"God hides in the details": design and implementation of technology-enabled learning environments in public education

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Abstract

Based on case studies conducted in Brazil, this paper proposes a framework to model intervention in education systems using technology. The motivation is to show that innovative learning with expressive technologies can happen even in economically disadvantaged regions, such as public education systems in Brazil. Our analysis reveals the importance building up from the local culture and expertise and fostering mutual trust, elements often disregarded in schools. Technology plays a central role, enabling diverse and innovative ways of working, expressing and sharing. In addition, it makes possible epistemological diversity, empowering of students and fulfilment to teachers, reinforcing the community's livelihood.

Keywords

learning environments, Constructionism, technology, public education, school reform.

1. Introduction

1.1. The Learning Atmosphere

The introduction of digital technologies in learning environments adds a rich layer of complexity. We do not have, however, a mature set of models or languages to understand and design such environments. The intellectual tradition of Constructionism and Emergent Design stresses the importance of a more fine-textured approach, relying on qualitative research and case studies, as well as emphasizing the analysis of micro-interactions and the understanding of the social and cultural context ((Cavallo, 2000), (Sipitakiat, 2000)). The contribution of this article goes in that direction. We introduced the concept of Learning Atmosphere in earlier work (Blikstein, 2002), which might be a model to further help the design and understanding of novel learning experiences using technology. Our approach considers several aspects, such as choice of what to build, which tools to use, affective relationships and hidden cultures/agendas as part of an indivisible whole (the *atmosphere*) in which the learning experience takes place.

We conceived and utilized this framework in a series of fieldwork activities conducted in Brazil during 2001 and 2002, within public and non-profit education systems. This paper will focus on some particular aspects of the first of them, which took place in São Paulo, Brazil, in August 2001, within a project with the Municipal Secretariat of Education. This activity consisted in a 13-day workshop for around 20 students with ages ranging from 10 to 14 years old (5^{th}-8^{th} grades), who were selected by the school. The goal of this pilot workshop was to explore new designs of learning environments using technology, but dedicating special attention to the specific conditions of the municipal public schools. Would it be possible and pertinent to use the digital apparatus within those schools? Could their use reveal, within this particular context, new ways of working for teachers and students?

Resistances to change

The discussion about school and its impermeability to change is certainly not new. Many authors ((Singer, 1997), (Papert, 1995), (Tyack and Cuban, 1995)) have discussed how the school system transforms innovative ideas and adapts them to its existing mindset.

Pierre Lévy, in Cyberculture (Lévy, 1999), argues against the simplistic and widely used "impact" metaphor, as if technology was a projectile and the human society a living target. He discusses the use of tools as inherent to human condition:

> The techniques would come from another planet, from the world of machines […] Not only the techniques are imagined, fabricated and reinterpreted during its use by humans, but **also it is the intensive use of tools that constitutes humanity as it is.** (Lévy, 1999)

We might derive that the *impact* metaphor, as well as the technocentric mindset criticized by Papert (Papert, 1985), constitute incomplete models to approach the issue of change in education. First, school is not a passive target for technology. Technologies are not extraterrestrial, non-historical artifacts, and our own interventions in schools bring about reactions. The complexity that emerges from the interactions of those elements in a social context cannot be ignored, and the solutions might waste opportunities to interact with the local culture and expertise.

Therefore we intentionally use familiar tools and technologies, but with significant changes to make people pay attention, challenge underlying assumptions, and work in new ways. This then becomes a part of the atmosphere and the role of the facilitator is to create a rich, convivial atmosphere rather than to be a rule-enforcer or conveyor of information. Learning atmosphere is also an idea that brings in an acceptance of complexity and ecology, in which things can be turbulent, and suggests that a homogeneous, rigidly planned atmosphere is not the best for learning.

2. Field work

2.1. Getting to know the learners' context: the "Energy Project"

Due to rain shortage and lack of investment, the Brazilian government announced in mid-2001 a huge crisis in the electric energy system. The situation was critical and blackouts were bound to happen. A new law obliged every household to save 20% of their energy bill. We realized after some visits to Brazil in 2001 that the situation was revealing some of Brazil's expertise: reutilizing objects in creative ways and improvising solutions.

