

One to One Connections: Building a Community Learning Culture

by

Claudia M Urrea

B.S. Computer Science, Universidad EAFIT, 1993
M.Ed. Educational Media and Technology, Boston University, 2005

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Signature of Author: _____
Program in Media Arts and Sciences
September 17, 2007

Certified by: _____
Seymour Papert
Professor of Education and Media Technology, Emeritus
MIT Media Laboratory

Certified by: _____
Glorianna Davenport
Principal Research Associate, Media Fabrics Group
MIT Media Laboratory

Accepted by: _____
Prof. Deb Roy
Chairperson
Departmental Committee on Graduate Students

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Claudia M Urrea

Submitted to the Program in Media Arts and Sciences, School of Architecture and Planning, on September 17, 2007, in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Abstract

The complexity of the school, society and policy, and dominant cultural beliefs about teaching, learning, and knowledge constrain people's mindsets, paradoxically preventing the fundamental changes that can take advantage of new technologies and address the inadequacies of current educational systems. The same constraints permeate reform efforts as most often the educational establishment tests the transformation of the system one element at a time while attempting to hold all other elements constant, thereby inhibiting more profound changes. The promise of one-to-one computer infrastructure provides such a dramatic alternative to current educational systems that it forces us to think about change at a deeper level, leaving us with the challenge of where to begin.

The fundamental aim of this thesis is to study the potential of the one-to-one computer infrastructure as a catalyst for change. This thesis presents a holistic model for rural school that builds on a rich body of Constructionist learning research. Key components of the holistic model are: sufficient amount of student-owned technology which can accompany them as they interact at home and in the broader community; activities that are designed with sufficient scope to encourage the appropriation of powerful ideas; and, teacher engagement in activity design with simultaneous support from a knowledge network of local and international colleagues and mentors. I introduce the concept of "whole-project" learning, which strategically integrates the elements of the model, and introduces a learning approach that is fundamentally different from the existent methodology of work.

The thesis findings rely on data collected during the one year intervention. This longitudinal study of a one-teacher school in Costa Rica over the course of the year allows me to present stories of change as well as a more quantitative analysis of the learning activities. The results of the study suggest that in order for appropriation to occur, three conditions are salient: computational technology must be mobile and owned by the students so that learning becomes integral to the culture of the community; activities need to be of a scale and quality that children and teachers can make rich connections to powerful ideas; and, participation and voice must be inclusive.

Thesis advisor: Seymour Papert

Title: Professor of Education and Media Technology, Emeritus
MIT Media Laboratory

Thesis advisor: Glorianna Davenport

Title: Principal Research Associate, Media Fabrics Group
MIT Media Laboratory

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by

Claudia M Urrea

Certified by:

David Cavallo
Research Scientist, The Future of Learning Group
MIT Media Laboratory

Certified by:

Fred Martin
Assistant Professor
Computer Science Department
University of Massachusetts Lowell

Certified by:

Fernando Reimers
Ford Foundation Professor of International Education
Director International Education Program
Harvard Graduate School of Education

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To the memory of my parents.

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1 Introduction

“When we talk about computers in education, we should not think about a machine having an effect. We should be talking about the opportunity offered us, by this computer presence, to rethink what learning is all about, to rethink education.”

*Technocentrism
(Papert and E. & L. Group. 1990)*

The ways in which computers have entered the world of education has been very superficial. Even today, as computers populate the classroom in large numbers, the role of the computer in relation to learning is not very powerful. For some people, the computer is the ultimate goal, and so they advocate students learning computer skills. As a result, computer classes have been added to the long list of classes that the students should take, and computer skills are now part of the countries' national standards and tests. Other people see the computer as the object that replaces the teacher, or in the best scenario that supports the teacher's instruction methods. Computer-Assisted Instruction has been a major trend in the use of the computer in Education. In recent years, as the Internet has become more accessible for some people, the computer is considered a “tool to help students access information, communicate information and collaborate with others” (Fullan and Smith 1999). At least in America, it has been reported to be the most pervasive practice in schools (Vaikakul 2005).

The reality is that the complexity of the school, society and policy, and dominant cultural beliefs about teaching, learning, and knowledge constrain people's mindsets, paradoxically preventing the fundamental changes that can take advantage of new technologies and address the inadequacies of current educational systems. The same mindset permeates reform efforts as most often the educational establishment tests the alteration of one element at a time, attempting to hold all other elements constant, thereby inhibiting more profound changes.

This thesis takes the idea of “One Computer Per Child” as a real opportunity to rethink education in the new century. The aim of this thesis is to study the potential of the one-to-one computer infrastructure as a catalyst for change. I chose to use the rural one-teacher school environment as the basis for this research not merely because such schools are numerous in developing countries and typically associated with poor quality of teaching and learning, but primarily because they do not fit traditional models of education. At the same time, they provide a fertile ground where technology can be present in sufficient quantity to constitute a computationally-rich environment; can be experienced as socially and personally relevant; and, can be linked to sources of social and cultural knowledge as well as powerful ideas.

This thesis proposes a holistic model for learning environments that builds on a rich body of Constructionist learning research. Key components of the holistic model are: sufficient amount of student-owned technology which can accompany them as they interact in school, at home and in the broader community; rich educational activities that draw on the Constructionist learning approach; and, teacher engagement in activity design with simultaneous support from a knowledge network of local and international colleagues and mentors. I introduce the concept of “whole-project” learning, which strategically integrates the elements of the model, and introduces a learning approach that is different from the existent methodology of work in that it invites deep multidisciplinary learning and can involve learners of all ages, hence challenging the need for segmentation of the school day into age groups and class periods.

Costa Rica’s educational system presents an appealing case for the study and implementation of the model proposed in this thesis. Costa Rica has a history of successful implementation and on-going support for computers in education. In 1988, Costa Rica, with the support and advice of the MIT Media Lab, took a bold step toward using computer technology to enhance its schools. The Omar Dengo Foundation, the institution that has implemented the computer initiative in Costa Rica, has created a number of programs, such as in-service and computer-based training, student mentors, and computers in the classroom, among others, which are conceived within a Constructionist philosophy (Anfossi and Fonseca 1999). In addition, the Foundation has established a support network of tutors who are teachers participating in the program, and

a nationwide conference for children. Through these initiatives, Costa Rica has shown how to introduce a nationwide change that is both radical and sustainable, which gives the country a culture of educational innovation.

Building on the foundation of Constructionist learning culture and experience in Costa Rica, I decided to work with one one-teacher school, called El Silencio, over the course of one year. In the rest of the thesis, I will describe the longitudinal study of the transformation of the school by the holistic model, and of the appropriation that took place. Although this thesis takes into account the dimension of students, parents, and teacher, it focuses on students' appropriation of technological tools in the context of their learning, and how parents' and teacher participation influenced how that happened.

The name "One to One Connections: building a community learning culture" was inspired by the concept of *family learning culture* introduced by Seymour Papert in his book *The Connected Family* (1996). As I worked with students, teacher, and the families at El Silencio, I observe a computer culture emerged as the digital technologies became part of people's "beliefs, preferred activities and traditions associated with learning." Papert tells us that a learning culture that takes into account new digital technologies is a necessary step towards changing education. This is needed even more when the learning culture of the school environment is going through a major transformation, and when technology plays such important role. Families and community members not only need to participate and support the new learning that happens at the school, they also need to engage in it. They need to change their mind-sets about what learning is, different from what they learned at school. This thesis takes a participatory approach to involve all stakeholders not only in the design of the holistic model proposed in this thesis, but also in the development of the practical experience at the one-teacher school in Costa Rica.

1.1 Motivation and background

I have always been fascinated with rural school, one-teacher schools, in particular. I found the idea of a small school, where learners of different ages share the same physical space, family and community members are physically close, teachers are sensitive to what students know and are interested in (and even parents), and the organization of

physical space and time are flexible, ideal for learning. As I visited this type of school in several countries (mostly in Latin America), I found myself amazed to meet sensitive and caring teachers, and sweet students, and I also found the most extreme conditions. Students walked daily a great distance to a school in poor condition, often without furniture, learning materials, drinking water, and sometimes even without a teacher. The idea of working with this type of school always stayed in my mind, and my plans!

Even though I had read about Constructionism, it wasn't until I started working at the Media Laboratory that I became familiar with the ideas. I participated in a number of projects and initiatives that involved students creating their own scientific instruments and becoming engaged in scientific inquiry (Resnick, Berg et al. 2000) to develop tools and methodologies to help both children and parents learn together about technology and explore their values (Bers and Urrea 2000), using a variety of Constructionist toolkits (Mikhak, Berg et al. 2000) (Sipitakiat, Blikstein et al. 2002). The more acquainted I became with Constructionism, the more interested I became in bringing my experience and knowledge to the one-teacher school environment.

“Learning for rural communities” program was the first initiative that I developed with a one-teacher school in developing countries. The goal was to study how digital technologies can enhance student learning and at the same time strengthen the relationships between rural schools and communities (Urrea 2001). I worked with several schools in Colombia and Costa Rica for several years. I ran workshops with students, parents, and teachers in which they used robotic technologies to create projects about their interests and lives.

Although the project wasn't designed to bring change to the school as a whole, I expected the teachers to integrate the technologies and the learning that happened during the workshops to the school environment. The results of these experiences were positive, but not sustainable. There was a lot of excitement during workshops; parents worked together with students and teachers. They learned together about the technology while creating projects that integrated concepts from different disciplines. But the teachers needed a lot of support in order to integrate these practices in the daily routine of the classroom. I realized that more support and access to resources was needed in order to

make an experience like this more sustainable. Let's review other experiences In Latina America that have integrated digital technologies into the classroom:

- The Omar Dengo Foundation started the “computer in the classroom” program (Anfossi 2007), in rural one-teacher schools in Costa Rica in 1998. As part of the program, students use Micromundos¹ and other digital technologies, and followed the project-based methodology created by the Foundation to design and build projects about different topics (Anfossi and Quesada 2005). The program has been implemented in more than 100 schools across the country, which receive from 2 to 5 computers depending on the number of students. Even though the methodology is oriented toward a global approach to the subjects, the design and creation of projects often become an activity in themselves; project-based learning doesn't get integrated into the daily routine of the school day.

The program also includes a student-mentor component, which had been very successful at improving the use of technology in the classroom, not only because the students push the teacher to use the technology, but also because they support the work, therefore reducing the teacher's workload.

- Escuela Virtual (Virtual School) in Colombia is a program that integrates information and communication technologies into primary school (one-teacher school) to support the teaching and learning process (Cardona, Arango et al. 2003). The program was started by the Departmental Committee of Coffee-growers in Caldas². Its main component is an online community³ for teacher, students, and parents with a number of resources, including forums, collaborative projects, teaching materials, among other things. The program is based on the Escuela Nueva model of rural education, which I will explain in detail in Chapter 2. Unfortunately, the materials adapted to integrate the use of technology suffer from the same characteristic static materials and lack of comprehensive teacher development and support recognized among the reasons that the model has begun to deteriorate during recent years (Kline 2000).

¹ I will be using Micromundos in the rest of the document. I want to make sure the readers understand that we used the Spanish version of the software.

² Caldas is a department of Colombia. It belongs to the Colombian Coffee-Growers Axis.

³ More details about Virtual School at <http://evirtual.recintodelpensamiento.com/escuelavirtual/index.htm>

The most recent evaluation of the program reported the following results: i) it has allowed institutions to get familiar with and to use information and communication technologies (ICT) in the educational process; (ii) it has promoted collaborative projects as spaces for connectivity and exchange of academic activities; (iii) it has changed teachers' perception about information and communication technologies. They now consider them educative tools; and, (iv) it has strengthened the relations between public and private institutions, and the educative community (Cardona, Arango et al. 2003): pag 1).

- Enlaces Rural program is the most recent computer initiative in rural multi-grade schools⁴ in Chile. It was started by the Ministry of Education in Chile as an extension of project Enlace, a national initiative to enhance learning environments and educational opportunities for Chile's students and teachers (Carrasco, Stingo et al. 2001). "Using a creative mix of computers and communication tools, Enlaces has created a virtual community of teachers and students across Chile and has linked this network to the rest of the world via the Internet" (Rusten 1999).

Similar to the Escuela Virtual program, Enlaces Rural incorporates strong use of communication and collaboration through its virtual environment, but it is an initiative at the national level. In addition, this program has a strong teacher training and support component, that is implemented through similar organizations called Microcentros (Microcenters)(Chile 2001).

Even though the experience described in this thesis involved a single one-teacher school, differences are critical. The most obvious difference is the quantity and quality of technology available to the students; the programs mentioned above bring only a few computers into the classrooms, depending on the students. In the thesis program, each child was given their own laptop which meant that they could take the technology with them when they left the class room. However, the deepest difference is that this thesis uses technology to rethink how learning occurs in school and studies the potential of technology to act as a catalyst for change.

⁴ Multi-grade schools include one to three teachers, depending on the number of students.

1.2 Road map to this thesis

So far, I have described the motivation behind the thesis and positioned the work amongst relevant initiatives in Latin America. I am now ready to describe in detail the thesis work using of the one-to-one computer infrastructure as a catalyst for change. This work builds on a rich body of Constructionist learning research. I will reference the relevant literature when describing the design of the proposed model, the experiment at the one-teacher school in Costa Rica, the analysis of the transformation of the school, and of the appropriation of technology and learning by students, teacher, and parents. This chapter describes the motivation behind this thesis and positions the work among relevant initiatives in Latin America. The remainder of the thesis is organized as follows:

- Chapter 2 describes the holistic model as it was envisioned. This model extends existing models of rural education in Latin America by bringing 1:1 computer infrastructure and by rethinking some of its components, such as the content and methodology of work, and the teacher and family involvement.
- Chapter 3 introduces El Silencio, a one-teacher school in Costa Rica where the proposed model was implemented. In the first sections of the chapter, I highlight the changes that occurred at the school as the proposed model was implemented. In the second section of the chapter, I describe the longitudinal qualitative research methodology used. I also introduce the participants and give a brief description of the main observations.
- Chapter 4 provides a detailed study of the transformation that occurred at a one-teacher school in Costa Rica. I offer the results in the form of stories, Stories of Change, which tell the tale of the evolution of the model as a result of the transformation process at the school, and the community. The process of the analysis is explained in the following chart (see Figure 1). In the first column, I include some of the principles of the model, which are described in detail in chapter 2; in the second column, I include the four stories of change that are discussed in this chapter; and, the last column lists the relevant outcomes that I use to support and illustrate the stories.

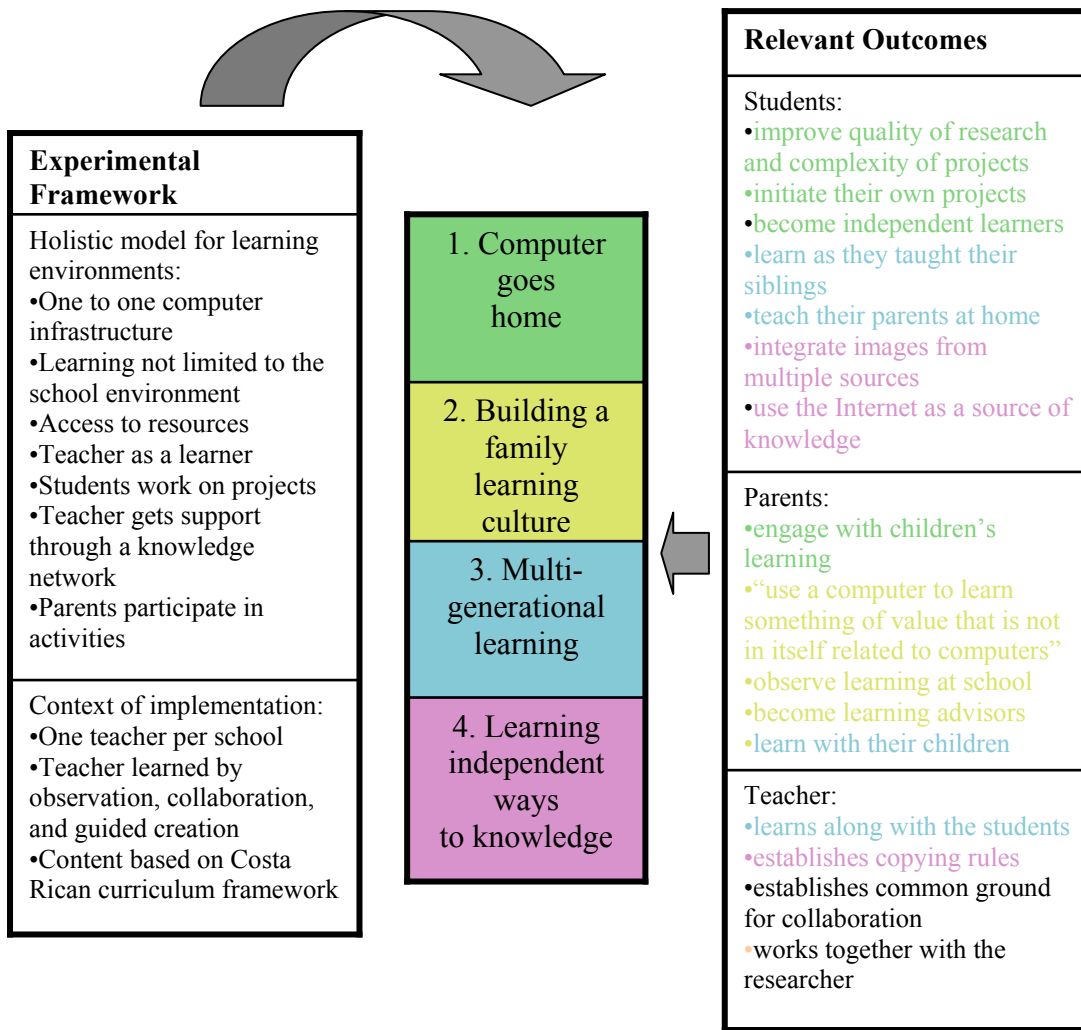
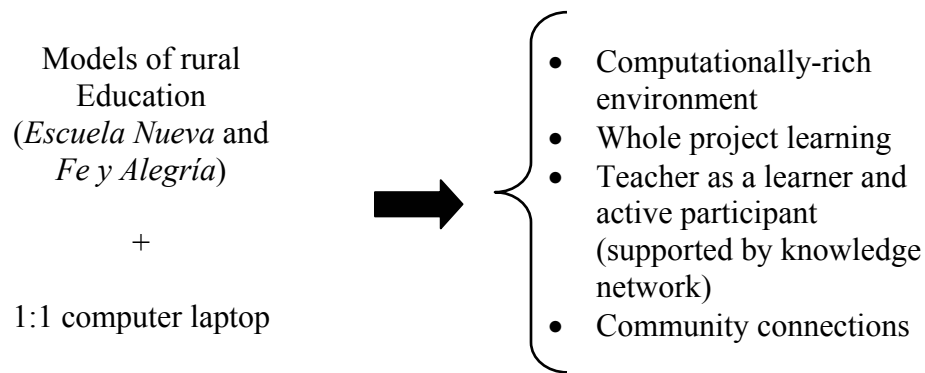


Figure 1. Stories of Change

- Chapter 5 offers a second study of appropriation by students, teacher, and parents. In this chapter, I discuss the different levels of appropriation observed during the practical experience at the one-teacher school in Costa Rica. Although this thesis takes into account the dimension of students, parents, and teacher, it mainly concentrates on students' appropriation of technological tools in the context of the learning, and how parent and teacher participation influenced how that happened.
- The closing chapter 6 outlines the contributions and future directions.

2 Designing a model for learning environments

This thesis proposes a new model for learning environments that builds on a rich body of Constructionist learning research. The holistic model extends existing models of rural education in Latin America by bringing 1:1 computer infrastructure and by rethinking some of its components, such as the content and methodology of work, and the teacher and family involvement.



Key elements of the holistic model are: sufficient amount of student-owned technology which can accompany them as they interact at home and in the broader community; whole-project approach to learning, employing rich educational activities that draw on the Constructionist learning approach; teacher engagement in activity design with simultaneous support from a knowledge network of local and international colleagues and mentors.

It is important to emphasize that the holistic model as is described in this chapter is as it was conceived. I do that for two reasons: first, to be able to analyze the model while it is implemented and to evaluate its feasibility, and second, to allow flexibility during its implementation. The idea is to provide a model that is shaped by general principles that can be adapted according to the context in which the model is implemented, and to suggest strategies that facilitate a transition and sustainability over time. In order to

introduce the proposed model, it is important to situate the work within the following framework.

2.1 *Computationally-rich environments*

Looking at voluminous literature on computers in school, I draw on three main examples to situate the work discussed in this thesis. First, I chose a highly publicized research study by Angrist & Lavy (2001), which studies the impact of computerization on both the instructional use of computers and pupil achievement. The study was conducted on 122 schools from the Tomorrow-98 program in Israel. The classrooms were equipped with computers at a 1:10 ratio. The results of the study show no effect between computers and achievement. However, it is not surprising that technology had no impact on student achievement given the students limited access to the computer, and the fact that no attempt was made to connect the use of computer to children's real lives or interests, or to connect with powerful ideas. Moreover, this study only paid attention to the computer-based activities performed by teachers (i.e., how to use the technology to teach), without looking at the activities the students engaged in or how students used the computer.

Second, I draw upon a study performed by a group of researchers at Boston University on South Elementary School, located in Andover, Massachusetts, that compared two types of classrooms: classrooms with a temporary 1:1 environment and classrooms with a permanent 1:1 environment (Russell, Bebell et al. 2004). The scope of the study is slightly wider since it paid attention to changes in teaching as well as learning practices. The findings resulted in higher use of technology and a higher level of motivation and engagement in classrooms with full access to laptops, but still there were no connections with students' lives or interests, and no connections with powerful ideas.

I contrast these studies with an experience designed and studied by Idit Harel at the Hennigan Elementary School in Boston (Harel 1991). Idit Harel worked with seventeen 4th grade students for about 70 hours over the course of four months in designing instructional mathematics software. Although there wasn't a computationally rich environment in terms of the quantity of computers available to the students, the environment was rich along a different computational dimension; students spent

significantly meaningful time using the computer and making connections to powerful ideas in math. I use this experience in particular because it happened in the context of the school environment, and also because the students spent time working on concepts that were part of the curriculum framework. This experience resulted in student engagement and math improvement in the regular math curriculum, but still did not connect with students' lives and interests.

From these experiences I draw the following conclusions: computation environments should be rich in both quantity of the technology available to students and quality of use in order to make connections to powerful ideas; and use should happen in the context of the lives and interests of the students.

2.2 Community connections in Latin America

Escuela Nueva (New School) and Fe y Alegria (Faith and Joy) are previous initiatives aimed at addressing the problems of rural education in Latin America, which inspire the work proposed in this thesis. One of the goals of the Fe y Alegria program is to provide quality education to children in underserved and rural communities (Reimers 1992; Reimers 1993). The program is a collaborative effort between the Ministry of Education of the country where the project is implemented, which pays teachers' salaries; and the community members, who help build and maintain the schools (Reimers 1993). The main goals of the program are: to provide teacher training and support, to create materials that are relevant to the community, and to foster state and community involvement.

The Escuela Nueva model for rural settings fosters connection between school and community by having one or two teachers teach up to five grades, encouraging collaboration between children of different ages, developing a curriculum around rural life, emphasizing project-based learning, and allowing students to follow their own schedules, so they can help their families if they need to (Reimers 1993). The Escuela Nueva program was introduced in the rural schools of Colombia in 1975 and has expanded, having incorporated 27,000 Colombian rural schools by 1992 (Colbert and Arboleda 1990).

Although both models have notably bridged the gap between school and community by encouraging new ways of learning and proposing a relevant curriculum, and have focused strong emphasis on professional development and support of teachers, they have paid less attention to the uses of media and technology for those purposes. In the case of Escuela Nueva for example, static materials and lack of comprehensive teacher development and support have been recognized as some of the reasons that the model has begun to deteriorate over the last years (Kline 2000), which consequently pushed teachers to use materials as recipes and kept them from facilitating connections to powerful ideas.

2.3 *Holistic model for a learning environment*

Experiences such as “Con-science” and the “City That We Want” present relevant characteristics: the Con-science project attempts to integrate learning about technology and values by providing tools and methodologies, including the construction of robotic devices (Bers and Urrea 2000). Con-science provided a computation-rich environment in the form of workshops, where students worked on projects that integrated issues of their culture (identity and values) with powerful ideas, but it was an isolated experience within the school – the goal wasn’t to bring change to the school as a whole.

The City that We Want project (Cavallo, Blikstein et al. 2004) “enabled the constructionist use of technology within a generative theme to enable students to design and construct their ideas about how to improve life in their communities.” This experience used a computation rich environment, facilitated learning based on school and community connections, and connected to powerful ideas. Contrary to the Con-science experience, the City that We Want project wasn’t designed “as an end in itself, but also with a goal of how it could best help lead to macro change, so that the project itself could serve as an object to think.” This experience was designed in a way that integrated the teacher not only as an active participant, but also as an advocate of change, who uses the experience to reflect upon ideas of teaching and learning. “The project is case-based active learning at the macro level.”

Motivating both of these projects is the underlying philosophy of Constructionism, in which the computer is seen as more than just a tool; it is a potential carrier of new ways

of thinking about teaching, learning, and education (Papert 1980). Interventions afforded by Constructionism will take into consideration the local knowledge and culture, people's interests, and different learning styles, and therefore have the potential of leading to appropriate actions in education. This thesis makes its specific contribution in those regards by proposing a new model for learning that takes into account the school learning experience as a multidimensional phenomenon where technology is not only present, but also: present in sufficient quantity to constitute an immersion environment, experienced as socially and personally relevant, linked to sources of social and cultural knowledge, linked to a source of ideas, and reinforced by a network of personal and intellectual support.

My definition of "holistic model" involves all the elements in the learning environment. I argue that in order to bring change, we need to rethink all the elements in the learning environment in light of the new capabilities and the pervasive availability of computational devices, and of the access to connected computational technologies. I am proposing a model that does not impose boundaries between teachers and students, children's ages and grades, school and community, local and remote places, disciplines among each other, or hours of the day, and in which technology becomes the glue that helps integrate all its elements. In this new model for learning environments:

- Learning is not limited to the school, but happens in the context of the community. Students use the laptop computer and other digital technologies to develop projects that make connections to powerful ideas in math, science, and social science, as well as civic and human values; and are relevant to the local conditions, interests and problems. They acquire the knowledge and skills they need, when they need them. Family and community members become active participants and supporters of the students' learning process.
- Appropriation by students, teachers and families happens when the laptop computer is also integrated into the culture and lives of community members.
- Teachers learn along with the students and vice versa. The teacher acts as a collaborator and facilitator rather than an instructor. Students of different ages also

collaborate among themselves. They create groups, work on projects, and help each other as they need to.

- Teachers can get the resources and support needed to develop and propose activities. They can also use the internet to communicate and collaborate with other teachers who have similar interests, problems, and ideas due to the availability of computers and other technologies. They can use videoconferencing to review their own methods and hold meetings, and use email to exchange ideas for projects and solutions to problems.
- Teachers and students have access to resources. They can collaborate on projects with people who share similar interests, and who are developing related activities. Support provided through these collaborations will allow sharing and refining ideas among the different sites; discussing project issues among kids in different places; and combining these projects to overcome limitations in local solutions and to seize global aggregation.
- Teacher capacity will be built by: 1) hands-on training to introduce teachers to Constructionist learning: to get teachers engaged with the technology and to get them motivated to develop their own methodology; 2) in-service training: to review teacher practices and review progress of the project; and 3) constant support through knowledge network to help teachers identify places where projects can be deepened and further connections with concepts in mathematics, science, social sciences can be explored.

Once I have defined a holistic model that integrates the 1-to-1 computer infrastructure in the context of school and community, I need to think seriously about how a school or a school system could get there: What would I say to a teacher, an administrator, and a family, so that they want to embark with me in this change process? How would I use what is already there to go to where I want to be? In order to address these complex questions, I take Seymour Papert's metaphor of "Monday vs. One-Day." This metaphor has its roots in John Holt's book "What do I do on Monday?" (Holt 1970), which he wrote in response to the many letters he received from teachers who said, "I understand what you're saying, but what can I do about this in my own classroom? What do I do on

Monday?" Papert extended this metaphor to explain his "reconciling dreams about the future with the reality of today's classrooms." In an interview with Edutopia (2000), Papert said...

