Statement of Intellectual Concerns and Research Agenda

As an undergraduate biology major, I was driven by the question: What evolutionary conditions favored the development of intelligent behavior in animals? After studying mostly primates, I became intrigued by the human species’ capacity to acquire and use language. This interest led me to the theories of cognitive development of Piaget, Vygotsky, Wallon, and others. In his writings, Wallon, Vygotsky and later Neo-Vygotskian psychologists called for a new paradigm to study “mind in society.” Convinced that any attempt to theorize about human cognition which did not take socio-cultural context into account would be incomplete and inadequate to explain non-western middle class populations, I embarked on the study of social anthropology. For my doctoral research I looked at how children in a non-western, mostly non-literate peasant village called San Juan learned to become competent peasants like their parents. While understanding how children learned within the context of agrarian chores seemed easy, I found formal schooling to be rather perplexing. Everything I had read about the cognitive consequences of schooling led me to anticipate that in school I would find routines that would develop a hypothetic-deductive reasoning. But this was not so. I found that most of the classroom activities were very difficult for the students to understand, and that in the end, most learning was reduced to rote memorization. For the first time, I encountered children who could talk articulately about how chores were carried out, and yet, when it came to describing what they learned in school, mostly ended up reciting a litany of disjointed facts and had no way of making sense of those bits of information. This duality in the modes of learning used by the same child to adapt to these contrasting learning environments was the central theme of my thesis.

The experience in San Juan was traumatic because as an educated Colombian, I became painfully aware that while these children had a great capacity to learn, five years of formal education did not match their aptitudes to learn; the educational system, in practice, turned out to be deficient. Throughout my professional career, I have worked on a number of projects, all of which were oriented toward improving, if not radically restructuring, formal schooling both in the US and abroad. First I worked on the Thinking Skills Project at BBN, a research and development think tank. Later, I worked on Teaching for Understanding at Project Zero. I then returned to BBN to join Co-NECT, a systemic reform initiative which was aimed at ‘reinventing the American classroom’ by means of a design combining project-based learning based on standards, multi-age grouping, portfolio assessment, and the ubiquitous use of telecommunications, computers and video to support the change. It was at Co-NECT that I first witnessed the role played by technology in shaping the way projects were run, including the shifting of roles and the emergence of new kinds of student performances. However, a close look at the profound shift which could be brought about when cyber-artifacts replaced the textbook as key structuring resource impressed me most vividly while participating in the formative evaluation of a multi-level genetics simulation called Genscope. The sequence of episodes sketched out below point toward a number of questions that are central to the way I think about technologies in education, the kind of research I have done and would like to continue doing, as well as the courses I have taught and want to develop.
A close encounter with “cybercy”……and the “Trojan Mouse”

Since my most deeply ingrained habit of mind is that of an ethnographer, let me start with an episode that reveals the significance of this line of research.

While working at BBN in the 90’s, a group of colleagues (educators, scientists and programmers), was developing a software program called Genscope, a multi-layered simulation which allows users to move between the various levels of a genetics simulation: from the DNA level, going though the chromosome, cell, organism, pedigree and finally population level. Because one of my colleagues told me that programs like Genscope would eventually replace the textbook, I was intrigued, and I attached myself to the research team as a participant observer.

Genscope affords learners the possibility of working at various levels and of seeing what happens when changes done at one level affect those at another with just a few clicks of the mouse. As students learn by doing, i.e. by manipulating the genes of dragons, they discover the rules of genetics, a kind of activity that can only be carried out in a digital medium. While testing the software in an urban high school in Boston, we were struck by how engaged the students got in solving the genetics puzzles presented to them. Students who, in the traditional classroom setting of a textbook and blackboard, seemed quite disengaged from the subject matter, now got wrapped up in solving the problems of Genscope, to the point of missing recess in order to finish a particularly challenging problem. Without much guidance or prodding, students in the lab focused on the tasks, appeared to enjoy working in small groups, and demonstrated their understanding by coming up with the solutions to problems. Back in the classroom, one student demonstrated her understanding by venturing to correct the teacher’s solution to a problem on the board. Her sense of being right was firm, because “on the computer it did not work like that.” The student was right, she knew it, and all, including the teacher, were impressed by how much the students had learned.