That seemed like a good theme to propose to the students of the Heliópolis School. How would they use technology to design energy-saving devices or models, now that energy was part of their daily lives? We had 13 days of work ahead of us and some Lego robotics kits, solar panels as well as various arts and crafts materials. One day before the workshop, I briefly met João Miranda, the main community leader, to explain the goals of the activity. We headed for the computer room to meet the students. João was supposed to open the workshop and explain our main theme.

However, everything turned upside-down.

I was sure that, by identifying a theme that was important locally (the energy crisis), I was proposing something close to their reality and to their interests. However, the real issue was a lot different, and constitutes a canonical example of the importance of having multiple media, openness for diversity, a flexible set of expectations, and being truly open to the interests of learners. Many project-based learning attempts pre-ordain the project based upon the educators' interests and culture and then impose.

Miranda estimated that more than half of the households in Heliópolis had illegal energy connections – and obviously no energy meters or bills. With the energy crisis, the utility company became more rigorous with the electricity payments. Many "legally" connected households could not afford the energy bill anymore and were disconnected. Then they somehow managed to get an illegal connection for themselves – using the Brazilian *jeitinho*. The transformers, being designed to handle the legal number of energy connections, would eventually malfunction – causing disastrous fires or power outages (Miranda, 2001).

Figure 1. A view of Heliópolis (left), and the pole with illegal energy connections (right)

After that discussion, my existing expectations were destroyed. If they did not have meters in their houses, and where being threatened by the utility company, how or why would they save energy? Proposing that was even offending to the community. While middle-class families were disconnecting their second refrigerator, people in Heliópolis were fighting for their safety and survival. That did not mean that energy was not a relevant issue for them. Especially after the field trip we did to the Estado de São Paulo newspaper, students decided to address the issue by creating a newspaper and a video-documentary raising awareness about the danger of illegal energy connections.

However, they were aware that it would be meaningless to advocate that all connections should be legal. Instead of that, they documented with still pictures and video various dangerous connections and decided to use their publication to teach people how to make *safe, yet illegal, energy connections*.

Figure 2. Unsafe energy connection pictured by the students

2.2. Building trust

Access to computers in schools is often regarded as an administrative problem, addressed with usage rules and constant supervision. The high cost of the equipment and maintenance (especially in developing countries) amplifies the concern of damaging the machines. During our fieldwork, we verified that in many schools the computer room was even more regimented than the classrooms. In one computer lab, students had to sit on their hands during the initial explanation of the activity.

I was not aware of that scenario when the workshop started. Legos, arts materials, electronics materials and my own notebook were scattered all over the floor. Two cameras were freely available for them to take pictures or video. There was no sign-up sheet, no strict rules, and yet nothing was broken or damaged. The final interviews with the participants revealed a surprising figure. Invited to mention the most important thing for them during the three weeks of work, about 70% of them mentioned "they felt trusted by me because I let them freely use the equipment, especially my personal notebook".

Figure 3. The notebook computer scattered on the floor and the students doing robotics.

A supposedly expensive computer lying on the floor, available to be used, turned out to be an extremely meaningful fact for them. That constituted one fundamental *displacement* from the traditional learning scheme commonly found at schools. This is also an example of how an external intervention can challenge behaviors taken for granted and solidified within a culture. Within the constructionist tradition, we are not

advocating that all teachers must scatter computers on the floor, but some of them did change their behavior[1] by going through a concrete, different experience. Moreover, just proving computers was not enough to motivate students. They were waiting to see how they would be treated, how they would be allowed to use them and with what purpose.

2.3. Demystifying the high cost of technology

One of the significant issues since the beginning was the *price of the equipment,* which they would ask many times over the days. They suspected that a video camera would cost more than the yearly salary of their parent. I told them that a Lego kit was priced at US$ 200.00, more than their average monthly. They realized that such a cost equation would not work in their school. As a result, I started to realize the importance of searching for lower-cost strategies. It was not only to make the materials more affordable. More importantly, that would improve the participants' belief in the sustainability of the project, and make them less afraid to play with the available apparatus – and consequently engage in a different way.