"I used to be tormented by an almost schizophrenic conflict between one me that thought about the future, how things would be one day, what it would be like for kids who grow up with access to knowledge and technology and are fluent in the use of all this from the beginning. They're not going to sit still for anything like what we try to teach them in schools today. But we're going to have to work very hard to make the stuff that they're going to learn.... So I've spent a lot of time doing that, trying to invent the kind of mathematics that they might be learning. But then when I talk to teachers and practical educators about this, they often find it inspiring, but then they come down to Earth and they say, "But what will I do Monday?" –which is teachers' jargon for, "Be real: I don't have those kids. I've got 30 kids there. They didn't have computers or some of them did and some didn't, and I'm restrained in all sorts of ways." So then I'd give up the dreaming, and for a while I'd concentrate on making activities for kids, teachers to do, they could use now. But then I'd realize, no ... this is like being in a boat without a rudder. Unless we know where we're going, it's no good just trying to improve the system making incremental improvements. So I'd switch back into the other one. And it took me a long time to realize that's not the way to think. The way to think is, "What can I do Monday that will prepare for one day?" And this leads to a different kind of criteria for what you would choose."

I too realized that I couldn't just go a country and say you need to discard what you are doing and start all over again. It didn't seem a good way to convince people to change or to gain the trust of people I would want to work with. I then started to think more like Papert, and propose something we could start doing "Monday," but it would give us the basis to jump to one day in the future.

2.3.1 Whole project learning

I introduce the concept of “whole project learning” to refer to a way of learning that is significantly different from what traditional schools do, which can link to existing elements (curriculum framework) and also deal with well-known problems of education (teacher qualification and isolation). I decided to introduce this new term to differentiate from project-based learning, which I find is an overused term that includes everything from doing a project during math class, to doing a project as an activity in itself. By “whole project learning,” I mean that instead of dividing the day into math, science, social science, English, or Spanish classes, students immerse themselves in and explore different topics by following activities which encourage students to propose, design, and create projects that they are interested in doing, and that connect to concepts from different disciplines. Topics and activities can vary relative to time of engagement; they can last one day, a few days, or several weeks. During any given time, the students gather to read their compositions or present their projects, to listen to a presentation by the teacher, or to discuss activities. The dynamic of the day evolves according to the activities, as well as the work developed by the students.

For example, students may work on the topic of “my community” and develop several activities (see Figure 2). A collection of activities could engaged students in the design and building of the physical model of the community. Several activities can engage students in the design and development of a physical map at scale. While creating the physical map, students learn and explore about the powerful idea of scaling. Details of an activity about the Community are included in Chapter 6.

week1	week2	week3	week4	week5	week5	week6	week7	week8	week9
Topic 1 My Community		Topic 2	T 3	T 4		T 5	T 6		
Activities: •Map (pencil and paper) •Map (Microworlds) •Physical model of the community									...



Figure 2. Whole project learning scheme

I engage here in a reflection on my role as teacher as I design activities, and I will describe aspects of both the activity and the teaching. The process of reflection is inspired by the reflective practice approach by Donald Schön (1983). As Schön tells us, the notions of "reflection-in-action" involves looking to our experiences, making connections with our feelings, and paying attention to our theories in use.

- Topic and activities

When designing and creating activities, I look for a topic that is of interest to me, that connects to students lives and interests (Freire 1970), and that I can easily expand into

a series of activities that would lead to opportunities to make connections with concepts from different disciplines, some of which may bring learners in contact with powerful ideas in the activity space. I introduce the topic to the students without giving much information. I only explain the ideas that I have and some of the possibilities and I make sure to take into account children's knowledge and feelings (Duckworth 1996). The first activity usually involves asking the students what they know, and what they are interested in learning about this particular topic. I define specific goals, which help me decide the subsequent activities that build on each other and contribute to the overall goals.

The process of design and development of activities is rooted in Dewey's theory of experiences (Dewey 1963). Activities provide a concrete learning experience that encourages the students to become active learners; encourage social interactions "in which all individuals have an opportunity to contribute something", and allow students the freedom to create their own interpretations and constructions (projects). The teacher acts as a coach, who is aware of the "capabilities, needs, and past experiences" of students, and allows their suggestions to help develop further experiences.

- Projects and powerful ideas

Taking into consideration students' suggestions, I then make a list of concepts that may be relevant to the main topic, which can become powerful ideas, and think about how they can be brought into the lives of students through the mediation of digital technology (Papert 1980). Building an artifact or project that learners can reflect upon and share with others in their learning community remains a central part of this learning approach. Students work on projects as part of the development of the activities. Sometimes they create one, which becomes more complex as they go through additional activities; other times, they develop several projects using a variety of media. I considered multiple representation of the same idea, a process well developed by Sipitakiat in his thesis (Sipitakiat 2007), and the idea of multiple sources of information that makes students' projects richer in content and aesthetic appearance.

Let's then engage on a reflection about powerful ideas. As Papert tells us (Papert 2000), powerful ideas can be used by people, meaning they learn it as they use it; can be connected to other situations, which means that they can be transferred or applied in a different context; and can be internalized over a long period, meaning that the people have opportunities to explore during a considerable amount of time to make it personal. Students acquire powerful ideas as they explore and experience the concept in a concrete matter. Teaching powerful ideas disempowers them. Not all the ideas become powerful to everyone, the role of the teacher is to identify potential powerful ideas, and design learning experiences where they can be acquired by learners. The power is in the activity and the experience the student goes through.

Table 1. Topic/Activities/Powerful ideas

Topics	Lesson/Activities	Powerful Ideas
Environment (water, electricity, nature, etc).	Study natural disasters/design scientific instruments	Collect and represent data: Children can study different phenomena by designing their own instruments (Resnick, Berg et al. 2000) and collecting data. They will have to think about the kind of data they need to collect (using sensors) and they can make speculations and come up with meaningful ways to represent the results (SEED project - http://www.seed.slb.com/).
	Recording water usage and especially wasteful usage	Multiplication: Having the students come up with their own ways to measure quantities of water usage and represent it over time really helps them to construct their own understanding of a concept such as multiplication. For example, a group of children can design a watermill to keep count of the amount of water used over time. They can also design their own ways to represent the event of one container used at a given time.
	Animal behavior	Randomness: Children can learn about this concept by building and simulating animal behavior using digital technologies (Martin 1988). For example, they can build a robotic fly and use randomness to simulate how it flies.

My community	Where is my community located?/Write a story of my community	Geometry and scale: Children can build a map of the community where they live. They can calculate distances by taking a walk between places, counting steps and scaling them on a map. They can use Microworlds and the concept of “body syntonic” (Papert, 1980) to draw the map and explore further concepts of geometry as they travel between places.
	Living in peace and harmony	Human values: In the same spirit of the Con-Science project, children can build robotic artifacts to explore human values (Bers & Urrea, 2000). They can also use narratives to complement their projects. For example, a group of children can build a conveyor belt that transports actions, and have people play with it to reflect about the good and bad things they have done and how they can improve their behavior
	Recreation (Games)	Probability: There is a lot of probability embedded in games. Students can explore the concept of probably by designing their own games and having community members play with them at a school fair. A group of students can design a contraption that gives yes/no/maybe type answers to people’s questions. They assign a probability of 50/30/20 to each of the possibilities.

2.3.2 Teacher as learner and agent of change

Educational reform efforts have overlooked the role and the potential of the teacher, and have failed to address important issues, which influence the educational opportunities of the students (Villegas-Reimers and Reimers 1996). Moreover, most attempts to bring technology into educational change address the degree of understanding that the technology requires by limiting the role of the teachers. They try to ‘teacher-proof’ the technology use, and limit things to office applications or other superficial uses, which then limits the potential impact of the technology and the change in education.

As Villegas-Reimers and Reimers frame the issue very well (Villegas-Reimers and Reimers 1996), “Unless education at some future time is re-structured in a way which no longer needs teachers, the pertinent question is not whether teachers are an input that matters for reform but (given how much they obviously matter) how can their influence be optimized?” This thesis addresses that question by integrating the teacher as an active participant and also as one of the most important agents of educational change (Fullan 1992; Urrea 2002).

Given that digital technologies play an important role in the proposed model, this thesis attempts to demonstrate the capacity of the teachers to understand and use computational thinking on a deeper level (Cavallo, Blikstein et al. 2004), which has been known as one of the limiting factors in educational reform. The under-qualification of the teacher is seen as a bottle neck because the educational experience of the students is limited by the educational level of the teachers (Navarro and Verdisco 2000). Constructionism challenges this apparently obvious assumption. It is possible to learn in action provided that the learning environment offers opportunity for the right kinds of actions. The constraint is that, in order for significant change to occur in education, teachers need to learn new concepts and new skills; but, they can't abandon the school to learn them. In order to circumnavigate this constraint, I propose to design and facilitate activities (whole project learning approach) in such a way that the teacher can learn those new concepts and skills while he is teaching in the classroom.

In order to design and facilitate these kinds of activities, the teacher needs support not only from a group of colleagues, but also from local and distant tutors. Teaching is by nature a very isolated profession (Lortie, 1975; Goodland, 1984), and the innovations such as the one discussed in this thesis have the potential to intensify the feeling of isolation. To address this issue, this thesis suggests a knowledge network of distant and local tutors, who will support teachers at all times. This support will be not only on the technical and practical aspects of the project, but also on the theoretical aspects and ideas behind the work. Constant communication with local and distant tutors will help teachers identify areas where the project can be deepened and where further connections with powerful ideas (Papert, 1980) in mathematics, science, and social sciences can be explored. Several support channels should be established:

- Permanent email and instant messaging access.
- Conference calls with the teachers, and the support team. If there is connectivity, videoconferences can be coordinated instead of phone calls.
- Collaborative projects will be established with people who share similar interests, and who follow similar principles and philosophy. Support provided through these collaborations will allow sharing and refining ideas among the different

sites; discussing project issues among kids in different places; and combining these projects to overcome limitations in local solutions and to seize global aggregation.

The implementation depends on access to scarce resources such as the distant support team. However, my working hypothesis is that an extended network of teachers becomes self sustained as more teachers and local tutors join the network.

To illustrate the transformation suggested by the holistic model of a learning environment, envision the following scenario:

Martha, a teacher from a one-teacher school, sets out to engage students in the solution of problems about scarce resources in the community, such as water and electricity. She selects this topic because it is relevant to the community, and also because it could facilitate connections to powerful ideas.

There are 20 students at the school, from first to sixth grade, and every single one of them has his own computer laptop. The students are sitting now in the middle of the room, ready to listen to Martha's story. She introduces the topic to the students by reading an article she found in the library. The article tells the story of a city in which citizens did not pay attention to how they used the water they had. Now the city is about to run out of water and its citizens were very preoccupied about the future of the city and its people. After reading the story, she posts the following question: "How can we help them solve the problem they have?" The teacher guides the discussion towards finding solutions and by using examples of their own community to propose concrete projects.

Martha asks the students to work in groups. She lets them decided who they want to work with. Then, she asks them to think about one of the solutions they just discussed. For example, one of the ideas the students have is to measure the amount of water usage; then, predict how much water citizens consume over the course of one day. They propose to use

the information in an awareness campaign to convince people to save water.

Martha thinks that measuring water is a very good activity for the students to engage in, but she doesn't know how to introduce the activity to the students in a deeper way, so she decided to send an email to the list of local and distant tutors. They schedule a meeting on instant messenger.

Teachers face the challenge of establishing more connections with powerful ideas in mathematics, science, social sciences, as well as civil and human values. The problem of mathematics is particularly critical because of teachers' lack the understanding of the mathematical concepts and limited mathematical knowledge outside of the curriculum. Having students come up with their own ways to measure water usage introduces the use of arithmetic operations, such as multiplication. Multiplication is usually introduced as m times n , which refers to m sets of n things. Then children are confused when they see multiplication coming up in situations like:

$$\text{distance} = \text{speed times time.}$$

In the case of water usage, it can even get more confusing:

$$\text{quantity} = \text{rate of flow times time.}$$

Having the students come up with their own ways to measure quantities of water usage and representing it over time helps them construct their own understanding of a concept such as multiplication.

After the meeting with the tutors, Martha has concrete ideas of how to coach the students into making deeper connections to arithmetic operations and data representation. She then asks the students to design their own ways to estimate the quantity of wasted water and also show this over time. Students continue to work in their groups. They use their computer laptops to design their models. They also use the Internet to search for ideas. They decide the goals of the project, state their interests

and capabilities, and choose the tools they want to use. They meet with the teacher in order to document their progress and discuss the feasibility of the ideas.

For example, one of the groups designs the following system. It is a watermill with four containers –all the same size (see Figure 3). They use plastic containers and parts they have recycled at their house to build it.

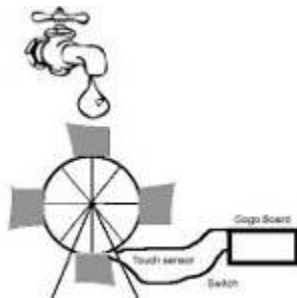


Figure 3. Water consumption measuring system

Students bring their computers home and continue to work on their designs. Carlos, a 12 year old child working on the watermill project shows his father the water measuring system they are building at school. His father becomes very interested in the project; he wants to participate. He happens to have the next day off, so Carlos asks him to come to the school. He arrives at the school the next morning with Carlos.

Carlos explains his ideas to the rest of the group. He proposes to use the robotics set to program a system that keeps track of the water usage. The idea is to use a touch sensor and a switch. The touch sensor activates the system: reset a timer and a counter for the number of containers used; and the switch detects every time a new container fills, so that the counter is incremented by one. Carlos' father doesn't really know how to use the robotics system, but the students help him, and, he helps them with building the system.

Students also collaborate among themselves. They work in projects and help each other as they need to. Two younger children working on the

project understand the idea behind the design and how the robotics set and the sensors work together, but they have a hard time writing a program that controls all of the components. Carlos spends time with them writing the program.

To represent the amount of water that runs over time, the group uses a measuring tape with increments of one minute (see Figure 4). They record the “wasting a new container” event on the tape to get a sense of the amount of water wasted over time.



Figure 4. Measuring tape

Students use their devices to measure the amount of water that they consume in the school bathroom. They use this information in their awareness campaign. A different group of students proposes a system to recycle and reuse grey waters at home (see Figure 5).

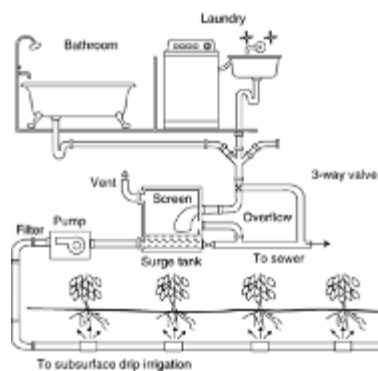


Figure 5. Water system

At the end of the session, students present their projects to other students in the class. Carlos’ father and a few other parents decide to join the presentation. Students reflect on the design process. Martha and parents ask questions. At the end, students document their projects with pictures they take with a digital camera and write their own reflections in their individual folder on their computer laptops.

In this scenario I have shown how students used their laptop computer to create projects that are of interest to them. They developed these projects not only in the context of the school, but also in the context of their lives, giving an opportunity for their parents to participate and become engaged with their learning. I have described how parents can participate in school activities as they want; they can not only contribute, but also learn by collaboration and working with their children on specific projects. I have also shown how teachers design and facilitate activities to engage students in concrete learning experiences. These experiences invited students to make connections to powerful ideas (such as multiplication) and also took into consideration their lives and interests. Finally, I have introduced the concept of the knowledge network of support by showing how the teacher can receive support from tutors regarding how to make deeper connections to mathematical concepts.

3 Implementation

“Significant educational change consists of changes in beliefs, teaching style, and materials, which can come about only through a process of personal development in a social context” (p. 124)

(Fullan 2001)

In order to understand and study the potential of the one-to-one computer infrastructure, a real change has to be implemented and studied. I chose to base the first effort in a rural one-teacher school not merely because such schools are both numerous in developing countries and typically associated with poor quality of teaching and learning, but primarily because they don't fit traditional models of education, and because they provide a fertile environment where technology can be present in sufficient quantity to constitute an computationally-rich environment; can be experienced as socially and personally relevant; can be linked to sources of social and cultural knowledge; and can be reinforced by a knowledge network of personal and intellectual support.

Building on the foundation in Constructionist computer work already in place in Costa Rica, I decided to work with a one-teacher school in this country over the course of one year. In the first sections of this chapter, I place special emphasis on the changes that occurred at the school as the activities and the proposed model were implemented. A primary focus of the work was to understand, prototype and communicate the “whole project learning” approach, which included activities of the scale and substance to general rich learning experiences, that crossed learning domains, and that make connections to powerful ideas. Further analysis and reflection of the transformation that occurred at the school is discussed in chapter 4 (stories of change) and chapter 5 (study of appropriation by students, teacher and parents). In the final sections of the chapter, I describe the evaluation methodology, and provide a brief description of the participants, especially the students.

3.1 The two ones: 1 laptop per student, and 1 teacher per school

The graded school has its origins in the Monitorial System, invented by Joseph Lancaster (Kaestle 1973). Lancaster developed an inexpensive method of education in a poor neighborhood in England known as the "monitorial system." His method promoted older students to teach the younger following strict set of rules, and routines. The Lancasterian system became popular because of economic cost, efficiency of instruction, discipline by routine, motivation by competition, and neutrality in religion. It was implemented not only in England, but throughout the world. Although the movement started to decline before Lancaster died in 1838, it is known as the "most important single development in education on an international scale in the first decades of the 19th century."

The monitorial system had positive aspects, such as the ability of an older student to help his peers, individualized student progress and immediate support; but it also had negative ones, such as the standardized procedures and routines, which still prevail in the traditional school (Miller 1995):

- Students of the same chronological age learning the same objectives.
- Students require the same amount of time, as in an academic year, to master predetermined content.
- Within the same grade level, students are expected to master pre-designed goals for all curricular areas at the same rate.

One-teacher schools, found in most rural areas, seem the best environment to challenge traditional school, because they do not fit these traditional models, and have characteristics that allow Constructionist principles to take hold: learners of different ages share the same physical space; family and community members are physically close, therefore, it is possible to take advantage of the community knowledge and expertise; teachers are more sensitive to what students know and are interested in; and the organization of physical space and time are flexible. Moreover, these schools are not merely typical of Latin America; such conditions exist globally. Providing compelling models for such situations has the potential to impact education on a global scale.

One-teacher schools offer an exceptional context within which to implement the holistic model throughout the entire school: the relatively small number of students, small physical space makes technology saturation possible at a reasonable cost, that is, where the aim is for a 1:1 student-to-computer ratio; makes it easier to foster connections between school and community, in particular students and their families; facilitates the ability to address teacher development issues; and, provides an environment where collaboration among children of all ages, work across different disciplines, and content relevant to the community evolve more naturally.

3.2 *The case of Costa Rica*

Latin American education presents a fertile ground for research and implementation of the model proposed in this thesis. Costa Rica, in particular, has a history of successful implementation and on-going support for computers in education. In 1988, Costa Rica took a bold step toward using computer technology to enhance its schools. The Costa Rican program of introducing computers into schools, and especially of providing support for teachers using these computers, places the country in the vanguard among Latin American countries (Rodrigues-Clare 2001; Fonseca 2005). The Omar Dengo Foundation, the institution that has implemented the computer initiative in Costa Rica, has created both in-service and computer-based training programs, which are conceived within a Constructionist philosophy (Anfossi and Fonseca 1999). In addition, the Foundation has established a support network of tutors who are teachers participating in the program, and a nationwide conference for children. Through these programs, Costa Rica has shown how to introduce a nationwide change that is both radical and sustainable, which gives the country a culture of educational innovation.

Costa Rica also presents a compelling case because of its number of rural schools, and its students. According to the Department of Statistics at the Ministry of Education in Costa Rica⁵, of the total number of schools in the country (4,026), 74.9 percent are rural schools (3,018) and 46.94 percent are one-teacher schools (1,890). Moreover, the total number of

⁵ According to the INEC (National Institute of Statistics and Census) and the United Nation population division, in 2005, Costa Rica had an estimated population of 4.24 million people; 979,418 of which are students (primary, secondary, and high school). The same organizations also reported that, in 2005, 38.3 percent of the entire population lived in rural areas.

students attending rural schools is close to 50 percent. This means that, like many other countries in the world, Costa Rica has close to 50 percent one-teacher schools; but, more importantly, they have small schools with two, three, and four teachers, that are located in rural areas, which constitutes nearly 50 percent of the students in the country. Expanding the collection of initial activities that can accommodate scrutiny of the curriculum framework, and using the knowledge network of support of the Omar Dengo Foundation, we have the potential of scaling up the experience to other rural school in the country.

The Omar Dengo Foundation has created several programs, which benefit children of rural and marginal urban populations of the public education system. For example, in 1999, the Foundation implemented a pilot program called Puentes (bridges) in collaboration with the Media Lab. This pilot program was implemented in 10 rural schools over the course of 4 years. It combined project-based learning, correlated planning, students as mediators, and the use of portfolios to document students' learning. The goal of the program was to study teachers' approach to use technology within the curriculum framework. Most of the elements of the program were implemented, but the Internet, which was going to be used to give support to the teachers. Some of the findings of the program are: teacher welcomed the students-mediator program⁶ as well as the use of portfolios; the majority of the teachers didn't have the knowledge to propose activities that integrate concepts from different disciplines and grades; students tended to develop short and superficial presentations, which get promoted as project-based learning.

The Omar Dengo Foundation implemented also the "computer in the classroom" program (Anfossi 2007), in rural school in Costa Rica. As part of the program, students learn to use Micromundos⁷ and other digital technologies, and follow the project-based methodology created by the Foundation, to design and build projects about different topics (Anfossi and Quesada 2005). Even though the methodology is oriented toward a global approach to the subjects and takes into account students' interests, the project-based work is an activity in itself; it doesn't get integrated with the regular school

⁶ This program has been implemented by the Foundation to support the teachers in the use of technology in the classroom.

⁷ I will be using Micromundos in the rest of the document. I want to make sure the readers understand that we used the Spanish version of the software.

activities. This program has been implemented in more than 100 one-teacher schools in the country, which were considered as possible schools for this research program.

With the support of a team of people from the Foundation, we determined the following four criteria for the selection of the school: 1) teacher's desire to participate in the program, 2) teacher's credibility with the members of the community, 3) teacher's technological fluency and willingness to innovate, and 4) school's location. We also reviewed the profiles of the schools, and selected five candidates, who I visited and interviewed at the schools. A teacher from one of the schools, El Silencio School, was invited to participate.

3.3 *El Silencio School*

The school is located in a small community, El Silencio. El Silencio is a rural community of approximately 117 residents⁸, located in Guanacaste, in the northwestern part of the country. The school was opened in 1964, a few years after the community was founded. The community received the name of El Silencio, which means silence; because it is located 10 kilometers away from the nearest town, and between mountains, so you can only hear the sound of the wind.

The main economic activity of the community is farming. A small percentage of families own milk farms and other residents work for them. Another economic activity is agriculture, the main produce being corn, banana, plantain, and sugarcane. Tomato, cilantro, radish, lemon, and guavas are also harvested. The community has the basic institutions: a school, a church, a community house with soccer field, a park, a health care facility, and a cemetery. All households have electricity and a private phone.

The community has 45 families, 12 of which participated in the project. A total of 15 children, first to sixth grade, participated in the program. At least one parent per household agreed to participate and get involved with the program. Most of these children had their mothers at home; only two of them stayed with their neighbors after they finished school. In the following section I give some information about each of the

⁸ There is more information about the community in Chapter 4.

students and the family members, who participated in the program. I also provide a brief description of the teacher and his experience both teaching and using technology.

Before the program started, the day was organized into four periods, each 45 minutes long. Preceding 1st period is an assembly period, where students sign the national hymn, pray, and sing or dance. Students are required to take math, science, social sciences, Spanish and agriculture. The physical space was very flexible; students had tables and chairs that they organized according to the activities. During regular academic activities, students gathered in groups according to grade and followed written instructions; the teacher walked around the room answering questions or giving further instructions. They sometimes engaged in group activities and projects.

The school had three computers. One of them was given to the school by Intel®'s Teach to the Future program (Intel), and the other two were given by the Educational Informatics program of The Omar Dengo Foundation. The school also received a printer, a scanner, and access to Internet from the same institution. In a survey conducted at the beginning of the program, the teacher reported that he mainly used the computer to plan and document his work. He used Word, PowerPoint, and Excel to prepare classes and reports. The children were using the computers as well. They used Word to write reports, PowerPoint to make presentations, Micromundos to make projects about different subjects, and Encarta to look for information. As part of the "computers in the classroom" program, students learn to use Micromundos and other digital technologies, and follow the project-based methodology created by the Foundation, to design and build projects about different topics.

3.3.1 Introducing the students and their families



Figure 6. Teachers and students at El Silencio School

I worked with an incredible and generous group of people over the course of one year. The teacher, the students, and their families were always (see Figure 6).

- Eduard

Gender: male

Grade: 1st

Family information: 2 adults and 2 children. Both parents finished primary school (6th grade).

Eduard was a self-confident and patriotic child. He was always interested in telling stories about the community and his family. During the program, he used a desktop computer, but he had a chance to use the computer laptop when he worked with other students at the school. I was impressed by how quickly he seemed to understand the technical aspects of the work, which he used pretty well to create his projects. He managed also to integrate his interests and the things he cared about into his projects.

He loved working on projects such as the Community, the National Campaign, and the Encounter of Cultures.

- Fernanda

Gender: female

Grade: 1st

Family information: 2 adults (grandparents) and 2 children. Grandparents finished primary school (6th grade). Her sister, Paula, is a 3rd grade student.

Fernanda was a very articulate girl. I was impressed by her reading and writing skills. During the research program, she used a desktop computer, but also had the opportunity to use the computer laptop at home with her sister, Paula, a third-grade student. At the beginning a lot of students avoided working with her, because Fernanda always wanted to take over the use of the computer. She was able to create small projects on her own, but she mostly worked on projects with other students at the school. Fernanda's mother was very involved with the school. She didn't really developed any particular activity with the children, but she visited the school constantly and observed dynamics of the class.

- Nicole

Gender: female

Grade: 1st

Family information: 2 adults and 4 children. Both parents finished primary school (6th grade).

Nicole was a very beautiful, shy girl. She had recently moved to the community, and seemed to be making an effort to fit in. She had very poor reading skills and felt uncomfortable reading in front of the class. During the program, she worked on the desktop computer, but during vacations she had the opportunity to work with the other students' laptops. She mainly did projects with her friends. She was always paying attention to the things I was doing, and trying to collaborate with me.

- Douglas

Gender: male

Grade: 2nd

Family information: 2 adults and 2 children. Both parents finished primary school (6th grade). There is a computer at the house; it belongs to his brother.

Douglas was a very energetic boy. He liked motorcycles and cars, and was very interested in playing outside. He was constantly distracted by his classmates, and became emotional every time the teacher reprimanded him. He enjoyed creating his own projects. He also enjoyed teaching his parents and his sister to use Micromundos to create simple projects.

- Mario

Gender: male

Grade: 2nd

Family information: 2 adults and 1 child. His father finished 4th grade and his mother finished 6th grade.

Mario was a very active boy. He liked to tell jokes and to make people laugh. He enjoyed playing outside with his friends. He seemed to enjoy school for social reasons, more than academic; he continuously ran into trouble with the teacher for not paying attention or following rules. He liked the computer, and felt very proud of what he had learned to do with it. His parents observed an immediate change in his motivation when we started the program.

- Carlos Wilson

Gender: male

Grade: 2nd grade student

Family information: 2 adults and 2 children. Both parents finished primary school (6th grade).

Carlos Wilson was a very quiet, shy, young boy. His family had recently moved to the community and he didn't seem to have many friends. He liked going to school, and interacting with his friends. He was completely in love with his new computer laptop. At the beginning of the program, he cried when he wasn't allowed to take his computer home. He enjoyed initiating projects about diverse topics; he actually was one of the students with the highest number of projects and folders, throughout the program. His projects weren't sophisticated, but most of them reflected the topic he wanted to explore.

- Jean Carlos

Gender: male

Grade: 3rd

Family information: 3 adults⁹ and 1 child. Both parents finished primary school (6th grade).

Jean Carlos was the sweetest boy at the school. He was very persistent; at the beginning of the program, his computer laptop had a virus, which made all his files disappear every time the computer was turned off. Every day, after having looked for his projects, he patiently started them over again. His mother reported how motivated he was with school, and how much he enjoyed working on his projects.

- Brandon

Gender: male

Grade: 3rd

Family information: 4 adults¹⁰ and 2 children. His father finished 4th grade and his mother finished primary school (6th grade). There is a computer at the house.