Much as I had done while investigating how the peasant children in rural Colombia learned in various environments, I invited the students to my office, and in a relaxed backstage mode of talking, debriefed them about what had gone on in class. They reported really enjoying learning through Genscope. I wondered if after working with Genscope, they would be able to use that understanding to comprehend their genetics textbook. Not so. They read to me fluently, but when I asked questions that entailed comprehension, I discovered that they were unable to answer them. Like the San Juan children, they tried to peek at the text and recall as much as they could by rote. I went into a more clinical mode and probed deeper. In conversation, they acknowledged that they, like most other students in that class, could not understand what the textbook said, and that their strategy to show that they had studied was to memorize as much as they could. I was confronted with the fact that the two kinds of learning did not seem to connect. In other words, learning about genetics in Genscope did not have an impact on their capacity to read about that same subject. However, while Genscope allowed them to learn genetics, what was later termed learning in cybercy did not have much of an impact on accessing the same knowledge represented the literacy-based medium of their textbook. I later asked the teachers if reading textbooks for understanding was part of
scientific literacy, and was told that the program assumed all students were able to read and understand the textbooks, and hence the concept of scientific literacy had nothing to do with actually being able to read science.

Concerned with moving students into a more linguistically mediated mode of representing what they had learned, I designed the following intervention. Recalling many of the strategies I had seen in teachers (mostly in low-tech environments), I devised a series of learning sequences which moved students from these cybercy-mediated performances to ones mediated in their speech, i.e., primary orality, and gradually imbued those routines with elements of reading and writing. The results were impressive: with some coaching on my part, a small group of students prepared one of their members to get up in front of the class and present their findings on the board. Having the students take to the board to express their ideas was a totally new activity in this classroom. Both the teacher and the classmates were delighted when the performance went very smoothly and demonstrated elements of scientific eloquence that no one suspected this particular student was capable of. His classmates broke out in spontaneous applause. That students were able to learn while interacting with the computer was already known to us, but that they could use that understanding to performances using the board was new. After class, the teacher asked me how I had managed to get that performance, and I explained it to her. A few days later, she tried to do the same—asked students to explain to the whole class what they had found in the Genscope lab. I was not there, and the problem was that the teacher had not really appreciated the need for students to interactively construct and rehearse their performance before presenting it to the larger group. Without previous rehearsal and peer coaching, the students floundered, and their performance on the board was poor.

The episode referred to above, as well as other research I have done in Co-NECT, and more recently, in my work at HIID in El Salvador, highlight how quickly teacher expectations can be challenged and, with proper support, how amenable to change teachers become. As they witness the transformation of their own students, most teachers realize that the premises on which their core practices are founded do not hold true under all conditions, and they are willing to try something new. This what is known “the Trojan Mouse Effect” — it is not the computers and software that turn out to have the most significant impact but rather the pedagogical conversations around how people learn.

How does the Trojan Mouse work? From the point of view of the theory of activity, the Trojan mouse works at two levels. At the level of the classroom practice itself, normal practice is disrupted because the tools of normal activity no longer function and can no longer structure the activity. Freed from the constraints of routine scripts, a constructivist activity can emerge if and only if students are led to learn in this manner. As a result, new roles can be enacted. At the level of teacher enhancement, an analogous process can take place as teachers themselves experience how they learn using simulation software. If

Laserna, C “Can you make a prediction? The role of video-conferencing in spreading local innovations” documents this process in the context of using Rellab. I found the same phenomenon using Genscope in Harvard Extension School course and a few months ago while working with principals and teachers in El Salvador.
these experience is subsequently reflected upon by participants, there is the possibility of questioning the assumptions that underpin traditional practice and hence move towards an intentional transformation of practice. After years of working with improvement and reform models that took a long time to be implemented (Project Intelligence, Teaching for Understanding amongst and others) the tactical efficiency of the Trojan Mouse truly impressed me.

