public school in São Paulo. Each of these episodes reveals a particular design dilemma that will be discussed in this section. My goal is to

demonstrate that school-based implementations of Freirean pedagogy should be interpreted not as curiosities but as viable alternatives to prevalent pedagogy. These are truly enriching experiences, not 'enrichment classes.' School, I argue, could and should be a set of Freirean experiences.
Following, I summarize the main pedagogical strands exemplified in the data.

GENERATIVE THEMES

The choice of 'energy' as the theme at the Heliópolis workshop was an example of how authenticity of generative themes is crucial for the implementation of a Freirean pedagogy. Well-intentioned educators can often be wrong about what matters to a specific community. It is vital to avoid the typical trivialization of local culture, by the way of finding archetypical models and "design" curricula for them. Barbara Rogoff would call this a "boxed" view of culture, which "creates a reality based on these identity categories" (Rogoff, 2003, p.79). Hutchins (1995) argues against the view of culture as a collection of things, which can be listed by someone else, transferred, accumulated. Designers are liable to "box" culture largely because it is difficult to penetrate beneath manifestations of cultural practice. Therefore, building on a superficial view of local culture or introducing prefabricated themes cannot generate the authentic and engaging learning experience which Freire so fervently advocates. At the same time, neither is a blind adherence to the values and customs of the local culture beneficial—we should also identify what is not in the culture —which the educator wishes to introduce.

IS TECHNOLOGY JUST A 'TOOL'?

In the learning stories which I described in this chapter, digital technology was not just a 'tool', but an agent of fundamental displacement, for several reasons:

- 'Chameleonesque adaptivity', or the multiple forms of digital technology: this aspect of computational media enables the acknowledgement and embracing of epistemological diversity, engendering an environment in which students, finding their own voice, can concretize their ideas and projects with motivation and engagement. It enables new, complex, and diverse ways of learning and thinking, both on and off-screen, with familiar and unfamiliar materials, using high and low-tech tools.
- Novel tool for teachers and students: Being a novel artifact for both, technology enabled teachers to step down as the "sage on the stage" and become playful learners again. Students could see their teachers as learners, and learn from their learning strategies.
- Complex projects: Compared to conventional school materials, the projects undertook by students were generally more integrative, diverse, and complex. This complexity, in turn, opens up more possibilities for connection with traditional disciplines. For example, designing sensors or robotics' devices demands extensive research in Physics, Chemistry, and Mathematics.
- Mobility and decentralization: The presence of those technological objects and tools, inherently decentralized, mobile, and sharable, "created a new dynamic that is non-existent in regular classroom, where everything is symbolic, on paper, and there is no opportunity to develop democratic control" (Papert, 2002).

– Multiple entry-points: Technology provides powerful tools for self-expression and multiple entry-points for students with different backgrounds and interests. In an environment which embraced diverse forms of expression and technologies, students would first find themselves comfortable in one particular medium (arts, moviemaking, or robotics) and then transition to other, more challenging media or activities. The role of the facilitator as a matchmaker is critical, identifying potential synergies between projects or people.

Therefore, despite the customary rhetoric, the above list suggests that technology can indeed be a humanizing tool – Pierre Lévy states that "it is the intensive use of tools that constitutes humanity as it is" (Lévy, 1999). Having multiple technologies augments and makes possible inherently humanizing endeavors: creation, expression, and interaction.

MANAGING DIVERSITY

A learner-centered, culturally-aware Freirean aesthetic raises the question of how to manage a classroom in which every student has a different background, as well as diverse interests and talents. Ostensibly, this would entail a significant amount of extra work from the teacher. Our data suggest that such a diversity-sensitive approach may in fact help alleviate the teachers' burden and improve their relationship with students:

– Increasing returns: I have shown that, following an initially laborious and intensive contact with students, through which I became familiar with student ideas, ways of working, passions, and talents, subsequent interactions became much easier. Not only did students become more autonomous and responsible, they learned to teach one another. By allowing students to work on their own ideas, not only could I more effectively understand their epistemology, but unprecedented motivation and engagement were generated. This kind of environment also enables teachers to spend less time as discipline-enforcers.
– Student motivation and engagement: The observations suggest that the lack of strict rules did not generate an "anything goes" or unchallenging environment, in which students would have engaged in activities that are only playful or amusing. In Heliópolis and other workshops, on the contrary, teachers reported being impressed by the number of hours students invested and by students' serious attitude toward the work. In turn, students' reported that they were driven by teachers' 'fair play' and genuine respect.

CONTENT

Should we settle for indigenous local knowledge and deny students the formal knowledge of normative sciences? Aren't these sciences instruments of emancipation? The answer calls for a closer examination of the term "emancipation." Truly emancipatory knowledge has to empower people to forward their own (or their social group's) agendas. A mere internalization of the so called "language of power" (official school content) might give students more mileage in a standardized test or in the job market, but such 'banking' view of content would still be only indirectly connected to actions in these students' world. Consequently, knowledge has no intrinsic value beyond cultural capital, as Bourdieu already discussed in his reproduction theory (Bourdieu & Passeron, 1977). It is not what

students are able to do with new knowledge that society typically values, but which social gates the knowledge enables one to cross. Consequently, learning can never be an enjoyable and personally fulfilling goal in and of itself. However, for those students in underprivileged areas in São Paulo, the gates are much less generous, if at all open, and the other side of the gate far more inclement than for middle-class children who, at least, have the prospects of high-paying jobs to retain them in the school system. Ironically, indigenous knowledge is not only valuable in and of itself (Morrow, 2005), but such knowledge can provide valuable avenues into scientific content and powerful ideas (Papert, 1980).