Brandon was a very bright and articulate boy. His family seemed to have high academic standards for him. He also liked getting attention; he was always the first to volunteer to present his projects to parents and guests, who came to visit the school.

⁹ Older siblings

¹⁰ Ibid.

He enjoyed working with the computer laptop. He had some previous experience programming Logo, so he very quickly started to program his own projects. He liked exploring the computer and changing the settings. He helped his friends with their projects, and also taught them how to change the computer settings. Brandon preferred working on his computer to writing on his notebook.

- Andrea

Gender: female

Grade: 3rd

Family information: 2 adults and 2 children. His father finished 3rd grade and his mother finished primary school (6th grade).

Andrea was a shy, soft-spoken girl. She has very good writing skills and liked to write about her own learning experience. She wrote about how scared she was the day the teacher told the students they were going to work with computers because she didn't know how to use it, and how much she liked working with her classmates. She was very interested in the computer, and made a very big effort to learn as much as other students, who had previous programming experience. She used to write the new commands she was learning in her small notebook. She has really benefited from the program. She is now designing and creating projects, both at school and at home. Like Nicole, Andrea spent a lot of time with me, hoping to get involved in what I was doing, no matter the nature of the activity.

- Paula

Gender: female

Grade: 3rd

Family information: 2 adults (grandparents) and 2 children. Grandparents finished primary school (6th grade). Her sister, Fernanda, was a 1st grade student.

Paula was a creative, articulate student. She was also very independent; she didn't care to be like any other student at the school, and enjoyed working by herself. She seemed to really enjoy learning. In her reflections about the program, she not only

writes about how much she has learned about Micromundos and the computer laptop, but also about learning other things. When referring to an activity in class, she says, “It is always good to learn something new.” Paula also liked drawing her own images and creating sophisticated animations. She created a large number of projects, both at school and at home.

- Fabian

Gender: male

Grade: 3rd

Family information: 2 adults and 3 children. Both parents finished primary school (6th grade). His brother, Byron, was a 5th grade student.

Fabian was a strong thinker. I also noticed Fabian’s great imagination and creativity. Even at the beginning of the program, he had concrete ideas of what he wanted to do with the technology; he wasn’t always able to create everything he imagined, but he wrote about them. Looking at his projects, I noticed Fabian liked creating games; he not only created games, but he also integrated game-like features into his projects. For example, in a project about a national celebration, he programmed a window to appear asking people to guess where a battle had happened and included a window message to congratulate you, if you clicked on the right province. Fabian was interested in exploring his computer, but he was also interested on using it to learn about many things. He was always looking for ways to improve his projects, by integrating information from different sources, including the Internet.

- Daniela

Gender: female

Grade: 4th

Family information: 2 adults and 2 children. Both parents finished primary school (6th grade). Her brother, Melvin, is a 6th grade student. There is a computer at the house.

Daniela was a leader at the school. She was a very good athlete, who participated in local and national competitions. She liked to be surrounded by her friends, but she

always complained about being the only student in 4th grade. One of the things she enjoyed about the program was the fact that she was able to work with other students. At the beginning, I thought Daniela's excitement about the program didn't go beyond the fact that she had her own computer laptop, but as I got to know her better I learned that she could be passionate about the things she was interested in doing. I worked on a particular project with Daniela; we were having trouble trying to build a device to measure the size of the school. We spent the entire day building and testing, and building again, until we got the results we wanted. It was inspiring to see such dedication.

- Byron

Gender: male

Grade: 5th

Family information: 2 adults and 3 children. Both parents finished primary school (6th grade). His brother, Fabian, is a 3rd grade student.

Byron was a quiet boy. He hardly volunteered to participate in any activity, especially if it involved him talking or performing in front of the class. At the beginning, he didn't seem to remember much of what he had "learned" at school. Other students mentioned concepts that were familiar to them, but every time I asked Byron, he didn't seem to remember. I also noticed that many times he asked for help on a particular thing I had just explained. As time passed, I started to see a big change in Byron. He became really interested in certain aspects of the technology, and he found his own way of doing things. He didn't seem as interested in programming, but he liked other aspects of the technology. He liked downloading information, especially music. His projects had a lot of animations and sound effects.

- Meryanne

Gender: female

Grade: 5th

Family information: 2 adults and 2 children. Her father finished primary school (6th grade) and her mother finished high school. There is a computer at the house.

Meryanne was a very talented girl. She was very quiet at the school, but she was fluent when she wrote and reflected about the program. I was fascinated reading her reflections about the program. She described in detail many differences in the way they were learning before and after the program. She also wrote about how she noticed other students' interest in learning.

Meryanne was taken out of the school for a few weeks. Her mother moved temporarily to a different community a few kilometers away, and took Meryanne to a different school. She almost drove her mother crazy, to the point that her mother decided to send her back to the community and asked one of the neighbors to take care of her. The mother was concerned because Meryanne refused to go to a different school, and she only had one more year at the school before she had to go to secondary school. Meryanne's mother worried that her daughter wasn't going to be prepared for the transition. Quite the contrary; Meryanne used the computer in a fluent way, to explore and learn about many things. I would not be surprised to learn that she was more prepared than most of the students in the region.

- Melvin

Gender: male

Grade: 6th

Family information: 2 adults and 2 children. Both parents finished primary school (6th grade). His sister, Daniela, is a 5th grade student. There is a computer at the house.

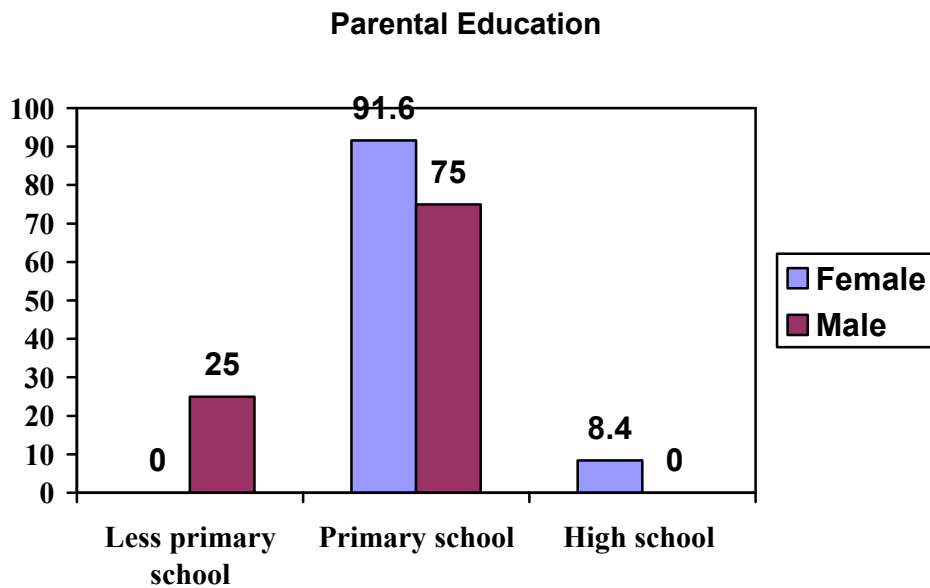
Melvin was a very generous and intelligent boy. He was the only sixth grade student at the school, but he interacted with every student at the school. Melvin was always helping other students at the school. They even called him after school asking for his help. He had programmed Logo before, so he learned the new Micromundos programming environment very quickly. He was very organized. From the beginning, he organized all his information in folders and gave his projects very intuitive names.

He graduated and moved to secondary school in the middle of the program. At the beginning, he had a hard time adjusting to the new way of doing things. He was comfortable in the small and familiar environment of the one-teacher school. I visited his new school once during the computer class. I noticed how his classmates had started to recognize Melvin's skills. I watching him help his classmates, the same way he was doing before. He was as generous with his time and his knowledge as ever and more.

To summarize,

- A total of 15 students participated in the program: 3 in first grade, 3 in second grade, 5 in third grade, 1 in fourth grade, 2 in fifth grade, and 1 in sixth grade. Of the total number of students, 9 are boys and 6 are girls.
- A total of 12 families participated in the program¹¹.
- 3 families had a computer at home before the program started.
- Most of the families own their houses, and have lived at the community for more than 25 years.
- There weren't significant differences in the level of education of the parents, who participated in the program. On average, mothers had completed a higher level of education than fathers (see chart below). Of the 12 mothers, 11 had finished primary school and 1 had finish high school; and of the fathers, 9 had finished primary school, 1 had finished 4th grade, and 1 had finished 3rd grade.

¹¹ Three of the families who participated in the program had two children at the School.



3.3.2 Introducing the teacher

A young, innovative, and caring individual, Edgar had been teaching for more than 11 years. Teaching was a tradition in Edgar’s family. His father, his sisters, and many other family members had been teachers, and he seemed very proud to have followed their path. He started teaching at El Silencio School in 2000, and he had gained the trust and respect of the community. He lived in the nearest town, Tilaran, and commuted to El Silencio every day, using his private car. I was impressed by his patriotic values, and by the way he promoted those in school. He respected students’ opinions and fomented healthy discussions about relevant issues.

Edgar had previous experience working with the computer. He had knowledge about Microsoft Office tools and also with Micromundos, which he gained by participating in Intel®’s Teach to the Future program (Intel), and the Educational Informatics program of The Omar Dengo Foundation. He was part of a group of one-teacher-school teachers, who had been working closely with the Ministry of Education on the design and formulation of the new curriculum framework for one-teacher schools in the country. He was well respected by the authorities at the Ministry and by his colleagues.

Edgar was so confident about the program that it made me nervous. I remember at the beginning, he didn't seem to have questions or need support; he would just listen to me or observe me teaching the students. As I was leaving after my first visit, I kept thinking he was either too confident or he was ready to go back to the "normal" way of doing things. He proved me wrong. Indeed, he was capable of carrying out innovations, and was open to receiving advice and recommendations about how to do things better. In my opinion, Edgar's nationalistic values and respect for authority kept him from further developing the program. I found he needed the endorsement of the people he worked with, in order to continue to take the ideas further.

Edgar was a wonderful colleague, who I respect and admire. He made significant adjustments to practice, by encouraging the students to use technology to learn about other things, by learning with the students, and by taking into account students' interest.

3.4 The process of transformation of the school

Several changes or adjustments were proposed and implemented at the school as part of the program, which involved the learning space, the tools, the content, and the teacher development and support strategy. First, preparation work was done with the teacher, Ministry of Education and the Omar Dengo Foundation. I came with the idea of developing new content based on the interests and lives of the students, but the Ministry of Education, and even the teacher, recommended me to use the current curriculum framework. The teacher knew that he still had to work with other teachers in the area, and it was important for him to be able to relate to them in terms of the current framework. I supported the idea. I knew how important it was for him to remain connected with other teachers in the area, and also knew that the themes for the framework's units were selected by the teachers themselves under the supervision of the ministry of Education.

Costa Rica curriculum framework is organized in thematic units (i.e., human body, energy, environment, etc.), which include the concepts of the different disciplines. The teachers are in charge of designing activities for each grade level and also discipline (math, science, social sciences, Spanish, and agriculture), keeping in mind the topic of the thematic unit. I proposed to use the curriculum framework as starting point to design the

new content. As described in Chapter 2, this new content consists of activities organized by topics that integrate powerful ideas in math, science, and social science; and integrated students’ interests and lives. The people from the Ministry of Education, the teacher and the team from the Omar Dengo Foundation welcome the idea. We even created a form to document the activities and to make explicit the different concepts learned during the activities (see Table 2).

Table 2. Activities template

<u>Topic:</u> My Community	<u>Grades:</u>
<u>Concepts:</u>	<u>Goals:</u>
<i>Mathematics:</i>	<u>Description:</u>
<i>Science:</i>	<i>Activity1</i>
<i>Spanish:</i>	<i>Activity 2</i>
<i>Social Studies:</i>	<u>Evaluation:</u>

Second, the first day of the program, every student from second to sixth grade received a laptop computer, and every student in first grade was assigned one of the desktop computers available at the school.¹² All of the computer laptops and desktops were given to the students with wireless capabilities, Encarta, and Microsoft Office. We also gave each of the students with laptop computers, an external mouse, in case they couldn’t use

¹² Intel® donated fifteen used laptop computers for the project. A technician from the Omar Dengo Foundation was able to repair twelve of the laptops, which were sent to the school.

the touchpad. Two different construction toolkits were introduced: Micromundos¹³ (Microworlds) and GoGo boards. Micromundos is a Logo-based construction kit that makes the process of creating a project a rich, learning experience. By allowing children to program their own simulations, games and videos, Micromundos fosters the development of problem-solving strategies, critical thinking skills and creativity. Similar kinds of constructionist toolkits are the GoGo boards (Sipitakiat, Blikstein et al. 2004), which are tiny, portable computers that can be used to build all sorts of artifacts and program them to interact with the world through sensors and motors. Both construction toolkits, Microworlds and GoGo boards, were designed to build a great variety of different kinds of projects and to support different learning styles (Turkle and Papert 1990).

And, finally, I introduced the whole-project learning approach to the teacher and the students at the school. First, I facilitated a practical experience by providing content in the form of activities, developing them with the students, and designing new activities together with the teacher. And, second, I coordinated and provided support with the help and advice of a knowledge network of distant tutors from MIT and from the Omar Dengo Foundation team. We provided support not only for the technical and practical aspects of the project, but also for the theoretical aspects and ideas behind the work. The teacher participated in the whole process as a learner of new ideas, as an observer of new approaches, and as a facilitator of new ways of learning and doing things. My role was to act as mediator of the whole experience. The process can be summarized in three moments, which did not happen on a chronological order, as follow:

- Demonstration stage: I took the role of the teacher, designing and facilitating activities. The main idea was to demonstrate the new methodology as I worked with the students in the classroom, and to gain the trust of the teacher by being able to work in his environment, introducing and maintaining a very different way of doing things at the school. During this particular time, I spent time interacting with the teacher, the students, and the families. The teacher was there with me to support and help, but he was mostly an observer.

¹³ In the rest of the document I will be using Micromundos, instead of Microworlds to reflect that we used the Spanish version of the software.

- Collaboration stage: I designed the activities, but I wasn't always there to facilitate the work. In fact, I intentionally planned to not be at the school all the time to give the teacher room to develop his independence. I tried to get the teacher involved as much as possible by encouraging him to facilitate activities and incorporate changes according to his needs and interests.
- Supported development stage: the teacher was expected designs and develops his own activities in the classroom, with the help and support from distant and local tutors on the knowledge network. The main goal was to allow the teacher to face and deal with every aspects of the program. It was also a good exercise to prove the concept of the knowledge network of local and distant tutors as a way to support and build the capacity of the teacher. Due to delays in the installation of broadband Internet service, it wasn't possible to maintain good communication with the teacher, but it finally happened during the second semester. This stage was very difficult for the teacher. It was a very big change in physical presence and support.

In order to show the interaction of the elements during the implementation, I provide a concrete and detailed example of the “whole projects learning” promoted on this thesis. This will give the reader a very good idea of the nature of the activities proposed, which integrate concepts from different disciplines and encourage multiple representations (Sipitakiat 2007); the process I facilitated and promoted in the classroom; and, the role of the knowledge network of support.

3.4.1 Topic: My community

The first collection of activities I design and developed with the students was about the community of El Silencio. The goal of this activity was to explore and learn about the community. This activity is important because it allows students to make connections with their every day lives. It encourages the students to investigate and learn about their community, while building models and using a variety of resources. In the process of building models, the students observe and tell a story, imagine how to represent the community in 2 and 3 dimensions, invent ways to measure the size of the community, among other things.

- A story of the community

I introduced the activity by asking the students about their community. They remembered some fact, but they weren't able to tell a coherent story. They also didn't know in detail the history of how the community was created, so I posed the question, "what would you tell a visitor about your community?"

We¹⁴ started by asking them to write a story about their community. They had to interview their families about the history of the community, its origins, and its population, and to write stories about what they learned. The following day, students read their stories in class. When students started to read the stories, we realized that even though the stories sounded very similar, they talked about different aspects of the community. We decided to make a list of things we learned together about the community.

- Create a map using pencil and paper

I asked the students to think about things that we could give people who visit the community, in addition to historical background. For example, tourists who travel the world visit and gather information about the places they go. What other information would a visitor need when traveling to a new place? The students suggested a map of the community, and we started to think about what we needed in order to make one. Some of the students said that in order to make a map, you need to know where things are located.

We introduced the concept of cardinal directions. Students talked about ways to tell directions, such as using the sunrise as reference since it always happens in the east; they also mentioned the cardinal rose on the map of Costa Rica. I gave every student a compass to play with and showed them how to use it. I asked them to use pencil and paper to draw their own maps of the community. As students drew their maps, they kept going outside to verify that things were actually in the place they had imagined.

¹⁴ From this point on, I start to use "we" and "I" almost interchangeably, as I try to reflect the work and support from a team of people, including the teacher, the Omar Dengo Foundation group, and my research group at the MIT Media Lab. I use "I" to emphasize my thinking and the work that I explicitly facilitated.

When they finished their maps, we put them on the floor and we started a discussion. Students drew very different maps of their community. For example, Fernanda, a first-grade student drew a partial map of the community (see Figure 7). She drew big houses, so the paper she had was too small to include everything in the community. Melvin, a sixth-grade student drew a more precise map of the community (see Figure 8). He included the houses and the different institutions in the community.

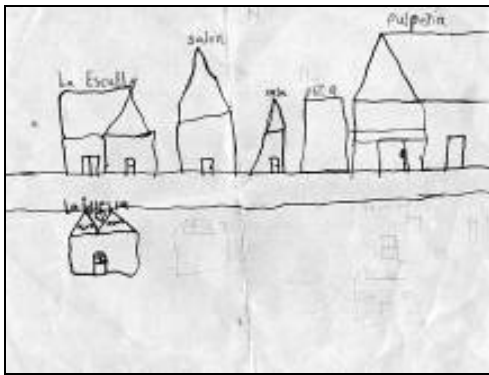


Figure 7. Community map by Fernanda, a first-grade student

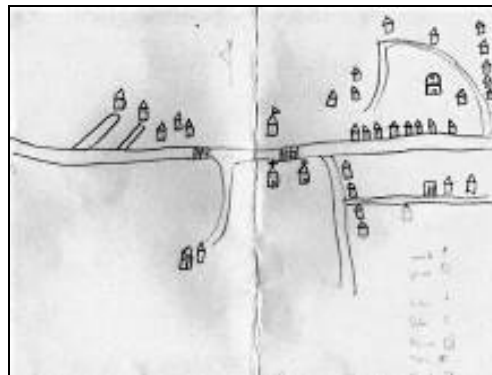


Figure 8. Community Map by Melvin, a sixth-grade student

Byron, a fifth-grade student, drew a very different map (see Figure 9). His map was correct, but the direction of the page didn't correspond to the direction north of the cardinal point. When we asked him why he drew the map the way he did he said, "I started my map thinking about the houses you see as you drive into the community." His strategy worked for him, as he created a useful map of the community.



Figure 9. Community map by a Byron, a fifth-grade student

We ended this first component of the activity by reviewing some useful strategies students had used to create their maps. We tried to emphasize the good strategies students came up with, and to suggest suitable ways to do things when appropriate. We wanted to emphasize with this first component that there are many ways to do things, and that we can all learn from what others do, even if they don't do things well from the beginning.

- Build a map of the community using Micromundos

Students started more elaborate maps using Micromundos. As they worked on their maps, they researched different aspects of the community, such as communication, transportation and recreation resources, fauna, vegetation, and so on, which they incorporated into their projects. To reinforce the concept of cardinal directions, students included people in their projects and programmed them to move between different locations. It was important to allow every student to make the connection between a new concept, such orientation and the cardinal points, using the something concrete, such as their own maps of the community, and their bodies. Papert describes this process as "syntonic learning" (Papert 1980), an important powerful idea integrated in Micromundos.

The following images show two different maps created by students at the school. The first, a map created by Eduard, a first-grade student (see Figure 10). He incorporated into his map the things he had learned about the community, its institutions and transportation, among other things.



Figure 10. Micromundos map by Eduard, a first-grade student

A second project was created by Paula, a third-grade student (see Figure 11). She incorporated some information about the community on her map, and she added a map legend, indicating the things she included on her map. She also created a separate page in her project listing mass communication services available in the community, and another one for transportation services.



Figure 11. Micromundos map by Paula, a third-grade student

Both of these samples show how students created projects and integrated information in very different ways.

- Physical model of the community

Building a physical model adds an important dimension to the students' learning experience and contributes to the acquisition of powerful ideas. As Papert says it (Papert 2002), "what gives the idea a high rating in a more intellectual dimension of idea power is the diversity of its connections." By making a physical model of the community students made connections to powerful ideas, such as scaling, converting measurements units, and so on. The technology, in this case the GoGo board, becomes a tool that facilitates such connections.

We chose a map created by one of the students as the example from which to build the physical model. We started to discuss strategies to create the physical map (see Figure 12). When I mentioned that we needed to create a map at scale, one of the students mentioned a scale factor he had noticed in the map of Costa Rica and he was wondering if we needed to create a scale factor for our map. I said it was exactly what we needed and explained that it represented the relationship between the size of the real community and the size of the wood sheet we were using to build the model. The biggest challenge was to measure the community.



Figure 12. Students working on physical model of the Community

Several students became interested in the issue, especially the students from third to sixth-grade. We talked about different strategies to measure the community. One student suggested walking and counting steps, and then measuring the steps to calculate and the approximate size; another student suggested using a metric tape, but he also said it was going to take a lot of time to finish. I asked if they knew cars had a device to measure speed and what the 50 kilometers per hour means. The students paused for a while and then said, “that the car is traveling 50 kilometers in an hour, so we could use a car to measure the distance.” I told them it was a great idea, but since the roads are very curvy and not paved, the car wouldn’t go at the same speed, so it would be difficult to calculate the distance.

I suggested using a bike to measure the distance. I explained that if we knew how many times the wheel of the bike rotated from beginning to end, we could find out the distance it traveled. Melvin, the sixth grade student said, “I know how to measure it; I learned the formula, π^2 , to measure the circle!” I told him it wasn’t the circle we wanted to measure, but the perimeter of the wheel. I told him we could use the formula, and we could also measure the actual perimeter of the wheel. I explained that we could think about the wheel as a measuring tape if we cut it and stretched it

over the floor¹⁵. This was a revelation for them; the whole idea of counting the revolutions made more sense then.

I showed them a magnetic sensor, which we could use to count the revolutions. We built a contraption using the GoGo board and the sensor, and attached it to the wheel of one of the students' bikes (see Figures 13 and 14). We wrote the program to keep track of the revolutions:

```
to count-rev
  resetdp
  make "rev 0
  forever [ if (sensor1 = 0) [make "rev :rev + 1 record :rev beep]]
end
```



Figure 13. Student ready to measure distance



Figure 14. Magnetic sensor installed on bicycle

We were able to calculate the size of the community using the number of revolutions we downloaded from the GoGo Board, which was 2133. First, we calculated the circumference of the wheel,

$$\text{Circumference} = \pi \times \text{diameter}$$

¹⁵ I actually explained to the students that you can find the value of $\pi = 3.14$ by stretching a circle of radius = 1, which is how the formula of circumference came about.

Circumference = $3.14 \times 24 \text{ centimeter} = 75.36 \text{ centimeters}$, which is approximately .75 meters. We had to convert the value of the circumference to meters because we knew that the size of the wood sheet was 4.5 meters, and we needed to have all the values in the same unit to be able to complete the mathematical calculations.

Second, we calculated the size of the community:

$$\text{Land's size} = \text{circumference of the wheel} \times \text{revolutions}$$

$$\text{Land's size} = .75 \text{ meters} \times 2133 = 1599.75 \text{ meters}$$

And finally, we calculated the scale factor:

$$\text{Scale factor} = \text{size of the community} / \text{size of the wood sheet}$$

$$\text{Scale factor} = 1599.75 \text{ meters} / 4.5 \text{ meters} = 355.5$$

All the students measured their houses and used the factor to calculate the new size; older students helped the younger ones to calculate the new size. We reached a critical moment when the students started to build the houses to scale; students thought their houses were too small and became very disappointed. For example, Mario, a second-grade student, had measured the size of his house, which was 10 by 8 meters long. At scale, his house became 2.8 by 2.25 centimeters long. We started to think about ways to solve the problem. When I looked at the layout the students had started to create, I noticed that there was a house far east of the community, and nothing in between the house and the center of the community, where most houses were. This house belonged to Maryanne, one of the fifth-grade students. Students talked about not including the east part of the community, which included only her house, to make the model a lot bigger. Maryanne did not welcome the idea, but suggested leaving the map's layout as it was, and making only the houses bigger. I pointed out that it wasn't going to work because houses were going to be too big to fit in the same space. I proposed a solution that included both of their ideas. I remembered that Costa Rica has an island, Coco Island, on the Pacific Ocean, far away from the mainland. On the map of Costa Rica, Coco Island appears in a small window at the bottom of the map. I proposed to make Maryanne's house a Coco Island house. Students loved the idea, especially Maryanne; she not only felt

included, but she also felt very important. We then built the rest of the houses using the factor 178, instead of 355.

As soon as I got back from the trip I met with Seymour Papert and David Cavallo to report on the trip. I told them the details of the Community activity. As I described the process of building the houses at scale, I told them we had decided to make the houses the same height, using the school's height as a reference; since all the houses at the community are ranch style, we just decided to do that. Seymour immediately said, "you could have used angles to calculate the size of the wall" (see Figure 15). In fact, this would have been a great opportunity to use a right triangle to calculate the height, but I felt the students were getting anxious to finish their community project. This kind of communications with the distant experts provided me with the support needed to create richer learning opportunities for the students.

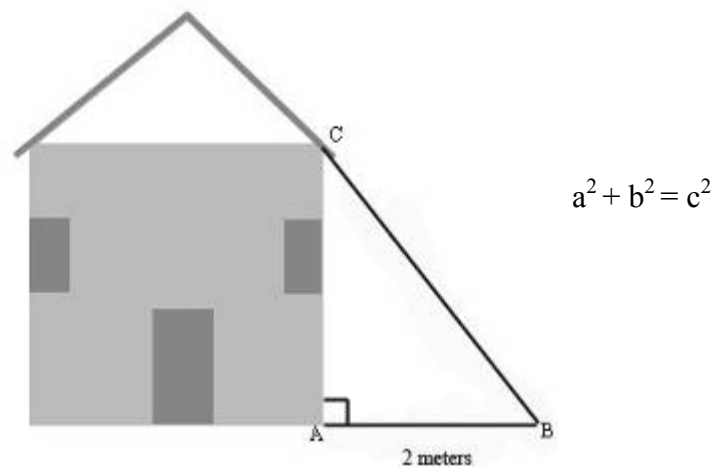


Figure 15. House's height

The students created groups to work on different aspects of the project: some children drew the layout of the community, and others focused on finding the materials to build houses, roads, grass, etc. A group of students built the rest of the houses in the community, all the same size; some students cut the cardboard, others glued the pieces, others painted, and so on.

Perhaps the most critical part of the process, was locating the houses on the map. We could have measured the real distance between houses and scaled it, but I thought it wasn't going to add anything to the experience that they already had. I decided to let the students figure out the location of the houses by negotiating and making decisions as a group. In fact, the students discussed and argued about house location, especially when they moved somebody else's house. We had to moderate the discussion to make sure they had a reasonable conversation while rearranging their houses and other things in the community. We heard things such as, "remember we were playing football that day and the ball went to the back of the community center, and my house was just there?" Students even went outside to look at their houses and to confirm that it was actually facing a certain way.



Figure 16. Physical model of the community

The last things that they incorporated into the project were an alarm system for the school, and the public street lights. The students really wanted to work with the Robotics set, so I helped them get started. We designed and built an alarm system for the school, and automatic street lights, controlled by light sensors. After a hectic week of hard work, we finished the model (see Figure 16). I knew there were opportunities for deeper learning, but I felt that the students were getting tired and ready to move to the next project.

We had a final discussion with the students. The students commented on how much they had enjoyed the work. They really liked working and building the community

together. It was very nice to hear comments such as, “I can’t believe we have so many things in our community; I thought it was so small, but it doesn’t look small at all.” This was a great project for all of us.

3.4.2 Topic: Solar System

The goal of the activity was to learn about the solar system by investigating and learning about the planets, their movement, and location. As you will see, this activity integrates concepts from different disciplines, and encourages students to use multiple representations of the phenomena. I designed this activity, and I was at the school during the beginning and end of its development. We picked the topic not only because it was part of the curriculum framework of the Costa Rica, but also because there is a lot of controversy about misconceptions regarding the seasons, the phases of the moon and the relation between planets and the sun.