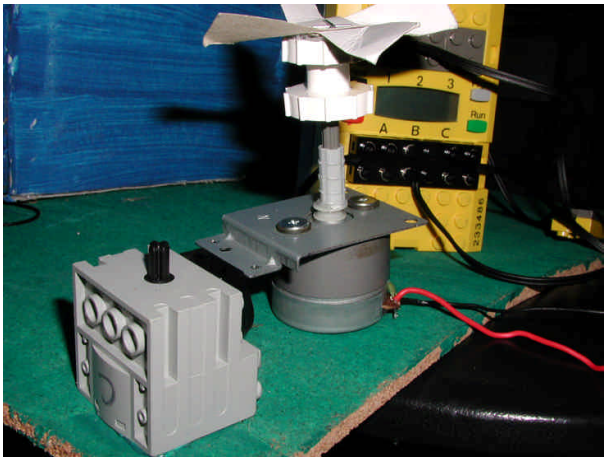

Figure 4. The US$ 20.00 Lego motor and the free tape recorder motor

One of the groups needed one extra Lego motor, but all were being used. On the next day, I brought a broken tape recorder to the school and we disassembled it together. The girls managed to scavenge the motor and adapted it for their project. At the same time, they were learning to apply a familiar way of working (the Brazilian "jeitinho", or a way out of every situation, just as they were doing with the electricity) and giving a new meaning for an object seen before as trash. That idea had a strong resonance within the students. By the end of our two weeks in Heliópolis, most of the students were using those found/broken materials instead of Lego pieces to build their projects – they appeared to feel more proud to assemble things with parts they found by themselves (ParticipantsHP, 2001).[2]

3. Discussion: the Learning Atmosphere

The framework of the **Learning Atmosphere** is an attempt to understand the process of sculpting the aesthetic of a learning environment such as the Heliópolis one. The

[1] For more details, see the case of Sueli de Abreu, from the Arthur Alvim School of São Paulo (Blikstein, 2002).

[2] We later adopted the "sucata" (found materials) strategy for the entire project in São Paulo, as well as integrated it within our other projects.

metaphor of the atmosphere is interesting for many reasons: first, an atmosphere can have micro and macro environments, which not only can be radically different but also can influence one another. Secondly, they are an organic, interwoven whole that contain many elements from which just a small part is known or visible. Finally, they are **multi-variable**, **meta-stable** and **hard to predict** systems.

Learning Atmospheres surround learning environments, but contain other dimensions as well, which are related to the main findings of this research, which I would categorize in three entities:

- Generative spaces: choice of what to explore and build.
- Multiple expressive media: choice of the tools to use.
- Relationship building: affective interaction.

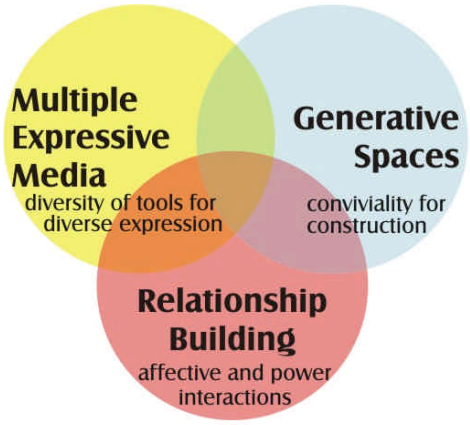

Figure 5. The Learning Atmosphere

3.1. Generative Spaces – conviviality for construction

Paulo Freire's **generative themes** and his methodology for illiterate adults were certainly one of the most influential elements to most modern progressive educators. David Cavallo comments in his PhD. thesis,

> The choice of projects and study by the learner is critical. We do not use projects merely as a means to get them to learn what we want. They are not pre-ordained, pre-planned, and prefabricated within a pre-determined, structured, rigid curriculum, used solely to teach a set of facts or concepts. Rather, their choice is an essential element to a positive, free, active engagement with their world. Instead of relying on the dictates of others, they take charge of their own learning and their own relationship with their environment and each other. (Cavallo, 2000)

In "The Pedagogy of the Oppressed" (Freire, 1974), Freire explains in details his method for coding / decoding elements in the local culture and coming up with generative themes together with the community of learners. He stresses, in the whole process, the dichotomy between being immersed in one's reality (being only aware of your own needs) and emerging from it (making sense of your needs). He states that the learners can go from the "consciousness of the real" to the "consciousness of the possible" very quickly, as they perceive the "viable new alternatives" beyond the "limiting-situations".