**Research Agenda**

My experience with this and other software has alerted me to the importance of focusing on the ways in which students use oral language, their literacy competencies, and how one can capitalize on the affordances of particular software tools such as Genscope to allow students to build understanding. Examining the relationship between orality, literacy, and cybery (O/L/C) has become a highly generative enterprise for myself and the students and teachers with whom I have shared it. The following are lines of inquiry that I derive from this research:

**Cybery and Enhanced Student Learning**

Because not all students arrive at a learning situation with the same kind of cultural capital, and educators are calling for both a student-centered constructivist approach and greater equity in learning opportunities, it seems imperative that both software developers and educators consider the learning aptitudes of a wide range of students from the start. A methodology for doing so needs to be worked out by an interdisciplinary team that can begin to research and systematize how different ways of learning interact with the affordances of particular software. Given the increasing amount of software available to teachers, I would be interested in developing a generic framework which would serve to orient teachers and software developers as to the kind of questions they should ask when using/developing software. Here are some specific questions I am interested in researching:

*How do students with different cultural experiences around O/L/C interact with various kinds of software?*

Based on my work around O/L/C, I would like to conduct a series of design experiments that explore how these three mediums of communication O/L/C can be strategically combined to improve performance on all media. I would invite the collaboration of colleagues who are in the field of literacy as well as software designers. Starting with Genscope, or its imminent successor, Biologica, we would first characterize how students from different backgrounds of O/L/C interact with the software. Based on this preliminary account, we would conduct design experiments aimed at getting students to be more fluid in all modes of communication. My working hypothesis is that moving students through different media would result in more robust and transferable understandings and a greater capacity to build knowledge represented in different media. My experiences with reflective ‘backstage’ talk leads me to believe that students would be effective co-researchers and that participating in this kind of activity would be beneficial to the students as they become more aware of their own learning process as
individuals and in the classroom community. It would be particularly interesting to do this work with minority students and gauge the effects on self-esteem and other factors described in the literature as key to promoting their success in school.

**Habits of mind.** Since understanding a discipline entails far more than knowing the basic facts, and includes learning the habits of mind associated with such discipline, we need to evaluate under what conditions teaching software such as GS promotes the scientific sense-making game of relating theories to evidence and in the process externalizing and testing ones’ mental models via predictions.

**Teacher Transformation**

A second area I want to consider is how particular cyber-environments transform teacher practices and expectations because, as the literature consistently reports, there is a strong association between teacher expectations and students performance.

The question becomes: How can we harness the Trojan Mouse effect in traditional classrooms? There are various factors involved. First, the hypothesis is that in the absence of a generic pedagogical framework such as Teaching for Understanding or project-based learning, the change will be temporary, and teachers will quickly revert to traditional core practices and the ideologies that legitimate them. If, in contrast, teachers have the opportunity to reflect on what happened as they and/or their students learn in new ways and teachers are supported in adopting a new mode of teaching, there is a greater chance of lasting change. In addition, one needs to be opportunistic and seek out a broader systemic context that might legitimize such a stance. For example, given the new standards from the National Research call for understanding of complex knowledge systems, constructivist approaches, and inquiry processes, it is easier to legitimize the use of modeling tools in science instruction. Not only do these tools allow for constructivism and inquiry activities to generate, learning to use some of these tools will allow students to experience how modern scientist work and in that context acquire key disciplinary knowledge.

Our central applied research goal should be to help high-school teachers incorporate particular computer modeling tools into their own classrooms, and in doing so, follow up by documenting the kind of learning that is afforded. Products of such study would be used to a) develop materials for familiarizing teachers and students with the way scientists work with modeling tools; b) implement a teacher enhancement strategy to make use of modeling software in the classroom, stressing the ways these modeling tools afford disciplinary knowledge and constructivist learning (NRC standards); c) promote networks collaboration and support for innovation and studying the kind of collaboration that occurs; and d) design ways to support leadership among teachers and students so that their work may be better known both inside their own school and in their wider community.
Leadership and supportive policy environments
While software such as GS is good for jump starting the transformation, much systemic work needs to be done in order for these small innovations to be able to spread and be accepted as legitimate ordinary activities (see Barrowy and Laserna, 1998, and Laserna and Carrasco, 2001). Under what conditions can teachers make this kind of “extra-ordinary learning” part of their ordinary core practices? This question raises issues related to teacher education and professional development. I am particularly interested in the kind of support that educational systems can offer to in-service as well as pre-service teachers to engage and sustain transformative practices. So far my work has focused on four critical ingredients: a) creating policy environments at the local schools and in the district that support innovation; b) developing professional development materials, particularly videos, that allow teachers to reflect and professionalize their practice; c) trying out and refining strategies such as design experiments to ensure that teachers are not only the object of research but also active agents; d) promoting the creation of a professional development community (both local and virtual) that supports new ideas and more recently e) seeking to develop a certificate for educators to support the infusion of technology into their classroom practices.