- Opportunities to develop their own theories about the phenomena

First, we assessed the students’ understanding and knowledge of the Solar System. We allowed them to present their own theories about how the solar system works. We asked the students to tell us what they knew about the Solar System. First, they wrote short paragraphs using pencil and paper, and then, we asked them to create a working model of what they had written, using Micromundos. After they finished their models, we asked them to reflect and tell others about what they did.

Student projects and comments made it clear that they did not understand how the sun and planets stand in relation to each other. They created models that looked very similar to the Solar System, but when they explained them to the rest of the students, the ideas were different. For example, in a project created by a third grade student, the sun is at the center and the nine planets are around it¹⁶ (see Figure 17). In the text box he wrote (and also said when he talked about his project), “the sun revolves around the planets.” Even though the picture of the solar system was accurate, his explanation of how the sun revolves around the planets came from his observation of

¹⁶ At the time we used this Solar System activity at the school, Pluto was still considered the ninth planet in the Solar System.

the sun moving across the sky. He didn't incorporate any movement in his project, so we knew we had to address that, as well as the fact that he needed to better understand the solar system.

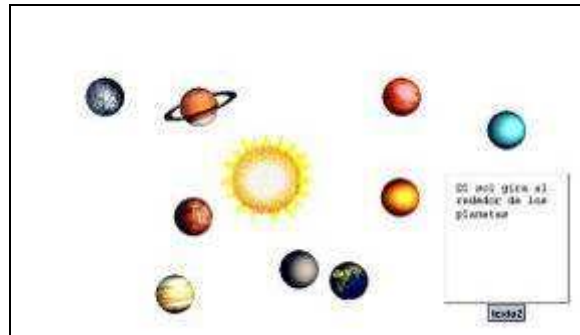


Figure 17. Solar system project by a third-grade student

Other students had a better understanding of the solar system, but they didn't know the technology well enough to represent their ideas. For example, a project created by another sixth grade student shows the sun, the earth, and the moon. The student wrote the following text at bottom of the page, "the moon is a natural satellite illuminated by the sun, thus can illuminate the earth" (see Figure 18). He was right about the moon being illuminated by the sun, and reflecting this light onto the earth, but he also didn't have a clear understanding of how the sun and the planets move in the solar system. He wrote in a text box at the right side of the page, "the moon and the sun revolve around the earth."

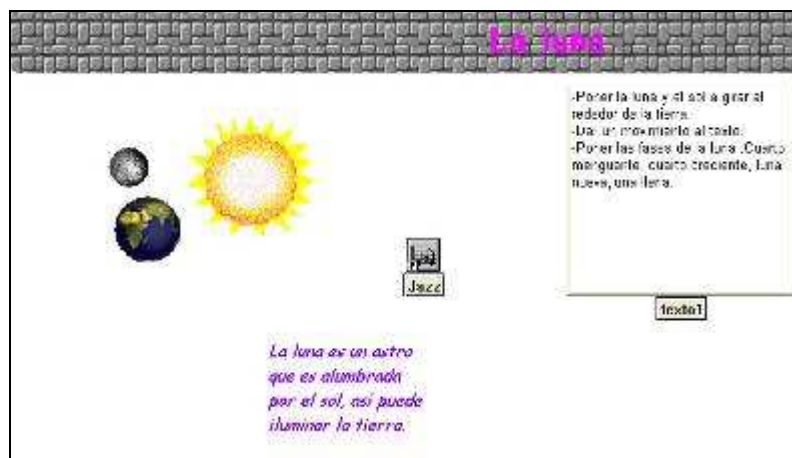


Figure 18. Solar system project by a sixth-grade student

The same kind of misconceptions about the solar system and the limited knowledge of Micromundos became evident when looking at the projects students created and by asking them to reflect on what they did. We then planned the rest of the activities based on these findings, which were facilitated by the teacher and one of the tutors from the Omar Dengo foundation. We didn't want to disqualify their projects and the information they had provided, but through the activities we facilitated a new understanding of the phenomena.

- Focusing on movement

The teacher and the tutor asked the students to use the available resources to investigate the solar system, and write a report. They started to guide the students' thinking by asking them to focus on the planets' location and movement.

They also asked the students to begin new projects in Micromundos to incorporate all of the knowledge that they were acquiring. They began by getting the students started with turtle geometry¹⁷. Turtle geometry is usually introduced to the students by asking them to use the commands *forward* and *right* to draw a line, until they've learned to draw a square (see Figure 19).

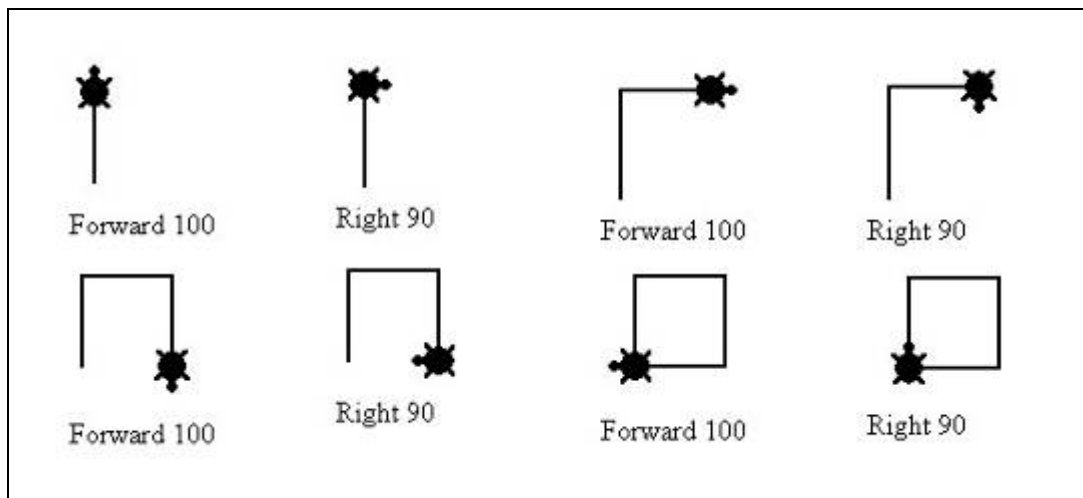


Figure 19. Turtle geometry, square

¹⁷ You can find more information about turtle geometry at the Logo Foundation website <http://el.media.mit.edu/logo-foundation/logo/turtle.html>

After that, you introduced the idea of teaching the turtle new actions. For example, you can teach the turtle to draw a square by writing,

```
To square
  Forward 100
  Right 90
  Forward 100
  Right 90
  Forward 100
  Right 90
  Forward 100
  Right 90
```

```
End
```

You can suggest that they simplify the procedure by teaching them the command *repeat*. In the *square* procedure, the commands *forward* and *right* are used four times, which correspond to the number of sides on the square. The new procedure would look like this:

```
To square
  Repeat 4 [Forward 100 Right 90]
End
```

You can continue playing with the number of sides and how much the turtle turns each time. You can ask the students to modify their initial procedure to draw a hexagon or octagon, until you get them to draw a circle (see Figure 20).

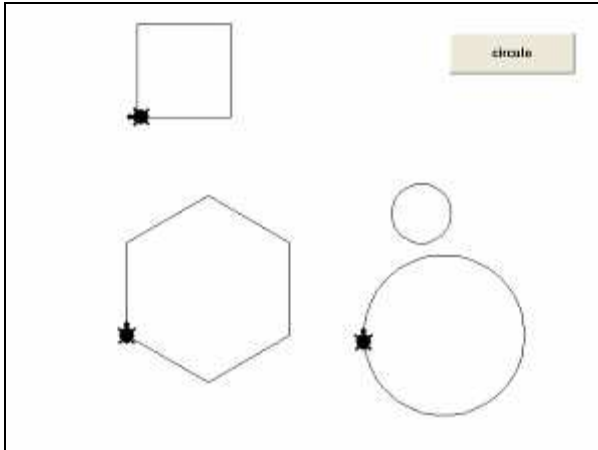


Figure 20. Playing with geometric shapes

```

To hexagon
Repeat 6 [Forward 100 Right 60]
End
To circle
Repeat 36 [Forward 10 Right 10]
End
  
```

The key is getting the turtle to return to its initial position, which takes 360 counts (degrees). Once the students get familiar with the geometry, they can start incorporating the movement of the planets around the sun (see Figure 21). You can also encourage them to program the planets to revolve around the sun in an elliptical orbit (see Figure 22).

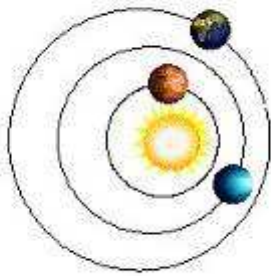


Figure 21. Circular orbit

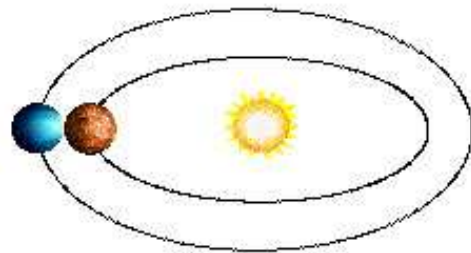


Figure 22. Elliptical orbit

The teacher and the tutor from the Omar Dengo Foundation followed the turtle geometry section relatively closely, and helped the students to incorporate the knowledge into their projects. To complement the experience, I suggested the NASA

simulator¹⁸, which the students can use to observe the movement of the planets around the sun (see Figure 23). They couldn't use the website often because the school had limited access to the Internet at that time.



Figure 23. View of the Solar System from NASA simulator

- Other planets in the solar system

Rather than providing them with the information about the Solar System, the teacher and the tutor from the Omar Dengo Foundation encouraged the students to do their own investigation about the planets. The idea was to have students become independent by looking and incorporating information in their projects the way they wanted. They asked them to use any available resource to find interesting facts about the planets, and to incorporate that into their projects. On the report they sent to me they wrote, “Individually, the children represented the Solar System in Micromundos; the majority managed to include the Sun, the nine planets, and their orbits; they also linked several pages using buttons; and, a few decided to make a page for each planet.” In fact, most of the students had created a separate page to include the information they had gathered (see Figure 24). Others had created a page with information for several planets. For example, Melvin, a sixth grade student, created a page with information about planets Earth, Mars, and Jupiter (see Figure 25). In the text boxes he wrote, “The Earth is the only planet that has water and oxygen; Mars is

¹⁸<http://space.jpl.nasa.gov/>

known as the red planet because its surface is cover by carbon dioxide; and Jupiter is the biggest planet in the Solar System, it has rings like Saturn and its surface isn't solid.” The interesting part about this last project is that Melvin included in his own words the most significant information about each planet.



Figure 24. Planet Earth



Figure 25. Information about the Planets

- Solar system role play

The goal is to facilitate a hands-on activity in which the students experience the movement of the planets around the sun. Students take turns representing the sun, the earth, the moon, and other planets in the solar system. Students learn how the planets moved by playing a planet, and moving their bodies as the planet would. Seymour Papert calls this connection between the body and the object you represent, “body syntonicity,” the idea of understanding how some external object works by thinking about your own body (Papert 1980).

The teacher can also have the students experience day, night, and the phases of the moon, by darkening the room and using a light to represent the sun (see Figure 26).

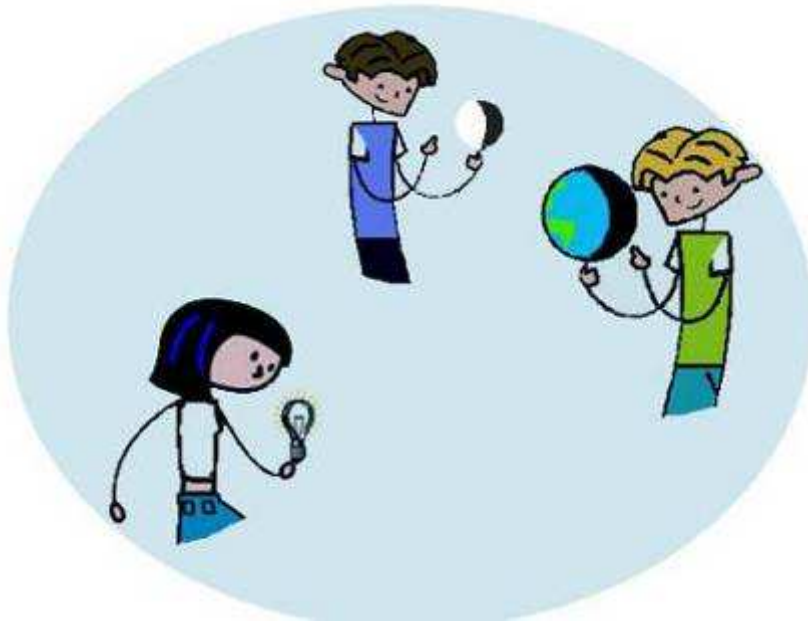


Figure 26. Solar System role play

On the report I got from the teacher and the tutor from the Omar Dengo Foundation, they wrote, “we used a sphere, a light bulb, and a white Styrofoam ball to represent the movements of the sun, the earth, and the moon. The students became aware of how the position of the sun and the earth makes the day and night, and they talked about the importance of the sun to tell time.”

Another important piece of information I got on the report was that the students had taken the computers home for the first time. The teacher and the tutor wrote in their report, “we gave students the opportunity to take the laptop computers home to develop further their projects. After all the recommendations we gave them, they went home feeling very excited! In the evening, there were no children in the streets, all of them were home working with the computers. They really made progress with their projects; they researched ways in which the Earth benefits from the sun, and about the structure of the Earth.” I was very happy to hear that the students were finally taking the computers home, and I was looking forward to seeing what they were doing with the computers at home. This moment is important for the program because it is at this moment in time when learning enters the home environment and parents start to get involved with their children’s learning processes.

They also reported that the students integrated the knowledge that they acquired into their Micromundos projects. They sent me several student projects. One project in particular, by a sixth grade student, caught my attention. Melvin was trying to incorporate the movement of both, the Earth and the moon, into his project (see Figure 27).



Figure 27. Moon revolves around the Earth

He started by making both, the Earth and the moon rotate in a circular orbit. He had written,

repeat 360 [forward 0.6 right 1 wait 0.5], for the moon orbit, and,

repeat 360 [forward 1 right 1 wait 0.2], for the Earth orbit.

If the Earth wasn't moving, the moon revolved around it in a perfect circular orbit (see Figure 28); but, the Earth was also supposed to revolve around the sun. By the time I looked at these projects, I was preparing for my next visit to the school, so I had the opportunity to help Melvin pursue his idea. We used pencil and paper to draw the orbit, and tinkered with the commands until we programmed something close to what we initially imagined. We included the following commands in his project:

repeat 90 [forward 1.5 left 2 wait 0.001] left 120, for the moon orbit around the Earth, and, repeat 180 [forward 2 right 2 wait 0.6], for the Earth's orbit around the sun (see Figure 29).

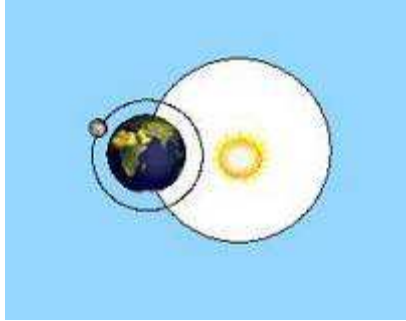


Figure 28. Moon revolving around the Earth

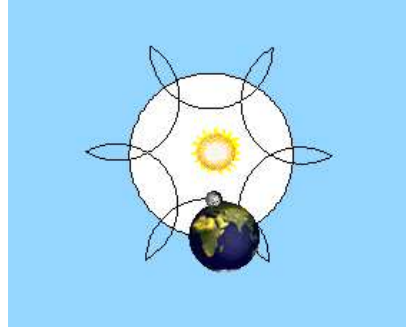


Figure 29. Moon, Earth and Sun

It is important here to emphasize that we didn't create an accurate representation of the real phenomena. You often face this kind of tension, and making a decision about what is best for the student in the longer term. It was clear to me that the students had understood the phenomena, even before he was trying to represent it using Micromundos. We spent a considerable amount of time working on this particular aspect of his project that he was happy getting this far. I did not want to impose or force him to keep working on it.

Students presented the projects that they had developed. Most of them had created the Solar System with at least five planets, and had been able to program the circular orbits around the Sun; they had a page similar to the one in Figure 30.

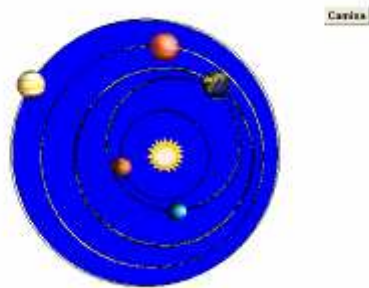


Figure 30. Planets revolve around the sun

Students had also done a lot of work on their projects. They had been working at home, not only finishing what they had started at school, but also integrating new ideas into their projects. For example, Brandon, a third grade student, created a game about the Solar System (see Figure 31). I was pleased to see that the students were integrating their own ideas into their projects. I was even more pleased to hear that

the teacher really valued these kinds of developments. The teacher said that since he found out that Brandon wanted to make the game, he had been encouraging him to finish it.

I asked Brandon about his game. I wanted to know why he had decided to make this game. He said, “we [the students] were searching on Encarta for information about the Solar System. I found this game and we really liked it. All the students wanted to play with it. I thought it helped us remember the planets, so I thought I could develop my own game to help the students remember where the planets are located in the Solar System.” I was very impressed by his ideas regarding, and his reflections on, the other students’ learning.



Figure 31. Solar System game

- Create a physical model of the Solar System

The final activity I proposed was a physical model of the Solar System. I identified a possibility to use again some of the *powerful ideas* that we learned while doing the community project, such as scaling, or translating number between different measurement units. The idea of making a connection to powerful ideas on a different domain presents the opportunity for students to really appropriate these ideas.

We talked to the students about making a model to scale, and they immediately welcome the idea, so we decided to continue. We asked them if they remembered anything from previous projects that we could use to make our model. We had done the Community project six weeks before that date and we wanted to see how much of that experience the students could remember. In fact, the students, especially the ones in third to sixth grade, remembered the scaling factor in the context of the

Community project, but they didn't remember exactly all the math they were supposed to do. They knew that we needed to know the size of both the Solar System and the wood sheet we were going to use.

When we started to discuss the details of the model with the students, we realized how big the Solar System was and the challenge of building a small model at scale, so we made some decisions: 1) we only used the distance from the Sun to Pluto in our model because the size of the table was already so small (4.5 meters), 2) we didn't scale the planets to the same scale because the size was going to be too small to see, and 3) we did the model looking from the top, which meant, we were not going to elevate the planets from the wood sheet. Some students created and painted the planets (see Figure 32), and others calculated the distance between planets (see Figure 33).



Figure 32. Students working on a physical model of the Solar System



Figure 33. Students calculating the distance

Since I have given the detail of how we calculated the scaling factor in the Community project, I am not going to include the same information for this project, but the process is as follows: First, we found the distance between the sun and every planet in kilometers; then, we converted that to meters and calculated the scale factor

(1.321.333.333.333); then, we found the distance at scale in meters; and, finally, we converted the final distances to centimeters and built the model. As we went through the process, Melvin, a sixth grade student, came up with the idea of creating a table (see Table below), which we then used to build the model.

Planet	Distance to Sun (Kilometers)	Distance to Sun (meter)	Scale (4.5 meters) Factor = 1.321.333.333.333	Distance in Centimeters
Mercury	57,900,000	57,900,000,000	0.04	4.38
Venus	108,000,000	108,000,000,000	0.08	8.17
Earth	150,000,000	150,000,000,000	0.11	11.35
Mars	228,000,000	228,000,000,000	0.17	17.26
Jupiter	778,000,000	778,000,000,000	0.59	58.88
Saturn	1,427,000,000	1,427,000,000,000	1.08	108.00
Uranus	2,870,000,000	2,870,000,000,000	2.17	217.20
Neptune	4,496,000,000	4,496,000,000,000	3.40	340.26
Pluto	5,946,000,000	5,946,000,000,000	4.50	450

3.4.3 Topic: Encounter of cultures

The goal of the activity is to explore and to learn about Costa Rica and its different regions. The students focus on identifying the main characteristics of each region, including economic and cultural activities, climate, location, elevations, etc. The idea is to construct a collective project where different groups concentrate on a province or region.

I sent the teacher a collection of activities about Costa Rica and its provinces, which included pictures and websites that had useful information about the topic. It was scheduled for October, around Columbus Day, so the teacher decided to change the activities I had proposed to accommodate the celebration. He sent me the report on the activities as he was developing them.

- Spaniards coming to American continent

In the first report the teacher sent to me, he wrote, “We worked on the encounter of cultures project. The students had to investigate the antecedents of the arrival of Spaniards to Costa Rica. They wrote reports about the information they gathered, and

initiated a project in Micromundos to represent what they had learned; they created pages to show the Spaniards traveling towards the American continent and traveling through the different provinces in Costa Rica.”

He also sent me the first projects the students had started to create. When I opened the projects I noticed that most of the students had included a map like the one you see in Figure 34, and had programmed a boat to travel from Spain to the American Continent.

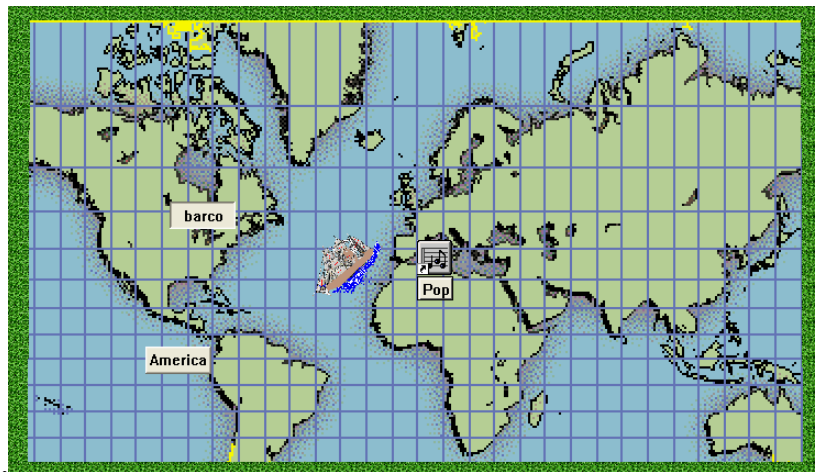


Figure 34. Encounter of cultures project

The teacher also told me in his report that he used the students’ writing to review some Spanish concepts such as, the construction of phrases, the use of verbs and nouns, and the dictionary. I was very happy to know that the teacher was taking the opportunity to integrate concepts of different disciplines as he developed his activities, so I asked him to tell me about other concepts he had been able to incorporate. He wrote back to me, “In social sciences, the students were able to identify the different continents, and the oceans and seas. We were also able to integrate some math concepts. For example, students calculated the years since the Spaniards arrived on the American Continent and the distance Spaniards had to travel. They also used a lot of math in their programs, as they had to calculate the distance that the different turtles travel on Micromundos, the coordinates, etc.”

- Provinces of Costa Rica

The teacher kept some of the original recommendations I had made for the activity. He asked the students to work in groups. Each group investigated a province, its location, climate and elevations, among other things. The students used different strategies to integrate the information. For example, a group of students incorporated information about the province of Alajuela (see Figure 35), location, coat of arms, and main economic activities. In a text box they wrote, “Alajuela is the province that has mango, sugar cane, and live stock.”



Figure 35. Province of Alajuela

- Culture, goods, and economics

The most creative part of the activity was the way in which the teacher presented the encounter of cultures to the students. He asked the students to think about the products and economic activities that were brought to Costa Rica as a result of the arrival of the Spaniards to the country. Most of the groups presented the information on a page with separated sections for each of the cultures (see Figure 36).



Figure 36. Products from America

Looking at the projects, I was able to notice that the students had incorporated information from different sources. As the teacher wrote in a report of the activity, “the students looked for images in Word and Encarta, and also used images that you [Claudia] sent by email.” Integrating images and information from different sources became part of the learning process of the students. They each found their own way and their own sources to make their project richer in content and aesthetic appearance.

- Physical representation of the ideas

Following the same approach to facilitate projects, the teacher supported the development of a physical component of the activity. The teacher sent me an email and told me that some of the students wanted to build the boat the Spaniards used to travel from Spain to the American Continent, using the Lego and GoGo boards. I told him that building a boat was going to be hard, but I recommended that he let the students explore and play with the technology. A few days later, the teacher sent me an email and said, “the students tried to build the boat, but it was very hard, they built a vehicle instead. They gave movement to this vehicle with two motors (one in each front wheel) and programmed it to travel certain distance” (Figure 37 and 38).



Figure 37. Melvin showing his car

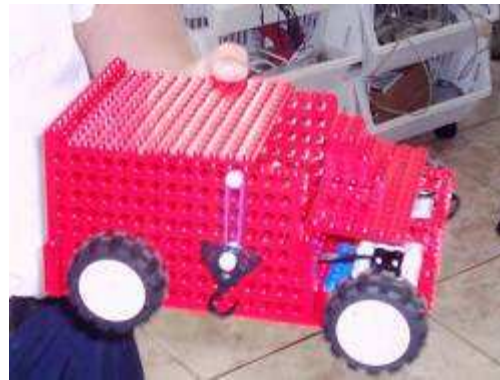


Figure 38. Lego car

In his folder, Melvin wrote a reflection about this project. He said, “As part of the encounter of cultures activity, we built a boat using the LEGOs and the GoGo boards. We used the GoGo Monitor to program two motors to move during certain time. We worked on Brandon’s computer, but Byron, Eduard, Daniela, Fernanda, Calos, and

Nicole also helped.” It was also good to know that students from different ages were working together on projects. In his reflection, Melvin also talked about how hard it was to build and also program the motors to move in the right direction, but he said, in the end, it worked.

I have described in action the whole-project based approach through the Community, Solar System and Encounter of Cultures topics. I have shown the scope and depth of the activities in each of those topics, which crossed learning domains and invite the students to make connections to powerful ideas; and have given examples of the projects developed by the students.

3.5 Capturing and evaluating the transformation

Before discussing what can be done under the heading “evaluation,” it is necessary to note some intrinsic limitations that are frequently not faced by innovators in education. To frame the issue, I present the following example of a successful educational action as described by Marc Tucker (2004), president of the National Center for Education and the Economy:

Danish story...

Change does not happen in a vacuum. What makes the educational actions taken in Denmark successful is not measured by short-term change in preparedness of individuals to pass a test, but by relatively long-term change in preparedness of the population to meet needs of the economy. Indeed, the situation is even more complicated when we recognize that even this manner of judging success does not rigorously isolate the educational part of a national program from economic and other components of national policy.

In a similar spirit, the real measure of success of the work reported in this thesis will be its contribution to long-term social development. The time-frame of a doctoral thesis, and indeed of most studies of educational actions, does not permit the use of such criteria. Therefore, it is appropriate to establish some indicators for the plausibility of positive impact on long-term social development.

Categorization of evaluation criteria:

1. The lowest level questions have to do with the workability of the procedures independent of their consequences. This question is not trivial. There are many ways in which attempts to bring change into schools can, and often do, fail during the implementation. Was I able to implement all the components of the proposed model? Do they work the way it was anticipated? I have started to address some of these questions in this chapter, which describe the transformation that took place at the school during the program. A summary of what was possible, including the limitations to development, will be included in Chapter 6.

2. The second level of questions has to do with the principles promoted by the proposed model: what emerged as a result of the implementation? Which components created the biggest impact? The conditions that were combined in this model include: a computer-rich environment; use of Micromundos and robotics as a basis for whole project learning; connections with community issues; teacher as an agent of change; and, the very different social-cultural context in which the model was implemented (a rural one-teacher school in a developing country) make this practical experience unique. Therefore, a study of the changes that emerge as a result of the implementation is necessary.

3. A final question has to do with the appropriation by the students, the teacher and the parents: how do I observe appropriation by students, teacher and parents? Although this thesis takes into account the dimension of students, parents and teacher; it mainly concentrates on students' appropriation of technological tools in the context of the learning; and how parents' and teacher participation influenced how that happened.

In order to address these questions, I decided the use a longitudinal qualitative approach to collect and analyze data for the practical experience (Marshall and Rossman 1999). By adopting this type of approach, I was able to assimilate information from different points in time during the program. This approach most effectively allowed me to document the transformation of the school, and study its effects on students, parents, and teacher over time.

The issue of bias in qualitative research is important, and demands special attention and discussion. As the researcher, I had the opportunity to develop a close relationship with

the teacher, the students, and the families of the community, which puts me in the best position to tell the story from the point of view of the participants. At the same time, I am aware that my experience and beliefs influence the research. In order to address the situation I implement two strategies: first, I use data triangulation, not only from multiple sources, but also from the point of view of the participants; and second, I make explicit the research process I undertake while collecting and analyzing data.