Freire never proposed that the researcher (*investigador*) should not contribute with his/her own themes and ideas (the *temas da dobradiça*, or connecting themes), but he

made it clear that the proposition should emerge within a specific context, and link themes already pointed out by the learners as meaningful. He also never proposed that the researcher should get to the classroom with a list of possible themes in order to achieve a curricular item.

I arrived in Heliópolis with the freirean methodology in mind – but still I had to change everything and be flexible to adapt to their reality – and not the one I suspected to come across. Nevertheless, how did the presence of digital technologies change the process?

3.2. Could it possibly happen without technology?

The availability of unusual equipment brought an extraneous touch otherwise impossible, in the Trojan horse sense – once "domesticated", it became a great object to play with. In addition, we have to consider their prior attribution of social value, potential, and meaning to this valuable equipment.

Play, to the eyes of many teachers, is a hindrance to learning; it has to be "regimented". Nevertheless, some teachers knew (and told me) that most kids learned computers only *fuçando* (fooling around), which was not allowed in the computer lab. They often asked the kids for help in dealing with the computer – but could not allow them to learn in that fashion once the activity became official.

The epistemological status of the teachers' comments is revealing. It is not only compatible with the traditional school paradigm, but with the way parents regards school. David 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 be learning (Cavallo, 2000). The idea is that playing around is bad and leads to nothing[3]. The epistemological belief of the teachers is that there must be concrete goals, plans to get there, and orderly sequences of knowledge construction. One of the biggest breakthroughs in our workshops is when initially reluctant teachers allow themselves to let go and start genuinely enjoying being a "playful learner" again, eventually getting in touch with many different disciplines and fields of knowledge.

Another element is that the presence of objects that have to be shared creates a new dynamic, which is inexistent in regular classroom. In the traditional setting, everything is symbolic on paper; there is no opportunity to develop democratic control. (Papert, 2002). The availability of different tools and media, both on-screen and off-screen, also plays an important role for this goal.

3.3. New ways to act in the world

As Edith Ackerman comments that

> (Papert and Piaget) remind us that learning, especially today, is much less about acquiring information or submitting to other people's ideas or values, than it is about putting one's own words to the world, or finding one's own voice, and exchanging our ideas with others. (Ackermann, 2001)

Imagining solutions for the community, in Heliópolis, was intrinsically leading to social research, reflection and intervention. The latter aspect – intervention, making something

[3] We are not advocating fun for its own sake, out of the context. It is also true that fun approaches leading to nothing are also common.

for real – was an *intrinsic part of the freirean method* for illiterate adults, as they could use their reading and writing skills in everyday life. Despite rhetoric to the contrary, the epistemological stance underlying traditional school practice is that knowledge is to be deposited in the kids' heads for an (unlikely) future use. Students are never ready, never prepared, never mature enough to put the knowledge into use, and consequently never considered capable of deciding what they should to learn. As a result, **Generative Spaces** come to exist when both the freirean principles and expressive technological tools are present, not only for up-in-the-air exercises of imagination, but infused in praxis and democratic decision-making.

Our contribution goes also in the sense that, in order to build a generative space, attention must be paid to certain critical details. We term them *details* because they have routinely been overlooked and disregarded in schools.

3.4. Relationship-building

The canonical example of such "details" was the control over equipment, and how much the students appreciated the fact that they were trusted to explore freely the computers, cameras and Legos. Just the fact of having a sign-up sheet for the equipment, controlled by someone from the school staff, could affects the atmosphere, as we verified in later experiences[4]. On the other hand, in some settings, equipment might be too scarce or the risks too high – one way out is to decide democratically (proposing and voting) how the equipment or the activities will be conducted.