Finally, a great concern of mine are the equity issues around cyber learning environments. Others are researching the possibilities and consequences of creating a digital divide in terms of race and class. Although I consider those to be important, my focus is somewhat different. Based on my work on orality, literacy, and cyberty, I argue that the notion of equity needs to be expanded to privilege and take seriously different modes of communication. That is, students whose dominant mode of communication is orality, will not be served despite expanded access to technology if that technology is exclusively designed with literate students in mind. This theme is reflected in my work both at the international level in developing countries as well as in this country with bilingual and minority students.

Design Experiments, a methodology that pulls many level together and needs to be tested and refined: In my own work with teachers in El Salvador, I have found design experiments, a form of action research where teachers are active participants in the design, implementation, and analysis of interventions are particularly useful in getting teachers involved in innovation and willing to pursue the transformations they see in their students and in themselves. Because in the course of a design experiment one gathers data around three sets of variables—student learning, classroom climate and systemic variables—such experiments collect information which is useful at various levels of the system, and in fact, creates awareness that this is so.

In sum, a research agenda which focuses in part on orality, literacy, and cyberty (O/L/C) combines all the elements of the kind of career path I envision myself pursuing: deeply challenging as an academic enterprise, rich in connotations and associations, while at the same time extremely relevant to the practice of education.
Developing an “epistemic game” machine
Aside from research carried out in classroom settings, I would be interested in expanding the concept of knowledge building reified in programs such as Knowledge Forum, to a generic “epistemic game” machine. Such a machine would enable students to learn key epistemic strategies that cut across disciplines and would include strategies such as form-function analysis for biology, critical-event analysis and multi-causal analysis in the social sciences. These strategies are labeled “epistemic” because they involve the construction of new knowledge and are used to make sense of phenomena in the world. The goal would be to develop an epistemic game machine that would afford knowledge builders to work at different levels of epistemic sophistication. My strategy for developing this machine would be to start with defining the epistemic strategies of a single discipline, in this case history, because I have experience in working with historians and history teachers as I did during my work in teaching for understanding. Working with a team which would include a historian, a software developer, experienced history teachers, and myself, we would go through the process of designing, developing, and testing this tool in a range of educational settings, mostly in middle school and in high school. The objective would be to support communities of learners in building historical knowledge, explicitly using some of the epistemic structures and strategies of professional historians. Starting the idea that every person can be his own historian we would seek to develop epistemic fluency by having students become the historians of their own life and family. Once the basic strategies are understood in a problem where students are authentic experts, i.e., their own lives, we would use the same knowledge-building environment to construct knowledge around a critical events or periods selected from the prescribed history curriculum. Very much like the knowledge-building communities that are mediated by Knowledge forum, we would encourage teachers to promote a culture of developing historical imagination along the lines outlined in my paper by that title. It would be important to work with teachers beforehand, to make sure they understand what it takes to establish and moderate a learning community. The program would be tested in different environments. This epistemic game machine would be linked to an electronic resource exchange where primary texts and other essential resources, such as timeline tools, would be available.

Formative testing would take place in schools with a wide range of students. I am particularly interested in working with urban student populations where issues of orality, literacy, and cybercy are particularly relevant. Data collected during the formative evaluation of this project would be used both to improve the design of the software tool itself, but also as evidence for the kinds of epistemic games different kinds of students play.

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2 Collins, A “Epistemic forms and strategies” BBN report, 1995