3.5.1 Data collected

I used data triangulation to assure the integrity of my qualitative research. Data triangulation involves the use of different sources of data (Marshall and Rossman 1999). In fact, I collected different types of data from different sources, which I use to draw conclusions about the transformation of the school and its effects on the students, the parents, and the teacher. For example, to study the students' learning process, I recorded my own observations while working with them at the school. I used the projects, available in every student's folder, to support my observations. I also use the students' reflections on their own experience and the questionnaires their parents answered to reinforcement my ideas. Finally, I discussed my findings with the teacher. If during the process I found a contradiction or an unexpected outcome, I proposed an in-depth interview with the parent to gain insight into their perceptions. This type of triangulation seemed very appropriate to study the practical experience at the one-teacher school in Costa Rica, and its effects on students, teachers and parents.

- Students' folders

I recorded four sets of student data throughout the course of the program (September 2005, October and November 2005, December 2005, and May 2006). I organized the information in separate folders for each student, which I call packages (see Figure 39). I compiled the packages as the program progressed/evolved, adding the questionnaires that each parent answered, and transcript of interviews, if applicable. I also added my own annotations.

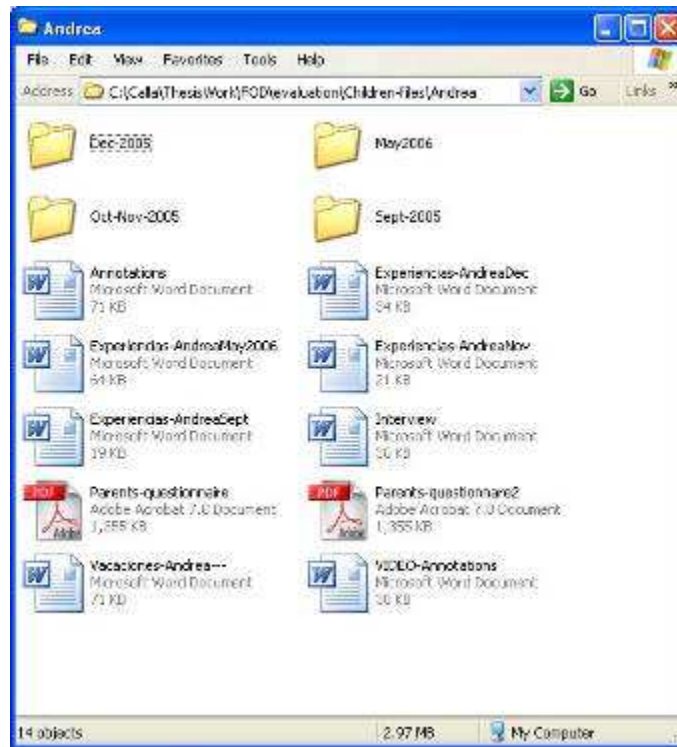


Figure 39. Student's data package

Each of the packages has a similar structure at the highest level. Information varies inside the folders, because each student created his own projects and organized information using her or his own classification. For example, in September 2005 when we started the program, two different students had the following information: Fabian, a third-grade student, had already created folders to classify his information (see Figure 40); Eduard, a first-grade student had only a few projects he had worked on during the first weeks (see Figure 41). I analyzed a total of 2632 files that the students created over the course of the program.



Figure 40. Fabian's data package



Figure 41. Eduard's data package

- Questionnaires and reports

I designed questionnaires for the parents and also for the teacher. The parents' questionnaire¹⁹ was designed to gather general information about the parents, what they think and feel about the school, and their relationship with the school. It also gathers information about their previous experience with digital technology and what they think about its role in their student's learning.

The teacher's questionnaire collected general information about the teacher; use of technology both, at home and in the classroom; teacher's observations on the impact of the program on students; and how he thinks and feels about his development and support. In addition, documentation and reports of the actual projects written up as case studies were collected. These case studies were used as a source for interviews and focus groups, both with the parents and the teacher.

- Interviews and focus groups

I conducted semi-structured interviews with the teacher, and family members. Semi-structured interviews were conducted with a fairly open framework which allow for

¹⁹ Copy of both questionnaires is available at the end of the document.

focused, conversational, two-way communication. Semi-structured interviewing starts with more general questions or topics. Relevant topics (student engagement, technology use) are initially identified and the possible relationship between these topics and the issues, such as change in attitude and nature of use, become the basis for more specific questions which do not need to be prepared in advance.

I also conducted focus groups with the parents at the school. I usually started by having the students present their projects, and talk about their learning experiences. I started the conversation by asking the parent to reflect on what their students' progress. It was always difficult to get the parents to talk about their concerns or difference of opinion, but usually, after one parent dared to talk, the others followed the conversation.

I used Transana²⁰ to transcribe and analyze the video (see Figure 42). Transana is a cross-platform tool for the transcription and qualitative analysis of audio and video data. It also provides the ability to identify and organize analytically interesting portions of videos, as well as attach keywords to those video clips. I didn't use all the capabilities of this tool because I had information in both Spanish and English, which made impossible to analyze content, but it became a very useful tool to analyze the interviews and the focus groups.

²⁰ For more information about Transana, visit their website at <http://www.transana.org/about/index.htm>

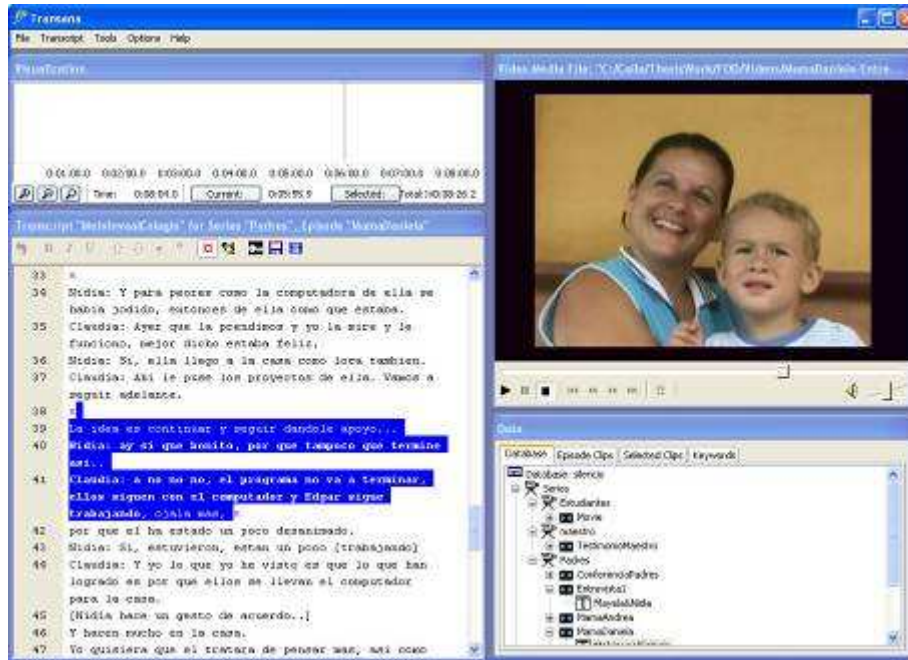


Figure 42. Transana

- Project Blog

I decided to start a Blog for the project (<http://createprojectblog.blogspot.com/>). I recorded information about the activities I was developing at the school, and about the projects the students were doing; my reflections on particular situations that catch my attention; and documented projects milestone. For example, I recorded an entry the day we got Internet access at the school (see Figure 43). I used to Blog to communicate with the other Tutors on the network, and also to select some quotes to support my arguments during the analysis.



Figure 43. We have Internet!

3.5.2 Data analysis

Analysis of collected data was done in an iterative process typically employed in qualitative studies (Miles and Huberman 1994). This process includes: transcription (total or partial) and reading of the data; identification of a thematic framework (a priori issues and issues emerging during the transcription stage); coding: the process of applying the thematic framework to the data, using numerical or textual codes to identify specific pieces of data which correspond to differing themes; charting: using headings from the thematic framework to create charts of your data so that you can easily read across the whole dataset; and, mapping and interpretation: this means searching for patterns, associations, concepts, and explanations in data, aided by visual displays and including excerpts from original data if appropriate (i.e., quotes from interviews, images of projects, etc). This process became iterative because I had the opportunity to conduct more interviews, observations, and surveys in order to confirm, elaborate, and clarify the emerging data.

The outcomes that were identified as part of the analysis are summarized as follows:

Students:

- become familiar with the technology, by exploring its functionality
- improve quality of research and complexity of projects
- initiate their own projects
- become independent learners
- learn as they teach their siblings and their parents
- integrate images from multiple sources
- use the Internet as a source of knowledge
- learn about the technology as they work on projects

Parents:

- engage with children's learning
- observe learning at school
- learn with their children
- "use a computer to learn something of value that is not in itself related to computers" (Papert 1996)
- become learning advisors
- demand for admission to the school increases

Teacher:

- uses the technology to prepare activities
- encourages the students to create their own projects
- learns along with the students
- accepts copying as a legitimate step in learning
- establishes common ground for collaboration

- get interested in students and parents learning

3.5.3 Outcome presentation

I use these initial outcomes to do further analysis, which I present using two frameworks. The first is an extensive analysis of the changes within the learning culture of the school and the community, which I describe in detail in the following chapter (Chapter 4). I offer the results in the form of stories, Stories of Change, which tell the tale of the evolution of the model as a result of the transformation process at the school, and beyond. I use the analysis to refine the conceptual model, and illustrate how it may result in a greater impact.

The second offers a qualitative evaluation detailing the appropriation by students, teacher, and families, which I present in Chapter 5. I discuss the different levels of appropriation observed during the practical experience at the one-teacher school in Costa Rica. Although this thesis takes into account the dimension of students, parents and teacher; it mainly concentrates on students' appropriation of technological tools in the context of the learning; and how parents' and teacher participation influenced how that happened.

4 Stories of Change

In the previous chapter, I describe the criteria that I use to evaluate the work reported in this thesis. I explained the approach I use to collect, and organize and analyze data. I provide details of the school and the community where the practical experience was implemented. Finally, I introduce the participants, students and their families, and the teacher. What follows is a study of the interaction of the components of the model as they got implemented at the one-teacher school in Costa Rica.

Informed by ideas of Emergent Design approach (Cavallo 2000) and design-based research methods (Collective 2003; Bell 2004). I conducted an extensive analysis of changes that emerged as a result of the implementation. The goal is to go beyond studying the effect of the intervention in a one teacher school in Costa Rica (which will be addressed in the following chapter) to discuss specific aspects of the implementation that resulted in deep change within the learning culture of school and family. The analysis is presented in the form of stories, Stories of Change, which describe the evolution of the experimental framework as a result of the implementation process. The themes of each of these stories will then be used to propose changes that strengthen my conceptual model in ways that make it more useful to people who are interested in the *one laptop per child* model in schools as well as to others who wish to understand how the computer can bring significant cultural change to an educational environment. While rooted in rural Latin America, I claim, the particular model discussed in this thesis has "spin-off" potential for most countries around the world.

In order to assist the reader in understanding the analysis, I present the following chart (see Figure 44). In the first column, I include some of the principles of the experimental framework, which have been described in detail in chapter 2; in the second column, I include the four stories of change that are discussed in this chapter; and, the last column lists the relevant outcomes that I use to support and illustrate the stories.

Stories of Change

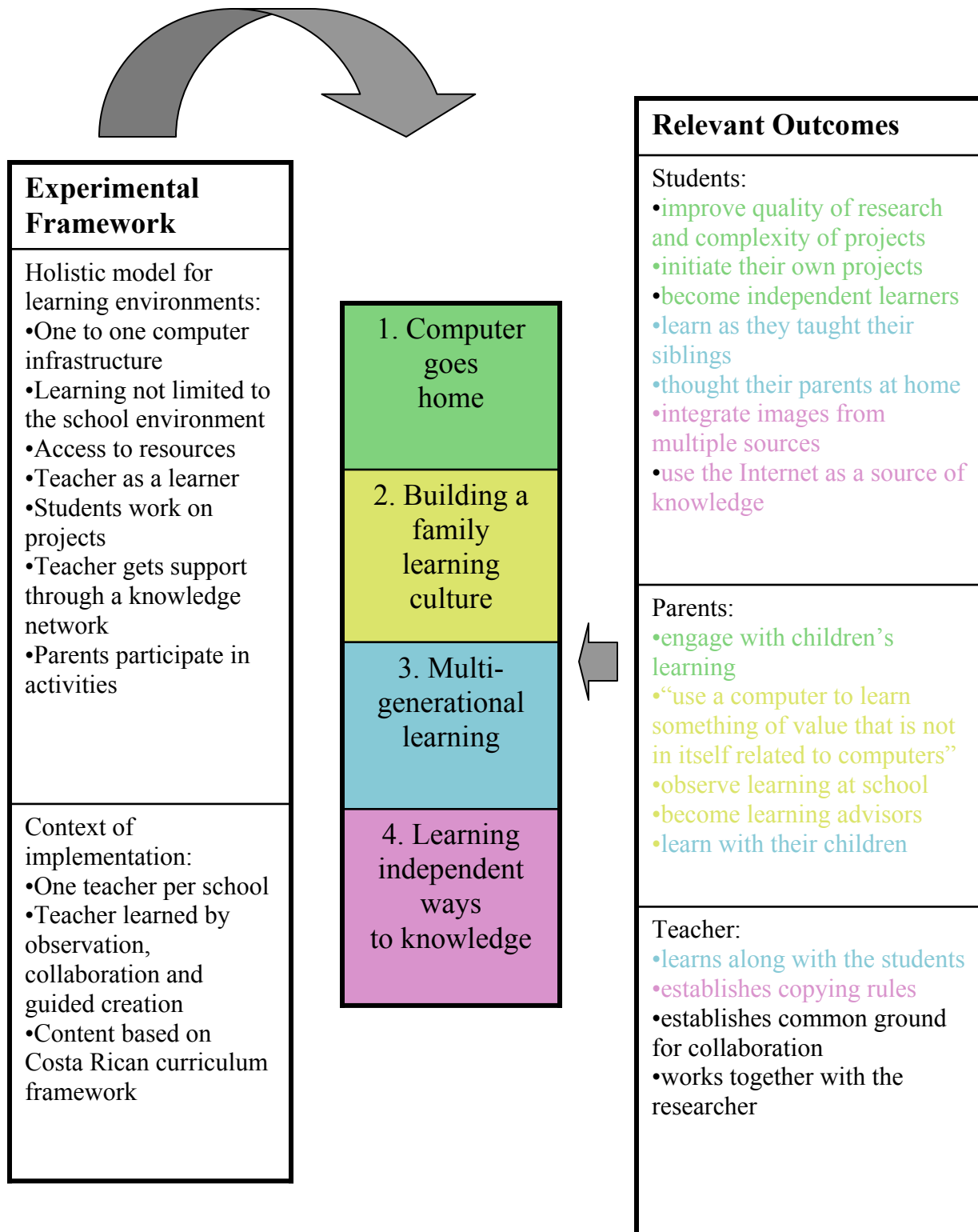


Figure 44. Stories of Change.

4.1 Computer goes home

As discussed in Chapter 4, in the proposed model for a learning environment, one to one computer infrastructure is one of the fundamental principles (Papert 1996). It recommends that the student would be allowed to bring the computers home on nights, weekends, and even vacations; when children take the laptops home, they are bringing new ways of thinking into the family and giving parents new opportunities to learn

At the beginning, not all of the people involved in the program were ready to make that decision. They didn't see the interaction with the computer at the home environment as important, but rather as putting the students' lives in danger. The computer didn't go home until several weeks after we started the program, therefore I was able to observe from the beginning the effect of the computer presence. Effects were almost immediate; students improved the quality of the research and complexity of their projects and initiated their own projects, and the parents started to engage with their children's learning. By the end of the program, a deeper kind of change had emerged: students became independent learners, and parents turned into real advocates of these new ways of learning, to the point that demands for admissions to the school increased.

During the first meeting, students, teacher, parents, and other family members excitedly welcomed the program. All the parents agreed to have their children participate, and were committed to get involved and support their children during the development of the program. Parents told us how much they cared about their children's education and considered the program a great opportunity for them to learn about computers, and therefore have a better education. They also said that they were concerned about their children, in the words of one mother, "paying a lot of attention to the computer and neglecting the regular school work." We explained that one of the main goals of the program was to have the students use the computer to learn about math, science, Spanish, and social science, while working on projects that integrated concepts from all of these areas. We considered their concerns absolutely normal, and we thought it was going to be easier for them to understand the program and the new methodology while observing and getting involved with the work.

Computers were given to the students since the first day of the program. From the very beginning they started to explore and learn about the computer and other technologies while doing projects and developing the activities that we had designed for them as part of the new curriculum. They were very enthusiastic about the idea of having a computer and never seemed tired of working with it. From the moment they arrived at the school in the morning, they wanted to work on the computers. They also didn't seem interested in playing outside during the school breaks, or even in leaving the classroom to have their snack or lunch.

It was becoming frustrating for everyone involved in the program. The students started to complain about not having enough time to finish their projects at school and do their own projects. The teacher also wanted the students to continue their projects at home; not all of them worked at the same pace, so it was challenging to continue with the subsequent activities. We knew how excited and curious they were with the new object, but we thought that by facilitating a meaningful experience and work with the computer through the activities we had designed and planned at school they were allowed enough time to get familiar with and to appropriate these technologies. We proved ourselves wrong; we had underestimated the students' need to spend more time with the computer in order to explore and experiment themselves. We were forcing our agenda upon them.

Almost two months after the program started, we decided that it was not only right, but also necessary for the students to take the computers home. Members of the community had already organized themselves to take turns and guard the school in the afternoons and at night. Parents agreed to accompany their children in the morning and at the end of the day to make sure they weren't taking on any type of risk in transporting the computers back and forth to school. Students were very excited about the idea of taking the computers home. They had started to bring their own carrying cases made out of a variety of print fabrics: Spiderman, teddy bears, flowers, cars, among others (see Figure 45). They had asked their mothers to make the cases for their computers, similar to the one I had, even though they never specifically asked to see mine. This showed how quickly students started to feel ownership over the computer and the need to take good care of it.



Figure 45. Students showing their computer case

During the first weeks after the decision to take the computers home, parents reported that the students did not want to play outside, but mostly work on their computers after they got home from school. Parents were concerned; because, they didn't know exactly what their children were doing and they thought that they were spending too much time working on the computer. After the second month, things started to fall into place; children got used to having the computer and started to balance their time more between different kinds of activities; parents were able to see what their children were doing, and started to participate and get more involved with their students' learning; and, we had more time to introduce new activities and to support the students' learning, both about the technology and about the different concepts in the projects.

In the short term, the effect was almost immediate. There were significant changes in the quality and the kind of the projects the students did, and also in the parents' understanding of the program and their involvement.

- **Quality of research and complexity of projects.** Students had more time to work on their projects, which was reflected in the amount of information they had in their projects and how sophisticated they were at integrating it into their projects.

To illustrate the difference, I looked at the first projects the students did at the beginning of the program. As part of the activity we facilitated about the community, students created projects that told the story of the community and integrated the

different aspects they studied and reviewed during class. Most of the students created a one-page project in Micromundos.

Melvin, a sixth grade student made a project about the community that integrated all the aspects he had studied about the community: transportation, communication, institutions, among other things (see Figure 46).

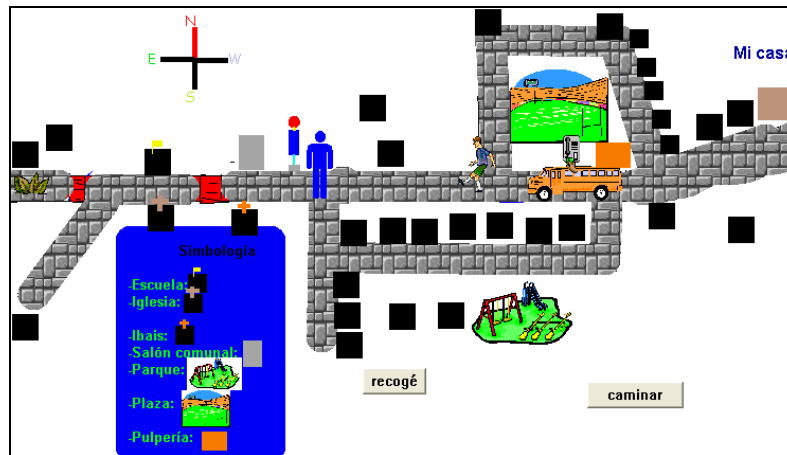


Figure 46. Melvin's map of the community²¹

A few of them created separate pages that presented additional information they had studied and discussed during class. For example, Fabian, a third grade student at the school included a page to present the communication media available in the community (see Figures 47 and 48).

²¹ You may see images in this chapter that you have probably been used before in the document. I have decided to give them a new number and name because I use them to explain a different aspect of the project or to emphasize certain features.

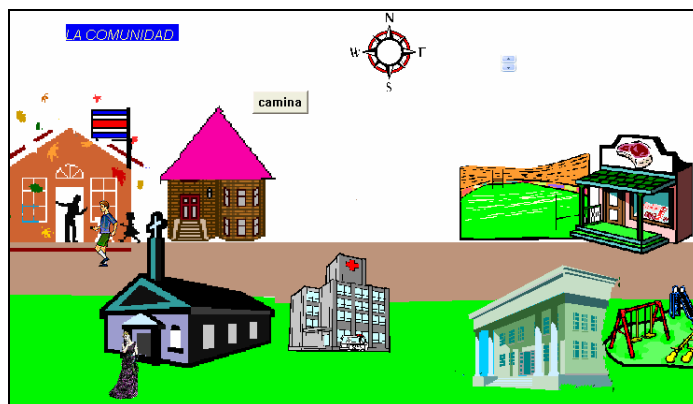


Figure 47. Fabian's map of the community

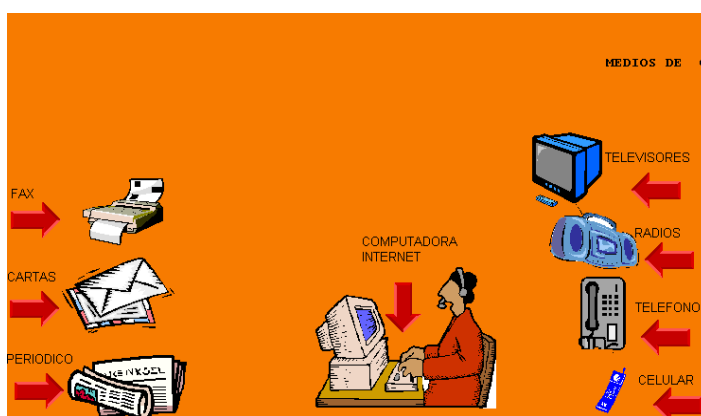


Figure 48. Fabian's page con communication media

The projects created after the students started to take their computers home were different. Students went beyond what had been proposed during class to create projects that looked very different from one another and that integrated more information. The same students created the following projects as part of an activity about the solar system. For example, Melvin created a project with 7 different pages (see Figure 49).

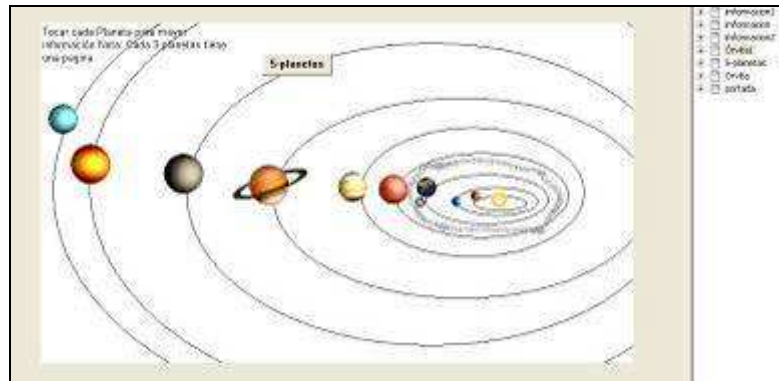


Figure 49. Melvin's project about the solar system

He gathered and included information about each of the planets, but he seemed more interested in how the planets moved around the sun. The following figure shows a page he had in his project on which he programmed the planets to move around the sun (see Figure 50). Melvin also had a page on which he programmed the Earth to move around the sun and at the same time the Moon to move around the Earth (see Figure 51).



Figure 50. Image of the first planets' orbit

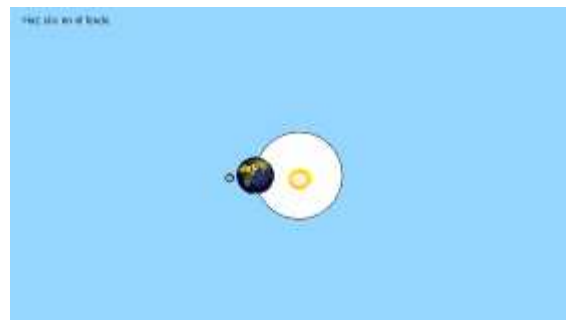


Figure 51. Earth and Moon on their orbits

Other students, such as Fabian, seemed more interested in the facts about the planets of the solar system. He had created a project with twelve pages, at least one per planet (see Figure 52).



Figure 52. Fabian's solar system project

The first image below shows a page on planet Earth with some facts Fabian included in a text box (see Figure 53), and the second an image of the page shows how he programmed the planets' orbit (see Figure 54). Like Melvin, he had also played with the orbits of the planets around the sun, but he had obviously spent more time finding and integrating information about the planets. He actually had a different version of the same project in which he included more information about every planet, but it was integrated as audio files that he recorded.



Figure 53. Fabian's page on the Earth

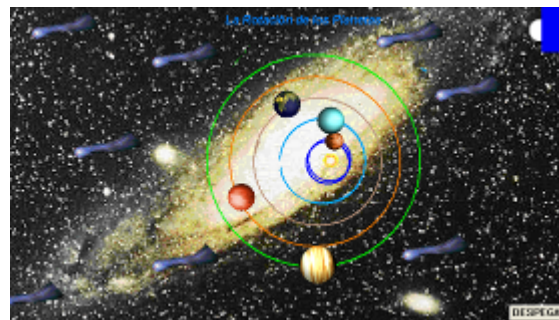


Figure 54. Fabian's page on planets' orbit

The following image shows a final example of how students extended and developed the Solar System project. Brandon, a third grade student, created a solar system game (see Figure 55). In this game, you can drag each of the planets onto its orbit. If you don't know the exact position, you can click on them and they will jump to where they belong.

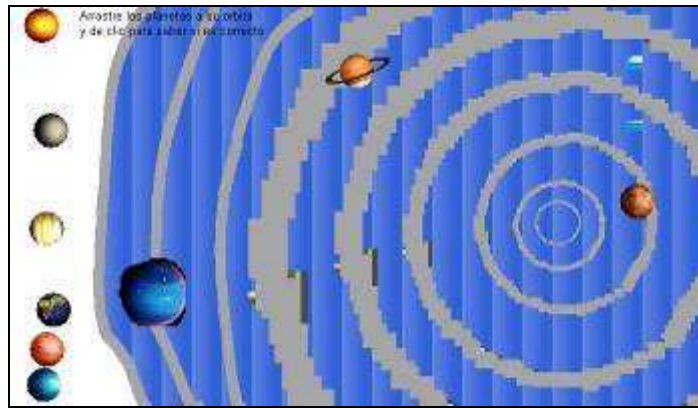


Figure 55. Brandon's game about the planets

Brandon wanted other students at the school to play with his game. He wanted to test if other students knew the order of the planets in the solar system, and also to help them remember the right order. This kind of development suggests that students thought about strategies to help others learn about what they are studying in their projects.

- **Students initiate projects.** At home, students had time to explore and use the technology to work on their own projects; they created games and projects about different topics that weren't directly part of the curriculum of the school.

The first example is a game created by Jeffrey, a third grade student. To play this game, called the House (see Figures 56 and 57), you have to go through the different rooms using one of the two available keys. If you find the right key at least 4 times you win, otherwise you lose!



Figure 56. First page on the game



Figure 57. You Won! Page

Jeffrey actually started this game only two weeks after we began the program and he didn't finish it. He didn't write a procedure to keep track of the user's performance, so it wasn't possible to calculate a final score; but, he included the following text on the final page (see Figure 58), "If you have opened more than 4 doors without making a mistake click on the red square, otherwise click on the green one." This shows he had the rules of the game, but he didn't know the tool well enough to write all the procedures he needed.