The workshops in São Paulo, indeed, foregrounded multiple links between traditional curriculum and the students' projects, many of which were inspired or guided by indigenous expertise. In order to build his water-avoiding car, Guilherme had to learn about electrical conductivity and even design an experiment with water and different concentrations of kitchen salt – thus reinventing chemistry lab experiments. One could easily imagine this experiment developing into a larger project in a Chemistry class. Caio had to learn about dynamos and capacitors to make his energy-generator for sewage pipes – another sets of topics that could be pursued later in a Physics class. The builders of a trash-recycling truck did extensive research on gearing, transmission, and linear-to-rotational movement conversion – the father of one of them was a car mechanic who was thrilled to help his son in a school project for the first time. Maria and Gina, to build the temperature-controlled fan for their energy-saving house, spent a long time analyzing how a fan generates wind, and how to optimize wind flow. A water-recycling project entailed visits to the local water facility, conversations with the Science teacher, as well as research in Chemistry and Physics. Also, their complex water-tight valves were a highly demanding engineering challenge. The groups that did documentaries, TV reports, and fiction movies had to write scripts, plan interviews, edit their narratives, and learn to express themselves in front of an audience. Within those spontaneous activities, there are endless opportunities to connect students with more traditional school content. If students enjoyed such opportunities along many years, they would eventually engage in most important parts of the traditional academic disciplines. In addition, the more students learn in this fashion, the more they learn about learning itself: students learning to learn is more generative that students only learning content.

CAN TEACHERS 'DO IT'?

The fieldwork suggests that the answer to this crucial question is a loud and clear 'yes'. I worked under inauspicious circumstances: the implementation team was small, most teachers had little or no technological training, most computer labs were not well supported, many materials were not translated into Portuguese, and in many schools basic equipment was lacking. Even under these adverse circumstances, teacher engagement was impressive. After the initial period of adaptation to the new environment, they let themselves become learners again, engaged playfully in projects together with students, and were enthusiastic leaders in subsequent implementations. The fundamental element, as we discussed in previous work (Blikstein, 2002; Cavallo et al., 2004), was to format the professional development of teachers according to the same principles which we wished for them to use with their own students: in our 'teacher training'

workshops, practitioners also worked on projects and built working devices to address relevant issues in their community.

GOD IS IN THE DETAILS: IMPACTING THE ECOLOGY OF THE LEARNING ATMOSPHERE

An atmosphere is a useful analogy to reflect about the ecology of learning environments. First, an atmosphere can have micro and macro climates. Second, they emerge out of local interactions. Thirdly, the meta-stability of atmospheres implies that all equilibriums are fragile, and a small variation in one component can set off abrupt systemic change (Blikstein, 2002).

The learning environments described in this chapter, too, manifest a very delicate equilibrium. As scientists are succeeding to explain natural and social behaviors as emergent phenomena (Wilensky, 2001), they realize that the true wonders of nature are in the details - local interactions between discrete elements, fine-tuning, and often overlooked micro-relationships. Dramatic change happens in nature by changing those simple fundamental interactions. For example, in subsequent workshops, teachers tried to deny students the right to choose their projects and team mates, or restrained unilaterally access to equipment. Results were very negative – either students disconnected from the activity, or started to behave as they used to do in a regular class. I observed the same outcome when they tried to stimulate unnecessary competition, over-engineer teamwork, or over-plan activities: even with the same technological tools available, the fragile atmosphere of simultaneous hard work and engaged learning broke down.

I posit that whereas envisioning new pedagogies is about the art of thinking "big," implementing these pedagogies is a science of details. A Freirean pedagogy can only survive if it permeates the mundane. Grand discourses about emancipation are not enough. The most significant part of students' learning experiences resides in the small power struggles, the minute decisions, the microscopic choices of what to teach and what to value, who has voice, who ultimately decides. It is precisely in those apparently insignificant pedagogical and personal transactions that the essence of the atmosphere is constructed.

In this section, I discussed a number of examples of such hidden elements and how they dramatically affect the learning atmosphere. Yet how can my narrative of a specific classroom with specific students possibly be useful to practitioners in their own classrooms? First, it contains examples and design decisions of very typical situations found in 'unscripted' learning environments. Second, this design calls for a more adaptative and flexible approach, in which teachers use their authority to establish democratic rules, and subsequently fade their role as a rule enforcer. Teachers, thus, create a generative space.

CONCLUSION[6]

This chapter is about expressive technologies for emancipation. I have shown Freirean emancipation is possible, even in schools with scarce resources, but by no means easy. The emergent characteristics of such designs (Cavallo, 2000b) sets these learning environments apart from traditional schooling, and calls for a significant change in teacher education.

Technology is a new kind of Trojan Horse: the educator introduces into the classroom familiar tools, practices and technologies, yet embedded in this familiarity is a potential for affective and conceptual change – a beneficial potential that surreptitiously permeates the classroom atmosphere through a sequence of displacements mediated by the experienced teacher. Students appropriate the Trojan technology as authentic means to liberate themselves from the incarceration of traditional pedagogy. Once deschooled, students shake off the dust and engage in authentic inquiry and construction.

FINAL REMARKS

Paulo Freire frequently referred to himself as the "itinerant of the obvious" (andarilho do óbvio). It might appear peculiar that an educational intervention in a poor fishermen community in a secluded part of Brazil could be so influential to educators all over the world. Almost 50 years later, after television, computers, internet and nanotechnology, here we are, still talking about Angicos.

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[6] After Heliópolis, under the direction of Dr. David Cavallo, "The City That We Want" project was extended to 30 schools in 2002 and 2003, reaching more than 3000 students. After 2004, Prof. Renata de Deus Lopes from the University of São Paulo received government funding for another 150 schools. Simultaneously, a non-profit educational foundation (Fundação Bradesco) took the project to its 39 school throughout Brazil.

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