Michel Foucault analyzed extensively the role of discipline and punishment in many institutions, such as prisons, schools and mental institutions. One of the common characteristic in those institutions is that power operates automatically: the feeling and the fear of being watched all the time causes the incorporation of the rules dictated within the environment - the panoptical metaphor (Singer, 1997). One of his important conclusions is about how power is increasingly invisible in modern society, but always present, and needs less and less demonstrations of force to ensure that the rules are fulfilled (*apud* (Singer, 1997)). This is accomplished mainly through discourses within the schools - what can be said, who can speak, who is in control, who really decides.

José Cukier, an Argentinean psychoanalyst, has extensively studied the psychopathologies originated from school (Cukier, 1996). Relationship building is a far more complex issue than letting students do whatever they want. He warns us 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. This also undermines the autonomy of the learner as learning becomes associated with being taught by the charismatic as opposed something the learner does and controls (Cavallo, 2002). Fernando Almeida describes how school stimulates a kind of schizophrenia and cynicism in the students, by having them learn to assume different personalities all along the day (Almeida, 2001). Between the two extremes, the traditional authoritarian teacher and the charismatic leader, there was space for less pathological transactions.

[4] During the Winter Institute, in Curitiba, the equipment was controlled by the receptionists of the event, supervised by staff from the Secretariat of Education. We found out that, as battery life of the digital cameras was short, the chief-receptionists decided (on her own) that only the adults should be able to get the cameras.

3.5. Multiple expressive media

By offering multiple technologies and media we are offering more than nice technological gadgets – we are providing the tools that we believe to be potentially humanizing in an atmosphere to support such development. We do not bring all technologies in the world, but a subset that we believe are more expressive and constructive. In addition, the presence of multiple expressive media is not important to train students to use technology, but as the Brazilian psychoanalyst Nize Maria Pellanda states:

> "We do not learn about reality by direct experience, but through reconstruction. For reconstruction to take place, we need a full interior symbolic apparatus so that we could make sense of experience. An atmosphere poor of signs reduces the chances of flexibility in the interaction with reality and lacks raw material for us to rebuild the universe inside and outside of us." (Pellanda, 1996)

Although digital media offers revolutionary possibilities for learning, it does not follow that it is the media of choice for all projects. The presence of digital technology is fundamental, but its *exclusive presence* is not necessary. The presence of digital technologies mixed with *traditional, familiar, hi-tech, low-tech media* is more powerful. In Heliópolis, as well as the following workshops, we observed that some students would stay for days working with paint and clay before engaging in some technological endeavor.

4. Conclusion

The discussion of the case studies demonstrated the importance of having dynamic, comprehensive models to understand the interactions in alternative learning environments. We emphasized the core elements of the Learning Atmosphere framework, and confirmed the possibility of giving students a different and powerful experience that builds up from their local culture, history and expertise.

The energy crisis in Brazil was a strong example. Only building on a superficial view of local culture, by introducing learning methodologies such as project-based approaches, by making available potentially expressive technologies, was not enough to create the displacement that would make people challenge underlying assumptions and work in new ways. Expressions such as "local culture" and "community development" became quite fashionable in the public debate around education. However, local culture is not automatically positive. Community values are not all virtuous (Eiles, 1996), (Chanlat, 1992). *Catalysts are important.* It was essential, thus, to have a more textured, fine-grained approach, and identify also what was *not* in the culture. The challenge is to use technology, which was extraneous and foreign, as a means to reinforce community's own livelihood, and create enabling spaces for mutual enrichment.

Technologies, and particular ways of using it, were the main elements of displacement. We showed how they play a central role in the process, enabling new, complex, diverse ways of learning and thinking, both on and off-screen, with familiar and unfamiliar materials, using high and low-tech tools. In addition, the atmosphere enabled new ways to simultaneously manage epistemological diversity, create trust and empower students and teachers.

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