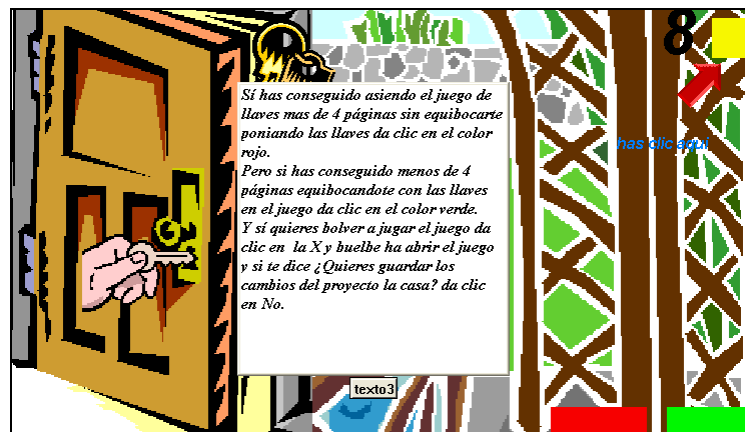


Figure 58. Rules of the game

Jeffrey also added at the end, "And if you want to play the game once more, click on the X and open it again. Answer NO to the question: "Do you want to save the changes?"

The second example is a project about music. Fabian, the third grade student mentioned earlier, created a project called “La Nueva Musica”, which means “the New Music” (see Figure 59). In this project, he studied how music has changed over the years. Fabian created several pages that showed different sources of music (violin, guitar, voice, among others), and a last page that showed how the music on a CD is the combination of all these sources (see Figure 60).

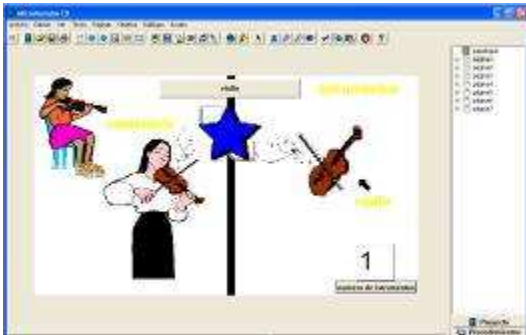


Figure 59. Violin page, The New Music Project



Figure 60. Final page, The New Music Project

- **Parents engage with children’s learning.** During one of the first parents’ conferences, a mother talks to us about how her daughter was doing the solar system project on the computer. She told us her daughter Andrea, a third grade student at the school, didn’t understand the activity that the teacher introduced and that she was struggling with the project until the mom called the teacher late at night. She said, “after the teacher explained the project, I told Andrea she misunderstood the teacher and had to do most of it again. My husband and I worked with Andrea until 11 pm to finish the project. I told my daughter she could work on the project at school the next day, but she said she wanted to do it right away.” She also added, “Imagine if this had happened with her notebook and she had to start all over again, she wouldn’t have done it.” After her comment a father said, “I agree. Having the computers is an advantage, because they feel so motivated; we don’t have to fight with them to learn; they just want to do it.” The fact that the laptops were in their homes made it possible for parents to engage with their children’s learning.

There were also long-term effects of taking the computer home. Students became independent learners, not only making decisions about how to integrate the different information into the projects they had developed, but also about the projects they want to design and create and how they want to make them.

- **Students become independent learners.** In rural schools in Costa Rica, the curriculum is organized in 6 learning units. It means that all the students from 1st to 6th grade work on activities related to the same topic. Every year, they follow the activities that deal with different aspects or levels of the same topic. The second year into the project, students started to work on the same theme, the community. Instead of creating the same community map we created the first year, they created their own projects about different aspects of the community. One group of students worked on a project about the Arenal Lake (see Figure 61 and 62), an artificial lake located in the region, which produces the majority of electricity for the entire country. The students decided to create a project about the expansion of the original lake in 1979.



Figure 61. Beginning of the Arenal lake project



Figure 62. Arenal lake

A second group of students created a project about animals and agricultural products in the community. They were very creative in the way they decided to present the information. For example, in the page about animals (see Figure 63), the students presented the benefit that each animal provides to the community in the form of a dialogue between animals. They also included a page about the different agricultural products available in the community (See Figure 64). They created turtles to represent the different products and programmed each to show its name at the bottom when they were touched by the turtle dressed as “agriculturist.”



Figure 63. Project about animals in the Community



Figure 64. Fruits and Vegetables in the Community

These are only some of the examples that reflect how the students, with the support and guidance of the teacher, have become independent learners, able to make decisions about the projects they want to make and how they want to make them. During an interview with the teacher, he talked about the students' ability to propose projects. He said, "we start off from the students' interest, and what they bring to school. I had never worked like that before. The children themselves tell me how the day is going to evolve. This is the most interesting part of the work!" I never had imagined the students working that way on the first day of the program.

- **Demand for admission to the school increases.** The teacher was expecting 19 children in January, but two more students joined the school just before the beginning of the academic year. A couple of families moved to the community. The teacher informed us that, "two families moved to the community looking for employment opportunities and for better education for their children." He also told us that people in the region, who have heard about the program from the members of the community who have participated, were interested in sending their children to the school. He added, "People not only see it as a good opportunity and future for their children, but also for themselves."

The student's ability and independence to imagine, explore, and create projects using the new technologies, and the parents' understanding of the program to the point of recommending it to others as an opportunity and better future for the students, are some of the most important outcomes of the program; it appears that this outcome was strongly influenced by the fact that the computers were taken home by the students. I strongly

believe that the decision to send the computer home should be one of the first ones made for any learning initiative that expects a laptop in the hands of every student to become a powerful learning tool.

4.2 Building a family learning culture!

Having the parents participate and learn about the technology was also a principle of the proposed model for learning environments. The goal was to design and facilitate activities that involved parents and other members of the community, in which not only new initiatives could emerge, but also new ideas for content development. While parents could take time away from their daily routine to participate in the activities, I found ways of getting the families involved at different levels. The participating and engagement that emerged contributed to the building of the *family learning culture*, a concept that Seymour Papert developed in his book *The Connected Family* (1996). In his book he defined the family learning culture as “the ways of thinking about learning- its beliefs, preferred activities and traditions associated with learning.” Papert talks about the creating of a learning culture as a necessary step towards change on education. I will describe in the following sections how the families started to create their own learning culture by participating in school activities and learning with their children at school, by observing their children’s learning, and more important, by making recommendation about learning activities.

- **Family members “use a computer to learn something of value that is not in itself related to computers.” (Papert, 1996)** During this program, family members participated in school activities, which allowed them to use the computer to learn about things they are interested in and cared about. One of the activities we did at the school was about natural disasters. We focused on three major disasters common to Costa Rica; as earthquakes, floods, and hurricanes. As part of the activity, I proposed that the children build instruments to measure and observe the natural phenomena that cause them. Students did research about the disasters and created Microworlds projects to simulate these disasters and also propose emergency strategies. They also started to build instruments and brought some materials to the school. They seemed really interested in being able to detect and measure the intensity of earthquakes. As

we started to work on a seismograph,, two of the students mentioned their grandfather worked at the seismic observatory in the region. I immediately asked them if we could get him interested in participating and helping with the project. The children were very excited and ran to their grandfather's house to tell him about the project²². Ten minutes later they came back with their grandfather. He wasn't only interested in the subject, but he is also a very good carpenter.

The children were really interested in earthquakes, so was the grandfather, who thought he fully understood how seismographs worked because he had been around them for many years. We started a discussion with the children, the teacher, and the grandfather about this instrument. We all had different design ideas and strategies to build the seismograph and to measure the intensity of the movement. I started by mentioning two parts of the seismograph, one to capture the movement, and the other one to illustrate it. I showed my design to them and the grandfather was confused (see Figure 65).

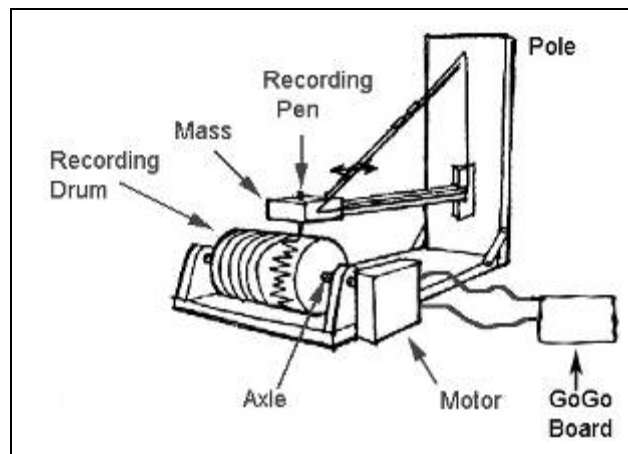


Figure 65. Sketch of the seismograph

In my design, I proposed to use a heavy mass attached to a horizontal wood bar. The bar hangs from a big pole, using a wire, and rests on one of its sides. The bar is free to move when the ground shakes.

²² Going home to tell their grandfather about the project did not seem a big deal. The teacher immediately supported the idea of the students going to invite their grandfather to participate in the activity. This is one more advantage of living in a small community... there is even continuity in the enthusiasm.

The grandfather did not understand why I needed a heavy mass. He told us, “I have seen the seismographers work at the observatory. When there is an earthquake, there is a needle with ink that draws the movement on a paper. As the roll rotates, it moves the paper, so the needle draws on the paper.” I asked if he knew how the device captured the movement, but he repeated the same to me. He said he was going to look and ask the next day at work.

We started to think and research other ideas. The children found a couple of ideas for the seismograph in a textbook. One was similar to the one I was proposing and the other one used a spring to suspend the weight. We all decided that it was probably easier to build something similar to what I had proposed. The grandfather found the materials at his shop and we started to build.



Figure 66. Grandfather working with students on the seismograph

The next day, after he came home from work, he came to the school. He said he had asked at the observatory, and in fact, there was a whole unit that captures the movement using electromagnetism, instead of a heavy mass. Without fully understanding how all the components worked, he started to build on the model. At the end of that day he told us, “I got it now!! I understand why we need a unit to capture the movement and draw it. I understand how the two components work together.” I believe this was a positive and great learning experience for all of us. We all contributed to the project and learned from our own previous experiences (see Figure 67).



Figure 67. Final version of the seismograph

As a result of this kind of interaction with parents and other family members, the relationship with the teacher also changed. Pedro's grandfather continued to visit the school and became interested in following and supporting the students' learning. He had been angry at the teacher for almost one year because a disciplinary matter with one of his grandchildren at school; but, as a result of collaboration and involvement with the projects at school, he had returned to the school and talked to the teacher again.

- **Parents observe learning at school.** Parents were always welcome to visit the school to observe and discuss students' learning process. The following story presents an example of the kinds of interactions the parents had with the school. Maria was a first grade student at the school. One day, her mom called and told us that Maria wasn't happy at school because she wasn't allowed to work on the computer. Maria and two other first-grade students used two desktop computers the school already had, instead of laptops. They had to share the two computers, which meant Maria sometimes had to work with one of her classmates. We figured Maria wasn't completely happy about the arrangement, but we knew she had worked on the computer like other students at the school and had created her own projects. Maria's mom sounded unhappy with the situation, so we decided to invite Maria's mom to visit the school to talk with her daughter about the problems she was having.

We asked Maria to open one of her projects. We knew the desktop computers shared the storage system and had the standard setting for a computer lab, which the Omar Dengo Foundation had created with at least 30 users per station, the security, and other things. Different from the students who had laptops and used the “My Documents” folder, Maria had to go through at least five levels of folders before she could find hers, but she had no problem doing that (see Figure 68).

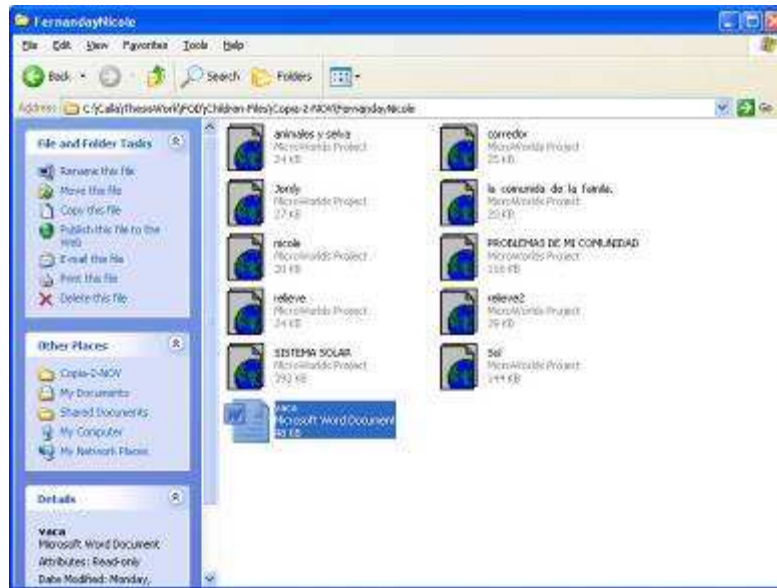


Figure 68. Maria and Nicole's shared folder

Maria’s mom was captivated by her daughter’s ability to navigate through the information, so were we! Maria opened at least three projects and told us how she created them and what she had learned in the process. She opened the Solar System project she had created with Nicole, another first grade student, and told us how they had created the project and how much they had learned. First, they created a solar system with the planets they found on the figures list (see Figure 69), and then they created the Solar System they learned during the school activity (see Figure 70). All of the students in the class had participated in a number of activities and studied the planets and how they are organized.



Figure 69. Solar system as students imagined

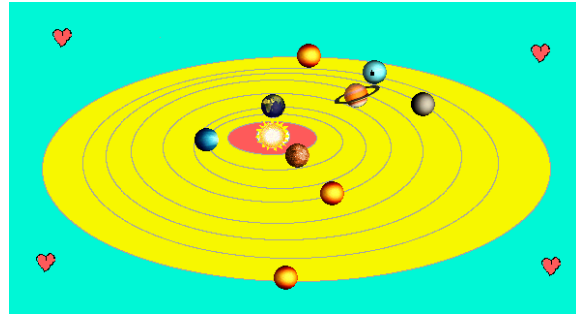


Figure 70. Solar System they learned

Maria's mother was impressed by the number of projects her daughter had done, how fluent she was in talking about them, and how confident she was with the computer. She understood her daughter's feelings came from her desire to have her own computer, but she understood why she was sharing it with other students in her class. She felt relief after what she had observed and continued to visit the school to observe the progress of her daughter and other students at school.

- **Parents become learning advisors.** During the final interview with the parents, one of the mothers told me how she had noticed a change in the kind of projects and the use of the technology during the previous months.²³ I explained that the teacher was going through an adjustment phase, which was part of the process of appropriating the program and becoming independent. I also told her that the teacher needed a lot of support from the parents in order to continue with the program. I am glad she was the one who brought up the issue, because I had a chance to emphasize how important their support was for the program.

I asked her if she had specific ideas and suggestions for how to improve the program and she told me, "for example he gave them an assignment the other day. He asked the students to research and write about the human cell, but in their notebooks. It would have been nice if he had asked them to do something with the computer. They could have studied the parts of the cell, drawn them, made a simulation, and who knows." I was expecting general recommendations, but I was pleased to hear very concrete ideas for projects, and asked her to make suggestions to her daughter about

²³ I only visited the school twice during the second semester of the program; I had been there two months before.

how she could use the computer to have richer learning experiences. It was clear to me that the parents had already developed their own learning culture, and the digital technologies were an important part of such a culture.

The program empowered all family members by providing an environment where they learned together with and about the digital technologies as they developed projects that were of value to them, and allowed them to make informed decisions about the learning for their future generations. In this program, the concept of *family learning culture* becomes a community affair as teacher, students, and family members share the same learning experiences, which are described in detail in the next story.

4.3 Multigenerational learning

Multi-age learning was one of the characteristics of the one-teacher school environment we incorporated into the implementation process, which I identified as favorable in the rural school environment. Having the students from different ages learn together and learn from each other is a more natural way of learning than the conventional graded-school environment (Miller 1995). The benefit of multiage learning is not merely that the less-informed child imitates the more knowledgeable one, but that the interaction between the children all ages leads to deep understandings of the concepts being studied (Katz, 1990).

I designed activities based on the assumption that students of all ages were going to work together on projects based on their interests, experience, and knowledge, which worked very well; but, I didn't anticipate what I now call the multigenerational learning environment that emerged, both at school and at home, as a result of the program. Students not only learned along with their classmates, but they also learned by teaching their siblings, at preschool, and parents and other family members at home; the teacher also learned along with the students, not only by guiding and facilitating activities, but also by sitting with students in class while I was introducing an activity involving robotics technology.

- **Students learn as they teach their siblings.** The students who had brothers and sisters in the preschool classroom started to ask if they could show their siblings what

they had been doing with the computer. They specifically asked if they could teach them how to create projects in Microworlds. We supported their idea and helped them design their own activities.



Figure 71. Students learning together with preschool kids

Gabriela, a preschool student, started to work on projects with her sister, Andrea, a third grade student at the school. Her first projects didn't have any particular theme. The following image (Figure 72) shows one of her projects with lots of turtles dressed in different images; none of them had animations. She wrote the following statement about her first experiences with Micromundos, "I have learned to dress the turtle with animals or people's costumes."



Figure 72. Gabriela's first Micromundos project

By the time Gabriela entered first grade, she had learned to create more elaborate projects. For example, Gabriela created a project about the five senses (see Figure 73). In this project, she had created multiple pages and animations. She had also included links to navigate through the different pages in the program.

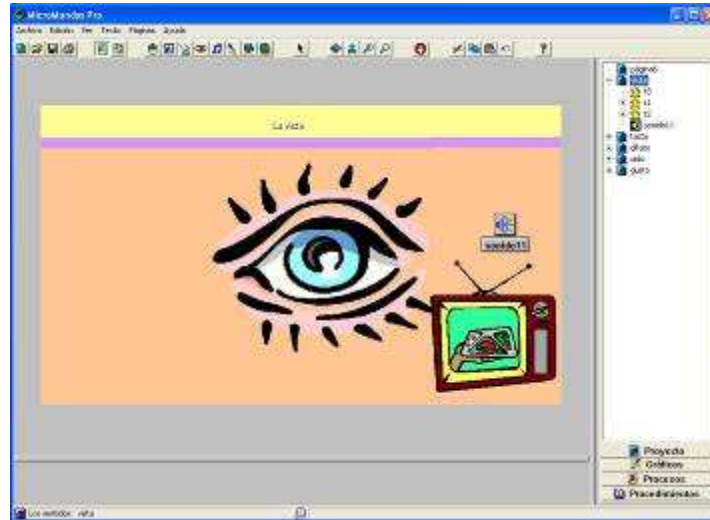


Figure 73. Gabriela's project about the five senses

The final reflection Gabriela wrote says, “I don’t have a lot of experience, but I am very proud to be learning more every day. In March 2006, I worked with my sister on the National Campaign project.” Besides her own project on the five senses, Gabriela and the new first graders had already started to work on projects with the older students.

Norman, another preschool student, worked with his brother and other students at the school. His first project (see Figure 74) is also an exploration of different things with Micromundos. On his reflection about the program Norman wrote, “I have learned to create figures in Micromundos. I have also learned to paint, create turtles, paint figures, create text, look for images in Word, and add sounds to the projects I have made with Brandon. I have had some trouble learning to use the mouse pad on the laptop.” Norman described all the things he had learned while working with the students at the school, which is what most of the preschool students learned during the first experience working with the other students.

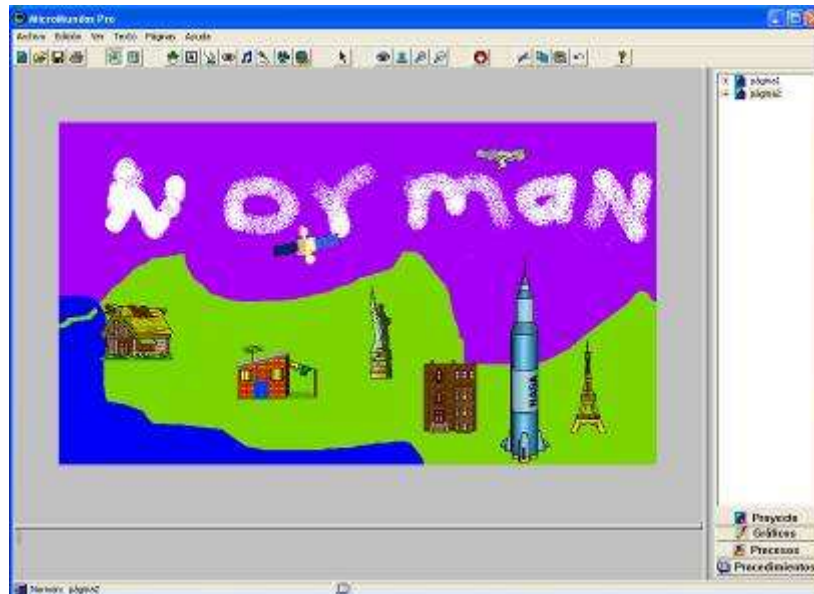


Figure 74. Norman's first project

As a first grade student, Norman started to collaborate with other students at the school. The first project he worked on was about the National Campaign of 1856, which commemorates the date on which Costa Rica fought against William Walker, president of Nicaragua, who wanted to take control of the country. Norman worked with his brother, a third-grade student, and a fourth-grade student on the project. They created nine pages, which tell the story of the national event (see Figure 75).

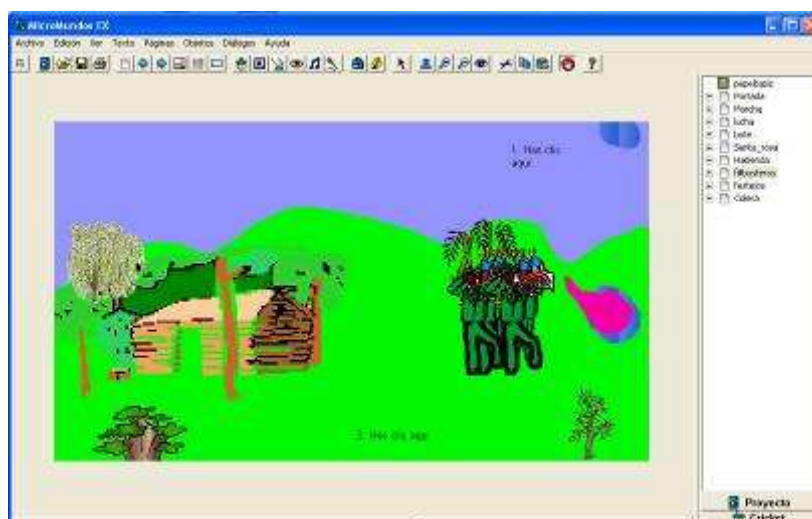


Figure 75. National Campaign project

The experience with the preschool students was very positive for the program. Students ended up introducing and preparing the preschool kids, who were not initially part of the program, to enter the program the second year.

- **Students also teach their parents at home.** At the beginning, parents were very nervous about having the computers at home because they felt responsible and they knew they couldn't afford to pay for any damage. On interviews and questionnaires conducted in October, all of the parents said that the computers had to be used only by the students to do school work and that they wouldn't touch or let anyone in the family get close to the computers.

By the third month, we heard some of the students talk about how they were doing work with their parents. Daniela, a third grade student, told us how her mom wanted to learn about Microworlds and do projects with her. Daniela started to teach her mom what she had learned and was very excited to be able to do work together with her. This family, who already had a desktop computer at home, decided to buy Microworlds because they wanted to be able to learn more with their children. Andrea, Daniela's cousin and a third grade student said, "after my mom found out that my aunt was learning to use the computer and doing projects, she also wanted to learn. Now most of our parents are doing projects with us." It was very impressive to see how in only a few weeks, parents had changed their minds about the computers and had decided to learn along with their children. Some of the families started to consider the possibility of buying a computer.



Figure 76. Grandmother presents her project during the open house

The following example was created by Brandon, a fourth grade student, and his father (Figure 77). They created several pages and procedures; animated turtles and programmed colors; and included sound. They also had several pages of what seemed the beginning of a game they were trying to create.

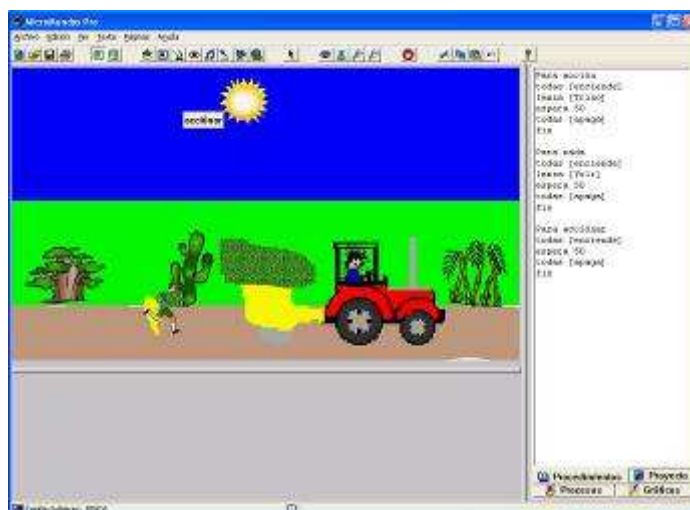


Figure 77 First Micromundos game created by a parent

I remembered students asking me one day if they could start two things at the same time in their projects; for example, play some music and move turtles. I mentioned the command “launch” and explained that they could find the proper way to use it in the vocabulary of Micromundos. Daniela, the fourth grade students mentioned earlier

in this story, and her mom, created a project together (see Figure 78). They actually used the command “launch,” which starts a process in parallel, to play some background music. They also used procedures, and animated turtles. I was pleased to find that students had managed to look through the vocabulary and learn how to use this command (and probably many others).

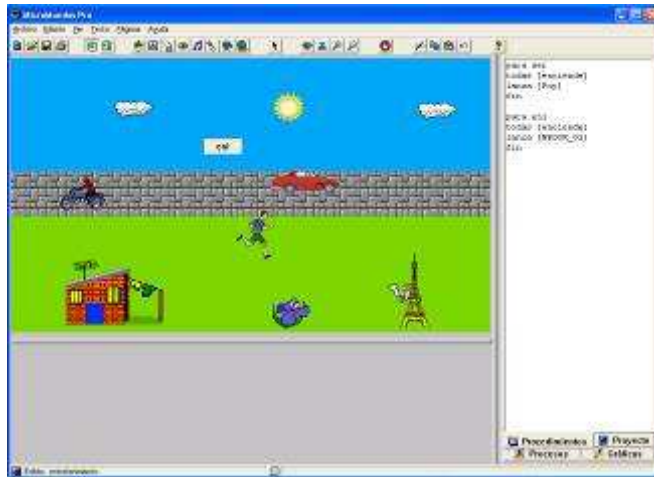


Figure 78. Second Micromundos project by a parent

By being involved and participating in different activities, both at school and at home, parents and other family member were able to experience the learning process and the work that took place at the school; they have also recognized that their participation and commitment contributed to their children’s learning; and lastly, they have realized that they can benefit directly from this experience by being able to learn about the new technologies available at the school.

- **Teacher learned along with the students.** At the beginning, I designed and taught most of the activities; but, as we developed the program, the teacher became more active and involved. We planned and reviewed activities and made changes according to the children’s interests and to the recommendation of the Ministry of Education. The teacher had previous experience working with Micromundos in a project-based learning environment, but he didn’t have much experience working with the Robotics set.



Figure 79. The teacher working with the students

During the first activities with robotics, the teacher decided to sit with the students and followed my recommendation to explore the technology. He wasn't afraid to develop activities with students and to put himself in the position of the learner; and the students felt comfortable with him.

As suggested at the beginning, in multiage-learning environments, the interactions between learners of all ages seem to lead to students' deep understanding of the topics explored. In the context of this particular experience, the fact that the students had to think about strategies to teach their younger siblings and parents about what they had learned with the technology led to further appropriation of the technology. This resonates with the experience of Idit Harel at the Hennigan Elementary School in Boston (Harel, 1991). Harel worked with fourth grade students in designing instructional mathematics software. Students had to design software to teach younger peers about fractions. This experience resulted in student engagement, and better understanding of the topic. Indeed, as several researchers have shown, having to teach a topic is a very good way to learn it (Harel 1991; Kafai 1995). It was through these strong and powerful multigenerational learning experiences that members of the community extended *Learning Culture* to accommodate the presence and use of digital technologies.

4.4 Borrowing, addressing, and learning to find independent ways into knowledge

In this model for learning environments, students have access to materials and resources by developing projects at school, and by working on collaborative projects with people who share similar interests, and who are developing related activities. Since the beginning of the program, students started to exchange information with their classmates at school and the teacher felt the need to negotiate and establish some copying rules. Empowered by their possibility of accessing information from different sources, including the Internet, the students learned to find independent ways into knowledge (Papert, 2002).

- **Teacher accepts copying as a legitimate step in learning.** The first thing students did when we started the program was copy commands to incorporate different behaviors into their projects. They quickly identified who had found a new command or had been able to incorporate new features into their projects. Some students asked for help, others just looked at the procedure and copied the new command. It wasn't hard to notice which students had copied commands without understanding how they worked. For example, in the following pictures you can see the Community project created by Brandon, a fourth grade student (see Figure 80). He was one of the most skilled programmers at the school, and was always helping others with their projects. On his project, turtle 52 (t52) represents a student, and turtle 8 (t8) represents the school. Brandon wrote in his projects the following command, *cuando [tocando? "t52 " t8] [t52, et], 52* to tell the turtle "t52," to hide every time it touches "t8." In other words, Brandon programmed the student to hide as soon as it got to school. I noticed that a few students were trying to incorporate the same behavior in their projects. For instance, Byron, a fifth grade student, copied the exact command into his project (see Figure 81); but, if you looked at Byron's list of turtles, there wasn't a turtle "t52" in his project. He only had nine turtles on his page, so the command didn't work in his project.



Figure 80. Community project by Brandon

```

Para inicio
fpos [222 56]
t52, mt
frumbo 270
repite 35[ad 10 espera 2]
cuando [tocando? "t52
"t8][t52, et]
fin
  
```



Figure 81. Community project by Byron

```

Para correr
repite 100 [ad 2
espera 2]
mt
cuando[tocado? "t52
"t8]
[t52, et]
espera 30 mt
fin
  
```

The teacher and I had a conversation about this. I convinced him that it was ok to “steal” commands and ideas, because it would make the projects richer and the students would be less dependent on us knowing, or explaining to them, how they worked. I told him that it was easy for us to tell whether students had really understood what they had borrowed and were able to incorporate the new knowledge into their project. Thus, we agreed that it was ok for them to copy commands and ideas, but on the condition that they had to understand how they worked. We then talked to the students about it, and they agreed.

- **Students integrate images from multiple sources.** Students started to copy images from Microsoft Word’s clipart and Microsoft Encarta ®, and imported images from

the Micromundos samples' folder. Some of them preferred to draw their own images instead. They used the images to improve the look of their projects.

This first project shows a collection of images Fabian, a third grade student, gathered for a project called "Animals." He collected these images from different sources: Microsoft's clipart, Microsoft Encarta®, and the Figures folder bundle from the Micromundos software. He didn't create any animations, but classified the images in different collections, such as farm, jungle, and marine animals (shown in Figure 82).

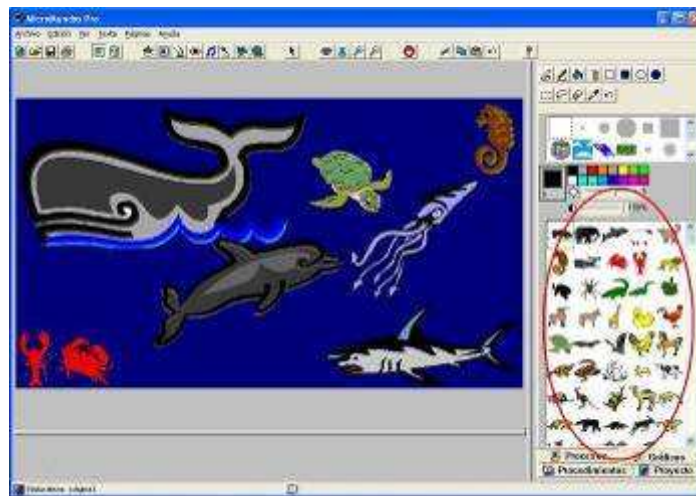


Figure 82. Animals' project

The following example shows how the students started to integrate the images they acquired from different sources. This project was created by Brandon, a third grade student (see Figure 83). He imported all of the dinosaur images from the folder bundle that came with the software into a project, and created animations.



Figure 83. Dinosaurs' project

A final example shows a more elaborate use of figures and background images. Maryanne, a fifth grade student, created elaborated projects, with a variety of images and programs. For example, she incorporated figures and images from different sources into a project about children's rights and duties (see Figure 84).



Figure 84. Rights and duties project

Maryanne created a background for the child's room, and incorporated different figures of objects she imported from the figures' folder. She also used an animation

she downloaded from the Micromundos' website²⁴. In this page, called child's rights, she programmed the child to do different things in his room, which she considered rights: he sleeps, plays with his toys, reads his books, and so on. She also had modified the figures she downloaded from the Micromundos' website. She added a book to one of the figures in order to tell her story.

- Students use internet as a source of knowledge.** Students also found sample projects on the Internet, which they quickly started to explore. I knew students had been looking at the Micromundos' website, but I didn't imagine that they had copied entire projects and used them for their activities until I was analyzing the contents of the students' folders. The first project I came across was about Central America's assets and problems, created by a group of students. When I opened the page they created with problems, I saw an image that looked familiar to me. I went to the Micromundos's website and I found a project called Rain-cycle (see Figure 85). My first reaction was disappointment; but, when I started to analyze the project, I was pleased with what I found. I know now that I shouldn't have judged the students' actions negatively. They had modified the original project and made it their own.

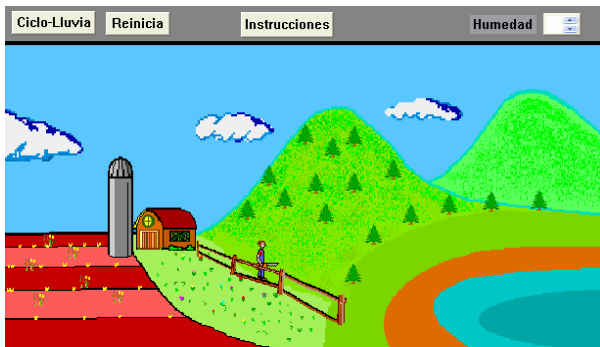


Figure 85. Rain-cycle project

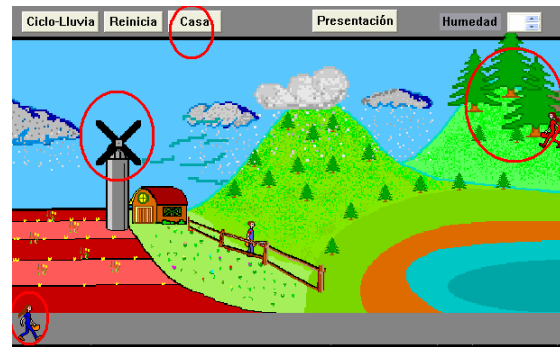


Figure 86. Assets and problems

They had changed the original instructions and made their presentation page with assets and problems in Central America. They used the rain-cycle page as their

²⁴ School had access to Internet via modem, since the beginning of the program, but the connection wasn't strong enough to support the connectivity of the entire network. At the beginning of the second semester, a 128 kbps ISDN connection was installed at the school. The new service provided a better service and allowed the students to use the Internet.

problem page and added new procedures. For example, they created a new procedure called “casa” to show how people in Central America were destroying the forest to build houses, added other characters, changed some of the existing figures, among other things (see Figure 86).

There is a constructive act behind what seemed a simple act of copying instructions, images, and projects. The students not only found resources to improve the look and performance of their projects, but they also found independent ways into knowledge (Papert, 2002); and, in this process, we had to find solutions that fit the students’ new interests and practices. As a result of this, students weren’t limited by their teacher’s knowledge on the subject (Papert, 2003; Urrea, 2004), nor were they constrained by the activities proposed in class.

These stories of change suggest the adjustments to the conceptual model where:

- computer should not only be present at a 1:1 student:computer ratio, but it should be present at home;
- “whole project learning” allows students to integrate aspects of the community life and to make connections to powerful ideas. It is also accommodates scrutiny of the curriculum framework;
- community learning culture emerges as parents and sibling get involved;
- and, students learn independent ways to knowledge.

5 Study of Appropriation

“Within the classroom setting there are in fact three actors ever present –the teacher, the student, and the parent(s), who are ‘present’ in the sense that the beliefs, attitudes and habits of mind of the family are thoroughly embedded in the mind of the child. The interactions amongst these three actors largely determine the students’ willingness and readiness to learn.”

(Coleman 1998)

The most important contribution of the work reported in this thesis is not the transformation of the school itself, but the effects of the transformation on the three dimensions: students, parents, and the teacher; and the cross-implications of the individual effects. This study will be used to suggest that "appropriation" is the most powerful theoretical lens for studying the effects of the computer's presence in learning environments.

According to Ackerman (Ackerman 2004), “Vygotsky’s theory of cultural appropriation is not so different from Piaget’s notion that children learn through acting in the world.” She also tells us “More than Piaget and Papert, Vygotsky stresses the role of adults as teachers, and cultural artifacts as teaching tools.” Wertsch extends Vygotsky’s idea of appropriation, defining appropriation as the “the process of taking something that belongs to others and make it one’s own” (Wertsch 2002):p. 53).

Appropriation has been employed to study the use of technology by teachers in education programs (Laffey and Espinosa 2004); to study intention, technology-use behavior, and satisfaction during distance education programs (Lin 2005); and to observe people’s adoption of mobile technologies (Carroll, Howard et al. 2002). A deeper instance of appropriation is defined by the Apple Classroom of Tomorrow research project, which defined it as “the point at which an individual comes to understand technology and use it effortlessly” (Tierney 1996).

Along the same lines of thought, but going back to Vygotsky's idea of appropriation, I define it in terms of the students' relationship with the tool (digital technology) and its use in the particular context of learning. I also make a distinction between technological fluency and appropriation; Papert and Resnick introduced the term "technological fluency" to refer to the ability to use and apply technology in a fluent way, easily and smoothly, as one does with language (Papert, 1995). In my view, thinking in terms of technological fluency still places a lot of attention on the technology. When appropriation happens at the deepest level, technology almost becomes invisible.

In his book, *The Children's Machine* (Papert 1993), Papert introduced the term "letteracy" to refer to the superficial sense of knowing how to read. In a similar way, the term fluency can be applied to the superficial sense of acquiring the skills involved in using the technology. If attention is paid only to teaching and evaluating how much the students know about the technology, there is a risk of losing the opportunity for them to appropriate the technology to become independent learners.

Although this thesis takes into account the dimension of students, parents, and teachers, it mainly concentrates on students' appropriation of technological tools in the context of their learning; and how parents' and teacher participation influenced how that happened. Before engaging in the study appropriation by the students, I observed what happened with the teacher and the parents.

5.1 On teacher

Edgar had been teaching for more than 11 years. He started working at El Silencio School in 2000, and he had gained the trust and respect of the community. He had previous experience working with technology; he had participated in Intel®'s Teach to the Future program and the Educational Informatics program of The Omar Dengo Foundation. He is part of a group of one-teacher-school teachers, who had been working closely with the Ministry of Education on the design and formulation of the new curriculum framework for one-teacher schools in the country. Edgar was well respected by the authorities at the Ministry and by his colleagues.

Since I only had the opportunity to work with one teacher, my attempt to understand his evolution over the course of the program is a reflection of my observations, the reports, and interviews I did with him. The story of his appropriation follows.

5.1.1 Becomes familiar with the new approach

I worked together with the teacher in the design and development activities for the students. Teaching a group of 15 children from 1st to 6th grade was one of the most challenging aspects of the project. Showing the teacher that I was able to include all students as I facilitated was critical to gaining his trust.

I spent as much time as possible at the school, interacting with the teacher, the students, and the families. The teacher was there with me to support and help, but he was mostly an observer. At first, I expected the teacher to play a more active role, but he spent a lot of time writing reports and documents. I was worried, because I thought that he was counting too much on my being there. I told him that it was important for the students to see him participate and collaborate with them. I described my own experience with the students during the first two weeks; how they gathered around me, and became interested in collaborating with me every time they saw me engaged in doing something: building a mechanism, programming a turtle, looking for information, and so on. I realized he was in fact paying a lot of attention to what was happening at the school when he mentioned that he had also noticed something similar with the students. He said, “there are two or three students who have become sort of role models for the other students. They are figuring out new things all the time. They incorporate new commands, change the windows’ settings and color, change the computer resolution, and so on; and, other students have started to pay attention, so they can do the same.” I agreed with him and told him that he could also become a role model for them. After our conversation, he started to participate and collaborate, not only with the students, but also with me as I was facilitating the activities.

The teacher became more active and started to collaborate with me. I intentionally planned to not be at the school all the time to give the teacher room to develop his independence. I tried to get the teacher involved as much as possible by encouraging him

to facilitate activities and incorporate changes according to his needs and interests. As time passed, he not only facilitated the activities I proposed, but he also modified and adjusted them according to his interests and needs. For example, he modified and facilitated an activity I had proposed to him about Costa Rica, which he called “Encounter of Cultures.” This activity has been described in Chapter 3.

As his confidence grew, he started to collaborate with me. During a meeting with the teacher, the students, and one of the experts from the Omar Dengo Foundation “Edgar said,²⁵ “we are working together [Claudia and I] as a team to combine the technology and the teaching methodology. The process becomes richer as we go.” He also explained the strategy we had developed by working together as a team. He said, “we decide on a guiding topic, and plan an initial activity, which usually involves having the kids research and tell us something about the topic; after that, the activity evolves based on what they are bringing and what they are interested in doing.” As a result of the collaboration and work, we started to introduce some changes into the activities: instead of designing an activity for all the students, we designed several activities which offered a range of topics; we gave the students the freedom to decide who they wanted to work with. On occasion we suggested alternative ways to create groups.

During the final phase, the teacher started to design and develop his own activities in the classroom, with the help and support of distant and local tutors on the knowledge network. The main goal was to allow the teacher to engage fully and creatively with every aspect of the program. It also offered the opportunity to observe the concept of the knowledge network of local and distant tutors as a way to support and build the capacity of the teacher. An example of the kind of activities the teacher designed and facilitated is described in the following example.

²⁵ You can find information about the interview on the project’s blog: <http://createprojectblog.blogspot.com>

Topic: The National Campaign

The teacher documented the activity as follows, “In the development of the classes of Social Studies, we worked on an activity about the National Campaign. The National Campaign commemorated the battle between Costa Rican troops, and a group of filibusters under the command of William Walter²⁶. The students created projects to represent the journey from San Jose to the Santa Rosa ranch, where the battle took place; the students programmed very good effects of the battle. This type of project allows the student to assimilate the content in a practical and dynamic way.”

This activity was developed at the school before March 20, the day Costa Rica celebrates the victory against William Walker and the filibusters. The teacher also sent me the projects the students were doing as part of the activity. Looking at the projects, I was able to guess that there was a sequence of events that the teacher probably took the students through. Most of the students had divided the project into three major events (see Figures 87, 88 and 89), and a few added more details, such as “Costa Ricans celebrate their victory.” I also noticed that the students had created their own images, as well as securing images from sources other than the Figures’ folder bundle from the Micromundos software; and, that they had made sophisticated programs and animations.

- The president of Costa Rica called all Costa Ricans to join forces and fight against William Walker.



Figure 87. Map of Costa Rica

²⁶ William Walter was a soldier, who attempted to conquer several countries in Latin America. He held the presidency of the Republic of Nicaragua from 1856 to 1857, when he tried to take control of Costa Rica. You can find more information at http://en.wikipedia.org/wiki/Battle_of_Santa_Rosa

- The troops travel from San Jose to Liberia gathering more soldiers. They arrive in Guanacaste, where they meet the Filibusteros.



Figure 88. Costa Rican soldiers travel Guanacaste

- This page represents the battle of Santa Rosa. The Costa Rican troops fight William Walker and the filibusters, and win after only 14 minutes of fight



Figure 89. Battle of Santa Rosa

What I was not able to tell by looking at the projects was whether or not the students had integrated concepts from different disciplines. I discussed this issue with the teacher in a conversation on Messenger.

Claudia... says:

I have looked at the projects that the students made

Claudia... says:

Do they integrate different disciplines?

Claudia... says:

Or was it only about the topic of Santa Rosa's battle for social sciences?

Edgar says:

No. We integrated concepts: in Spanish, we worked on composition, and spelling

Edgar says:

In Science, we reviewed the climate and the vegetation

Claudia... says:

Very good...

Edgar says:

In Math, some aspects of agricultural production, temperatures and amount of rains

Claudia... says:

It is more than the projects reflect

Claudia... says:

It is very important to document these activities

I was pleased to hear that the teacher was trying to integrate some concepts from other disciplines, but I couldn't see that reflected in the projects he sent me. I decided to check in the students' folders for related information or projects, and I found some projects. The first one was about climate in different regions in Costa Rica (see Figure 90); and the second one was about Central America's assets and problems (see Figure 91). In this project, the students seemed to be looking at vegetation, rain, and elevations in Central America, with a particular emphasis on Costa Rica.

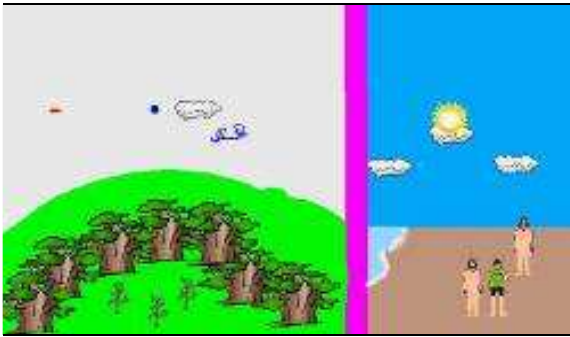


Figure 90. Climate



Figure 91. Vegetation

The teacher sent me the final version of the students' projects and some reflections about their work. He wrote, "after the presentation of the projects, we have seen how the teaching/learning process is developed in a playful way, and the interaction with the computer allows a pleasant and lasting learning experience for the student."

I can also infer by looking at the type of projects facilitated by the teacher that he was able to integrate some concepts from different areas, but not within the same project. He used a topic to create activities, but he didn't incorporate all of the concepts into a single activity, and the projects reflected that. When I asked the teacher about this he said, "I am trying to design activities, but it is very hard to integrate concepts from different areas." Given the way the Costa Rican framework for rural school is organized, I understand the complexity of the work. Based on my own design of the activities, I argue that it is possible to go beyond the constraints of the framework to design and facilitate activities that integrate concepts from different disciplines, make connections with students' lives and interests, and foster collaboration among students of different ages. Still, based on

what Edgar achieved it may take more time, a more active support network, examples in more schools and acceptance by the Ministry to offer this idea in a sustainable way.

As I visited the school on less frequent basis, I tried to communicate with the teacher and the students on a regular basis to follow their work and to provide support and ideas, but it was hard to get him to communicate with me in time to give me the opportunity to help him develop his ideas further. I started to communicate more with the students, who sent me email and also some of the projects they were doing in class. I then started advising them on how to make their projects better.

5.1.2 Becomes interested on other people's learning

The teacher also supported my work as a researcher. He helped me with the process of gathering data by recording video, taking pictures, making copies of children's folders, and giving parents questionnaires. From the beginning, I made sure to keep Edgar informed about the research process, and the preliminary findings. He was as interested in the research as he was in the other aspects of the projects.

He asked the students to reflect on their experiences over the duration of the program. At the beginning of the program, I told the teacher that students' reflections about their experiences were very important for my research; I specifically requested the students to write short reflections, at the beginning and end. When I started to look at the children's files during the final analysis, I found 40 documents with reflections that the students had written²⁷ at his request. All of the students had written at least one reflection, some students had written as many as four reflections (See Annex A).

Edgar also contributed changes to the questionnaire I had designed for the parents, which I had asked them to answer few times over the course of the program. I discovered the changes as I started to review the answers. The teacher had decided to rephrase and change the order of some of the questions. When I asked if he had changed it, he said, "yes, I changed the questions a little bit, so the parents could understand better what you were trying to document." It was obvious that in order to make suggestions, the teacher

²⁷ The collection of children's reflections is included in the appendix.

not only read the questionnaire, but he also reviewed the answers. What it would have been nice if he had told me, I found his initiative both relevant and positive.

Edgar, the teacher, and I had a long conversation about how to inform local authorities and colleagues about the work he was doing. He frequently gave me reports about the conversations he had with them about the program and how he dealt with the differences between his work and the others. I was always impressed by his commitment to share his experience with his colleagues, and by his confidence to influence them. One day, I suggested to him that he could organize a meeting with the other teachers in the area to give us feedback on the program, and to make recommendations about how to create similar experiences at similar schools in Costa Rica. He liked the idea and organized the meeting. He actually sent a report back to me of the meeting he had with the other teachers, a few weeks later. In the report, Edgar and the other teachers, said:

One-teacher schools have special characteristics; one teacher interacts with all of the students. He makes sure the content is developed in parallel with the students. When technology is incorporated into the learning process, the learning process itself is augmented, favoring the individuals, as well as the group.

He also included the following recommendations for future development: improve communication and collaboration between the ministry of Education, the Omar Dengo Foundation, and the school; prompt response to technical problems; support from Omar Dengo advisors²⁸; and, absolute commitment from the teachers. Coincidentally, the recommendations that the teachers made were relevant to a support strategy. But the point that I want to make is not only that the teachers had important recommendations to make, but also that they felt empowered by their participation at a deeper level.

I don't have enough evidence to backup this finding as something that emerged as a direct result of the interactions that occurred during the project, but researchers in the

²⁸ In the case of Costa Rica, the Omar Dengo Foundation advisors give support to the teacher on the methodology to introduce the technology into the learning process; therefore, the teachers meant that a program like the one implemented in Costa Rica, requires support on the methodology and the use of technology in the learning process

“collaborative knowledge building” field have identified similar conditions (Scardamalia and Bereiter 1999): “the teachers who remain continually fascinated and involved are ones who have a dual interest. They are interested in advancing their understanding of history, geology, biology, cultural anthropology, and so forth; and, each year they experience some advances themselves as they work with students on problems in those areas. But they are also interested in understanding the process of understanding itself.”

5.1.3 Big crisis and shift of attitude

The greatest shift for the teacher happened as he realized that the project had become his alone. The transition from having me and/or the Omar Dengo foundation tutors there to support his work to not having anyone was very hard. Even though I kept calling him and communicating with him and with the students, he started to pay less attention to the work that the students were doing with the computer.

During the last months of the program, I didn’t visit the school as often. Edgar and I worked together via email, video conferencing, and instant messaging. As time went by, the teacher started to communicate less; and the projects that I received from the students showed that the nature of the projects had changed; they started to look more like presentations. For example, a project about the respiratory system created by Daniela²⁹, now a fifth grade student. First, she incorporated a picture of the respiratory system (see Figure 92); the picture already had the names of the organs, so she did not even have to write that. She created a second page about the respiratory organs and functions (see Figure 93); she included some text that explains the system’s functions, organs, and how it works. Reading the text, I can tell that she used her own words; but, I can also tell that she probably doesn’t remember how a respiratory system works. I questioned the way in which she used the technology; first, she lost time doing something she could have done with pencil and paper; and second, she missed the opportunity for a greater learning experience that would have resulted if she had approached the subject in a more creative way (i.e., a simulation, a game, etc.).

²⁹ Costa Rica has a different academic calendar than the United States. We started the program in September, which corresponds to the second semester of the academic year; therefore, mid-way into the program, the students transitioned to the next grade.

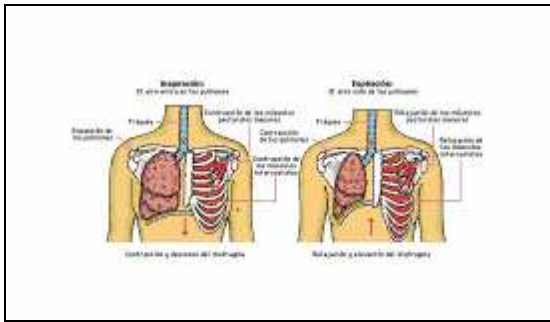


Figure 92. Respiratory System

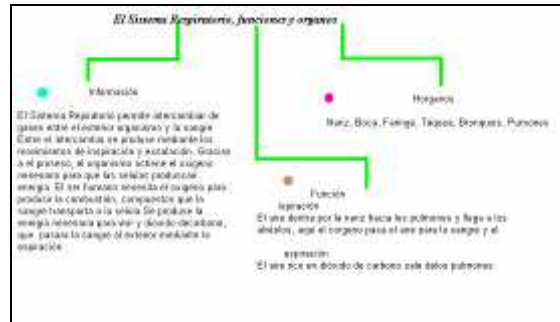


Figure 93. Respiratory organs and functions

Another example is a second project created by Fabian, now a fourth grade student, about the digestive system (see Figure 94). His project was more elaborate; what seemed a simple picture of the human digestive system, turned out to be a collection of organs, which he placed on turtles and programmed to show their name when you click on them. Different from what Daniela had done with her project, Fabian had spent time working with each of the components of the digestive system, learning its location and name. In fact, I found out that Fabian had done his project by downloading a project from the Micromundos website, but he was already changing the project to also create his own skeleton (see Figure 95).

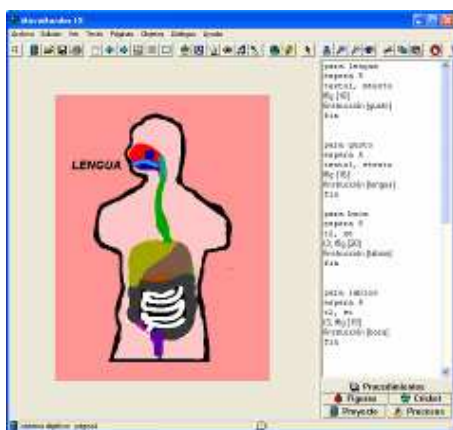


Figure 94. Digestive system

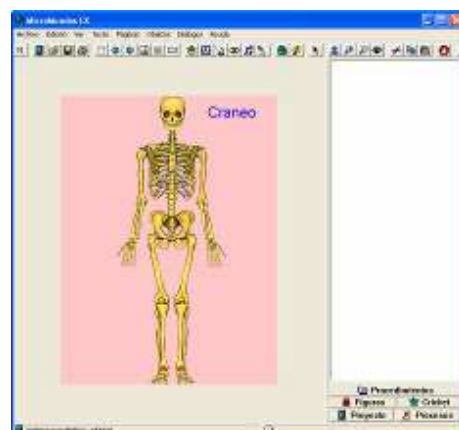


Figure 95. Skeletal system

Neither of those two projects was finished; they had pages with missing information or had missing procedures. This example reminded me a lot of traditional school; there is little room to pursue the students' interests and ideas; and, there is little time to explore and learn concepts further, because students have to move to the next class and work on the next topic. I talked to Edgar about it, and he told me that the students were creating these kinds of projects as part of the curriculum he was developing. Then, I questioned the fact that some of them weren't finished. He said that he evaluated what they had learned, and he had given them the option to finish the projects during their own time. I was grateful to him for not keeping the students from using the computers, but he was obviously not paying the same attention to what they were doing, nor encouraging them to use the technology in more creative ways. I recommended specific ways in which he could guide the students to develop their projects further. He accepted my advice, but I knew the problem was deeper than lack of knowledge and vision.

I went back to the school once more before the research program was officially over. I talked extensively to Edgar about these issues and his interest in continuing the program. He wasn't as motivated; he felt a lack of support and continuity. I had to remind him about the many conversations we had had via instant messenger and video conferencing, and I also reassured him about my willingness and availability to work with him on specific projects. I also talked to him about the Omar Dengo Foundation and their role in the program. They had been following and supporting our work from the beginning, and they were still committed to doing so. He knew what I said was true, but he still felt he didn't have the support he needed. In the end, he understood that continuing the project was his decision alone. Today, when I talked people at the Omar Dengo Foundation about El Silencio, they refer to the students as "your kids," meaning Claudia's kids, but when I talked to the teacher, he talks about being proud of how much "his kids" have accomplished, or the wonderful projects "his kids" are creating at the school and how advance they are compared with other children in the country.

The teacher finally realized that the project was his only and he was in charge of carrying forward. He continues to work with the students; he has accommodated the learning approach to his own needs and interests. The students continue to work with their laptop computers; they use them to work on projects and collaborate with students of all ages.

One of the last projects I received before finishing the work at the school was about the community. I was expecting to see projects about the community map, but instead I received very different projects. For example, a project about the Arenal Lake created by a group of students, two from 6th grade, one from third grade, and two from first grade. Arenal is the biggest artificial lake in the country and is located a few miles away from the community (see Figures 96 and 97). This group of students decided to work on this aspect of the community and the region; they had even visited local facilities to take pictures and get information.



Figure 96. Preparing to build lake



Figure 97. Building the lake

If you look closely at the Figures, you will see that they even included the real pictures of the land before it was flooded. They researched the benefits of the lake to the region and the country (see Figure 98). The lake became one of the main sources of power, employment, and tourism in the country and it provides water for the region.



Figure 98. Benefit of Arenal Lake

To summarize, I believe that the collaboration and communication routine I established with the teacher provided a strong foundation for the sustainability of the change introduced by the implementation of the model. The teacher was able to design and facilitate activities that integrated concepts from different disciplines, and invited students from different grades to work together, but he was not able to facilitate a deeper connection with mathematical ideas, as I had expected and anticipated. For instance, he could have engaged the students in the creation of a physical model of the digestive and skeletal system and investigation, which can add an important dimension to the students' learning experience about the body and also can reveal powerful ideas.

A big challenge was getting the teacher to communicate with me about the activities he was planning when I was no longer at the school in time for me to give him feedback on his proposed approach and implementation. Initially, I hoped he would be able to communicate with me similar to the way in which I was able to communicate with Seymour (and David) when I was beginning the program. It is not clear whether the teacher's hesitancy came from laziness, habit, or time pressure arising from no advanced planning.

I can only think now of what I could have done differently: 1) first, I believe that having at least a second teacher, or a similar intervention, would have made a difference. While I served the function of the second teacher for a time, I could not maintain the type of long-term partnership and critical culture that could develop between two or more teachers, a culture in which innovation, sharing, and critique would become on-going activities in the community of teachers; and 2) having access to materials could have encouraged the development of physical activities. As described in the stories of change, students took creative advantage of resources they found on the Internet to download Micromundos projects, and also used the example projects they had on their computers. These were available and did not require extra purchase by the school.

5.2 On parents

In order to understand how parents appropriated the technology and the ideas behind the program, let's review who they are:

- A total of 12 families participated in the program.
- Most of the families own their houses, and have lived in the community for more than 25 years.
- 3 families had a computer at home before the program started. Only one of the mothers reported that she used the computer at home.
- There wasn't significant difference in the level of education among the parents, who participated in the program. On average mothers had completed a higher degree of the education. Of the 12 mothers, 11 had finished primary school and 1 had finish high school; and of the fathers, 9 had finished primary school, 1 had finished 4th grade, and 1 had finished 3rd grade.
- Parents truly valued and cared about their students' education. They saw it as an opportunity to improve their lives, to become professionals, and to be good citizens.

My description of the parents' participation and involvement follows:

5.2.1 Computer belongs in the computer class

At the beginning of the experience, parents considered the program a great opportunity for their children because they understood the program as an opportunity to develop computer skills, which they associated with great opportunities for their future. At the same time, they were concerned that their children were spending too much time with the computer, so they weren't learning other things.

Results of the questionnaires done by the parents at the beginning of the program reflected how the existing culture drove the expectations parents had about the program. They questioned the fact that the students had nothing written in their notebooks. During interviews and focus groups parents and talked about the computer and other school subjects in the same way. They actually expected the computer to be one more school

subject, and they had a hard time imagining how the students were going to graduate and finish the academic year, if they spend so much time “learning about computers”. They basically said, if they are learning to use a computer, a computer class should be added to the school day; but, computers shouldn’t be used all day at school.

I had a few meetings with groups of parents and also individual discussions; but, the more I explained, the more confused they got. They said they supported the program, but were stressed about their children’s “performance.” I told them I understood their concerns, and I asked them to let the program continue, and advised them to get involved and observe their students’ progress.

5.2.2 Observe, learn and participate

The biggest shift happened as the parents started to observe the learning and the use of the computer by their children at home; they realized that they were not only learning about the computer, but they were also using the computer to learn about other things. Parents also started to learn about the computer with the guidance of their children.

At the beginning parents were very nervous about having the computers at home because they felt responsible and they knew they couldn’t afford to pay for any damage. In interviews and questionnaires conducted in October 2005, 100 % of the parents said that the computers had to be used only by the students to do school work and that they wouldn’t touch or let anyone in the family get closer to the computer. Children continue to take the computers home not only to do school work, but also to do other projects or activities that they are interested in doing.

The participation of the parents had a domino effect, which I was able to observe given how small the community was and how close I became to some of its members. By the third month, we heard some of the students talk about how they were doing work with their parents. During a discussion session with the students, Daniela, a student from fourth grade told us how her mom wanted to learn about Microworlds and do projects with her. She started to teach her mom what she had learn and was very excited to be able to do work together with her. This family, who already had a desktop computer at home, decided to buy Micromundos because they wanted to be able to learn more with their

children. Andrea, a student from third grade said, “after my mom found out that Daniela’s mom was learning to use the computer and doing projects, she also wanted to learn. Now most of our parents are doing projects with us.” In only a few weeks, parents had changed their minds about the computers and had decided to learn along with their children. Some of the families were even talking about buying a computer. During an interview with Andrea’s mom, she told me, “we don’t want to stay behind!”

On a questionnaire conducted by the end of the first semester (December 2005), 100% of the parents reported that they used the computer, and learned from his/her child how to create a Micromundos projects (some of the projects are described in Chapter 4), and two of them also reported that they also used Microsoft Word. Parents also liked working with their children. When asked if they help their children with the homework, all of the parents said that they participated; only two of them said no. When asked if they like working with their children on the computers, only one mom responded she didn’t; she said, “I don’t like to use it, but my daughter insists that I have to use it.” This was Maryanne’s mom, who was the only parent that answered that she wasn’t satisfied with the program because she didn’t want to be held responsible for the machine. During a focus group with the parents, this mom also complained about national tests and feared that “[her daughter wasn’t] receiving the same kind of preparation that other students in Costa Rica were receiving.”

A few parents also became involved with school activities. Fabian’s grandfather who came to help build the seismograph with the children, and ended up learning about how they work (this story is described at length in Chapter 4); and, Fernanda’s mom, who came to the school complaining about her daughter’s participation, and ended up passionate about the students’ work; she ended up assisting me at school when Edgar, the teacher had to leave early for a meeting. As described in Chapter 4, both of these events had a positive effect on the relationship these family members had with the teacher, which has nothing to do with learning, but it was important for the support of the project.

5.2.3 Appropriation through children's learning

Although not all the parents appropriated the ideas about learning in a deep way, when asked about the program, parents referred to the solar system, the community, the natural disasters, and so on. They didn't talk about the program in terms of the computer. They did recognize and were proud of how much they knew, but as one of the moms said during the last interview, "I am not worried about the program. We know that our children are learning the concepts, they are just learning them in a different way".

There are a couple of instances of parents who showed a deep level of appropriation. One of them was mentioned on the previous chapter (Chapter 4). During an interview with one of the moms, she complained about the teacher not continuing to facilitate the same kind of activities with the use of technology. I asked her if she had specific ideas and suggestions for how to improve the program and she told me, "for example he gave them an assignment the other day. He asked the students to research and write about the human cell, but in their notebooks. It would have been nice if he had asked them to do something with the computer. They could have studied the parts of the cell, drawn them, made a simulation, and who knows." Her comments and concrete ideas about what was possible with the computer showed that she understood the program and imagined an opportunity the teacher didn't, or was choosing not to.

The other story is about Mario's mom. I only met his mother once, but the written information I got from her on questionnaires was very interesting. I started to pay attention to Mario's progress and started to analyze what his mother thought about the program and his relationship with the computer. Mario, a 2nd grade student, was a very active boy. He liked to tell jokes and to make people laugh. He enjoyed playing outside with his friends. He seemed to enjoy school for social reasons, more than academic; he continuously ran into trouble with the teacher for not paying attention or following rules. He liked the computer, and felt very proud of what he had learned to do with it. He always wanted to work with the computer, and got frustrated every time he couldn't take the computer home.

His mother always wrote about how impressed she was with all the things she saw him doing, talked about how she enjoyed working with him on different projects and learning

from him how to create and animate creatures. She also talked about how motivated he was with school after the program started. She not only said that Mario wanted to go to school, but she described how the new learning environment was more appropriate for her son's learning style. When asked about what she thought of what her son had done with the computer she said, "My son has learned a lot. The programs brought a lot of enthusiasm because he likes to discover and the computer has managed to provide that for him." Her understanding of her son's learning process and relationship with the computer was very deep. When asked about what she thought about the program she said, "I think the program is great because the students learn so much and all of them in different ways because they discover different learning styles."

The endorsement and appropriation by the community was very important for the project. Even though not all parents participated or appropriated the ideas in the same way, the effect of a few becoming involved had a positive effect on the rest of the community members. An interesting fact, which I can not support with data, is that there was no negative effect on Meryanne's mom, who didn't seem satisfied with the program. Research on social networks such as that done by Juan Carlos Barahona (Barahona 2007), would be useful in understanding the influential members of a community, and how they could influence innovations in education. Barahona found that patterns of advice and use of media provide an effective way to identify the influential members of a community.

The interest and motivation of the parents reached other communities. The number of children at the school increased during the second academic year. The teacher was expecting 19 children in January, but a couple of families moved to the community just before the beginning of the school year and he had 21 students enrolled. He said, "two families moved to the community looking for employment opportunities and for better education for their children." He told me that people have heard about the program from the members of the community, especially from parents and students who have been participating. He mentioned that families from other communities have talked to him about sending their children to the school, but that they wouldn't have access to public transportation. He said that people see the project as a new opportunity for the children. He also added, "People not only see it as a new opportunity and better future for their

children, but also for themselves.” He said this increase in enrollment is not normal for this type of school, but quite the opposite, “students usually leave³⁰.”

It is known that parent involvement is one of the conditions that affect students’ performance at school (Coleman 1998; Fullan 2001), but the significant aspect of this outcome is that, in fact, parent involvement and participation emerged as a result of the program, it wasn’t forced on people.

5.3 On children

A total of 15 students participated in the program: 3 in first grade, 3 in second grade, 5 in third grade, 1 in fourth grade, 2 in fifth grade, and 1 in sixth grade. Of the total number of students, 9 are boys and 6 are girls. As a result of the practical experience, I observed that students became familiar with the technology, by exploring its functionality. They improved the quality of research and complexity of projects as they took their computers home; initiated their own projects; learned as they taught their siblings and their parents; integrated images and information from multiple sources, including the Internet; and, became independent learners, fluent with the technology as they designed and created projects.

I observe different levels of appropriation by the students. The first has to do with the object and its functionality, the second with the technological fluency and the third, the deepest level of appropriation, concerns learning and changes in attitude. My observations follow.

I define the following levels of success, which I will be using in rest of the document, to assess the results: 0 = does not happen, 1 = barely happen; 2 = happens, 3 = happens well, and 4 = happens beyond expected.

I also use the symbols. A star means a girl, and a dot means a boy; and assign a number to every student. To identify siblings, I added a letter next to the number. For example Fernanda(2a) and Paula(9a) are sisters, they both have a letter “a” next to their number (see table below).

³⁰According to the Department of Statistics at the Ministry of Education, the dropout rate for one-teacher schools in the country is 8.7 percent.

Table 3. Student

Number	Grade	Student
1	1	Eduard
2a	1	Fernanda
3	1	Nicole
4	2	Mario
5	2	Douglas
6	2	Carlos Wilson
7b	3	Fabian
8	3	Andrea
9a	3	Paula
10	3	Jean Carlos
11	3	Brandon
12c	4	Daniela
13	5	Meryanne
14b	5	Byron
15c	6	Melvin

5.3.1 Appropriation of object and the functionality

Students expressed their commitment with the project and with the technology. As described in Chapter 4, students took very good care of their computers, and even had their mom's make carrying cases to protect them. This commitment and connection with the technology was extremely important for the success of the pilot experience. On the one hand, if the students would not have felt ownership over the technology, they probably would not have taken such good care of it, which would have resulted in problems for the pilot experience. On the other hand, it would have been difficult to take the project any further if the students would not have seen the technology as a valuable object to own and protect.

Students also became familiar with the computer’s functionality. Students explored the technology and found ways to make personal connection. They appropriated the technology even further because they made it their own.

To give a sense of how knowledgeable they are with the technology, I locate the students in the following table according of the level of proficiency with the technology.

Table 4. Knowledge of technology

Level	0 Does not	1 Barely	2 Yes	3 Well	4 Beyond
Knowledge of technology			2a ★ 3 ★ 1 ●	8 ★ 9a ★ 12c ★ 13 ★ 4 ● 5 ● 6 ● 10 ● 14b ●	7b ● 11 ● 15c ●

Observations

All of the students became aware of the different features of the computer; starting from simple things such as setting the background picture, changing the appearance of windows, and creating different screen savers. First grade students had less opportunity to explore and play with the technology because they used the computer desktops available at the school.

The rest of the students spent more time exploring the technology. They engaged in more complex tasks such as accessing and organizing their files, and sharing folders to exchange files using the wireless network. Some of the activities developed during the program required the students to integrate their work in a collaborative group project. Since the Internet connection was not activated at the time, they used the local network to exchange information. They also used this mechanism to exchange messages.

Students were not only interested in learning to use the wireless network, but they were also interested in understanding how it worked. One of the tutors from the Omar Dengo sent a report about an experiment the students decided to run. They wanted to find out how far from the school they could take their computers without losing network

connectivity. They took their computers out of the school and kept checking the network. They found out that a computer could be as far as the church, which was probably 80 feet from the school, and could still see –or be seen –by other computers. They finally had a discussion about how the wireless network was set up and whether or not they could have access to it from home.

Three of the students, explored the technology even further. They knew how to fix problems with the display, set up the network, the printer, perform backup, etc. They learned all of these things as they were creating projects and came across problems which became opportunities to further appropriate the technology.

I have an interesting anecdote about my observation of appropriation of technology, which that happened to me as I was working at the school. I annotated on my Blog an observation about how technology centered the program seemed to me (see Figure 99), “The children opened beautiful projects about community issues and solutions, about the solar system. When I asked them to tell me about the projects, they started telling me about procedures, commands, and buttons. I kept asking about the design and process, but most of them focused on the technical aspects of the projects. We actually talked to the children about this ... I told them that I was really impressed with the projects they had created, and I was also interested in hearing about what they had learned by building the project. I talked to half of the children and all of them kept doing the same thing.”



Figure 99. Technology Centered, Blog page

On the same day, Seymour Papert sent an email giving me his interpretation of what was happening at the school. In his email, he wrote:

It is interesting that they talk about technology.... At Hennigan, we consistently observed the following sequence of kinds of answers to "what are you doing?"

---In first month: "Using the computer"

---After 3 months "using Logo"

---after 6 months: "Working on a project about Mars"

To be expected that a similar sequence will be anywhere. It will take time for them to be decentered from technology.

At this point I opened my mind to further appropriation of technology, but I didn't stop paying attention to the students' relationship with it. I was happy at that point to know that the situation was known and that I had to be more flexible during this initial part of the program.

5.3.2 Technological Fluency

As described earlier, technological fluency refers to the ability to use and apply technology in a fluent way, effortlessly and smoothly. In order to become fluent, students have to come in contact with the technology and use it in a meaningful way.

In the case of this particular experience, I looked at the level of sophistication of the projects the students had created. I also looked at my observations and the teacher reports. I considered the level of understanding of project evidence of fluency, especially when younger students had participated on a project with older students.

I locate the students in the following table according to the level of fluency that they gained.

Table 5. Technological fluency

Level	0 Does not	1 Barely	2 Yes	3 Well	4 Beyond
Technologic al Fluency			2a ★ 1 ● 4 ● 5 ● 6 ●	8 ★ 12c ★ 10 ● 14b ●	9a ★ 13 ★ 7b ● 11 ● 15c ●

Observations

All of the students gained a level of fluency that allows them to use the technology to create their projects. They acquired this fluency by using the technology to learn about other things, not because they had a specific class about the computer, Micromundos, Encarta, or any of the other digital technologies.

The level of fluency varied with the capabilities of the students and also with the age. For example, younger students did not use procedures, but they program their turtles by writing few commands on the textboxes. Younger students created less sophisticated projects, but they were able to integrate elements of the topic that they were studying.

Students also used the available resources, which they incorporated in their projects. For example, students used Encarta to find information about different topics and Microsoft

word and the Internet to find images that they integrated on their projects. A few students access the Micromundos website and the example's folder to download projects; they analyzed those project and integrated new commands and program strategies into their projects.

5.3.3 Appropriation of new ways of learning

This is the deepest level of appropriation, which involves changes to how the students approach learning, not only what was expected by the Costa Rica curriculum framework, but also other things; and how they reflect about their learning. This level of appropriation involves integrating the computer into their ways of thinking and perceiving the world. Students gained a level of fluency with the technology that put them in a better position to actively learn what might be impossible or at least a great deal more difficult to learn in a traditional academic way.

I study this level of appropriation by looking at the following aspects:

- Curriculum assimilation: refers to the capacity of the students to assimilate the knowledge integrated in the activities, which covered the curriculum framework recommended by the Ministry of Education.

In order to locate the students in the table, I looked the student progress reports, and my own observations on their progress. I also looked at the projects they created. I used the activities that we had designed and developed at the school, as a reference to identify some of the projects and the concepts that were incorporated into the projects.

Table 6. Curriculum assimilation

Level	0 Does not	1 Barely	2 Yes	3 Well	4 Beyond
Content assimilation		6	2a, 13 1, 4, 5	8, 12c 13, 10 11, 14b	9a 7b 15c

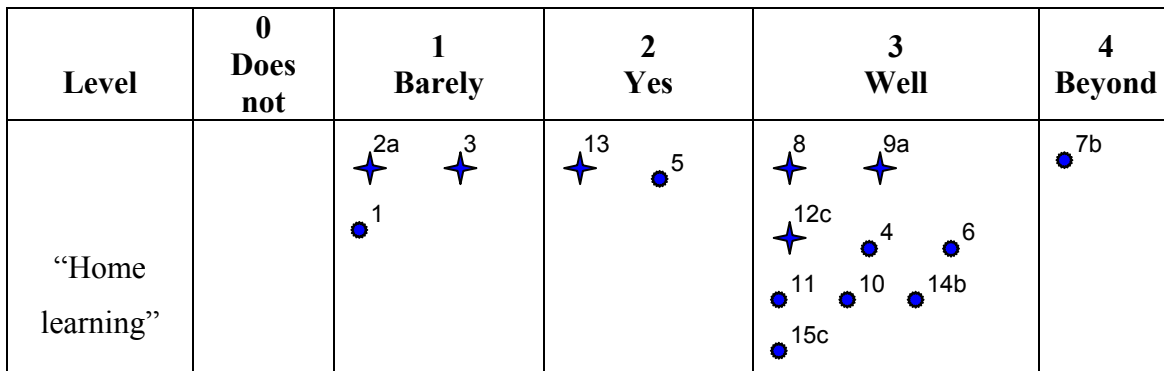
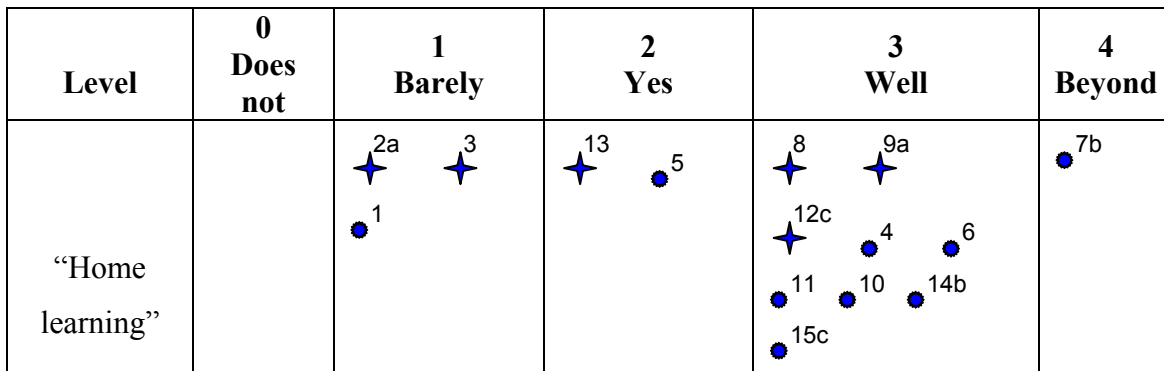
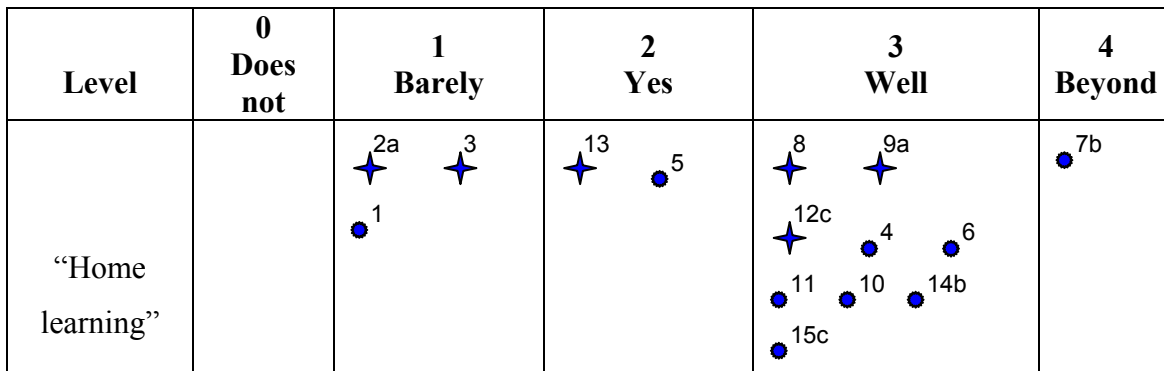
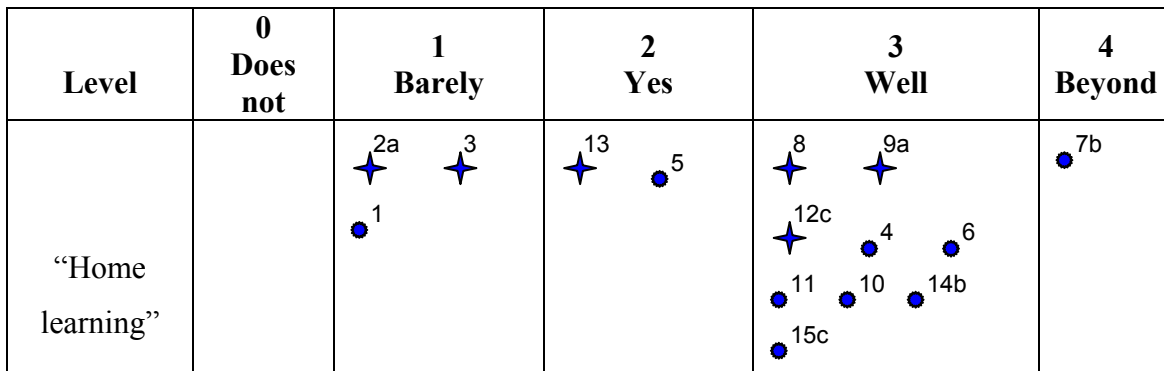
Observations

As you can see on the table, most of the students were able to learn the concepts recommended by the curriculum framework recommended by the Ministry of education. Only one student was in the limits (6).

Students from first and second grades were able to cover the curriculum framework, but they didn't go beyond what was recommended. Older students (3rd to 6th grade) were in better position to go beyond the curriculum framework and transfer what they learn to other situations.

- Home learning (Papert 1996): I use home learning to refer to what happened at home when the students worked with their computers. I looked at students' ability to generate ideas for projects according to their interests and experience. Since regular activities guide the student in the creation of projects, I looked for evidence of their own projects or ideas. For example, games, animations, etc.

Table 7. Home learning

Level	0 Does not	1 Barely	2 Yes	3 Well	4 Beyond
"Home learning"					

Observations

Students created a large number of projects over the course of the practical experience. Students in first grade only had the projects they created at the school. Since they worked with desktop computer, they didn't have the opportunity to bring them home, but I observed that they developed project in their own particular way, using the resources they found in Encarta and Microsoft Word.

Other students (13, 5) extended the projects they started at school, but there is no evidence of projects created at home. Most of the students created their own projects (robotics and Micromundos) and extended the ones they had started at school. Fabian (7b), in particular, created a great amount of projects at home, and integrated a great deal of information on his school projects.

- Reflection: capacity to reflect about their learning process. I used the students' reflection about the experience, which they recorded in their folders over the course of the program (see Annex A); the transcript of the presentations the students did at different times during the practical experience; the observations I had recorded on my blog, and the teacher's reports about students' learning process.

The capacity of reflection of the students not only had to do with the understanding of their projects, but also with their personalities. For example, some of the students were very shy and they didn't feel as comfortable talking about their projects in public, so I looked at their written reports for evidence of their reflections about their projects, the learning experiences, etc.

Table 8. Reflection

Level	0 Does not	1 Barely	2 Yes	3 Well	4 Beyond
Reflection		3 ★	2a ★, 1 ●, 5 ●, 6 ●	12c ★, 4 ●, 7b ●, 10 ●, 11 ●, 14b ●	8 ★, 9a ★, 13 ★, 15c ●

Observations

Most of the students were able to reflect on their learning process. They were able to talk, as well as write about the difference on the learning implemented at the school, and about their learning. At the beginning of the program, they concentrated more on the technical aspects of the project, but after the third month they reflected also about the topic of investigation. Younger students were not as verbal as the older students. I noticed that the capacity of the reflection was also associated with their ability to

create elaborated and complex projects. Girls also seemed to be able to reflect more about their learning experiences than boys, especially on their written reports. On the contrary, boys wrote about their learning of the technology and its technical aspects.

To summarize and to make further reflections about students' appropriation I provide the following table (see Table 9). I divide the students in two groups according to their levels of appropriation: 1) the group of younger students (1st to 2nd grades): these students learned about the computer and its functionality at their capacity. They achieved a level of fluency that allowed them to learn in action concepts from different disciplines, and made connections to their interests and lives; and 2) the group of older students (3rd to 6th grade): these group of students also achieved similar level of fluency and experience with the technology. They explore further the technology and were able to gain more experience. They also were able to reflect about their learning in a deeper way.

Table 9. Students' Appropriation

Students			Appropriation				
			Functionality	Fluency	New ways of learning		
					Curriculum	Home Learning	Reflection
Younger	1	Eduard	2	2	2	3	2
	2a	Fernanda	2	2	2	2	2
	3	Nicole	2	2	2	2	1
	4	Mario	3	2	2	3	3
	5	Douglas	3	2	2	2	2
	6	C. Wilson *	3	2	1	3	2
Older	7b	Fabian *	4	4	4	4	3
	8	Andrea	3	3	3	3	4
	9a	Paula	3	4	4	3	4
	10	J. Carlos	3	3	3	3	3
	11	Brandon	4	4	3	3	3
	12c	Daniela	3	3	3	3	3
	13	Meryanne *	3	4	3	2	4
	14b	Byron	3	3	3	3	3
	15c	Melvin	4	4	4	3	4

This new approach to observe appropriation allowed me to understand the relationship between the level of fluency and their learning. I argue that fluency might be needed in order for appropriation to take place on a deep level and in order for it to have important effects, but appropriation should be the central goal for thinking about the role of the computer in education. I am aware that this was a small group of students and that further research is needed to draw more definite conclusions. Nevertheless, I was able to use the experience to develop close understanding of the students and their learning process. My evaluation suggests that the model when implemented in its entirety leads students to appropriate learning in a deep way.

5.3.4 Case studies

I studied the students almost on individual bases. All of them reached a level of appropriation according to their abilities and interest. Further observation of three of the students follows.

5.3.4.1 Carlos Wilson

Carlos Wilson started the program as a second grade student, and continued as a third grade student. Carlos Wilson was a very quiet, shy, young boy. His family had recently moved to the community and he didn't seem to have many friends. I noticed he did not like to read in public because he was not very fast, and he was worse when the other students made fun and tried to correct him. He was completely in love with his new computer laptop. Despite the fact that they didn't participate on any school activity or responded to any of the questionnaires, they created projects with Carlos Wilson at home, and he reported that he enjoyed working with them.

At the beginning of the program, he cried when he wasn't allowed to take his computer home. While students created the project about the community, Carlos created a few projects about different aspects of the work we were reviewing in class. Instead of working on the project he was doing the previous day, he would start a new project; he did not seem to be making progress. I noticed this and I started to work with him to make sure he was continuing his work. He managed to finish his first project about the Community (see Figure 100), but he also created other 6 projects.

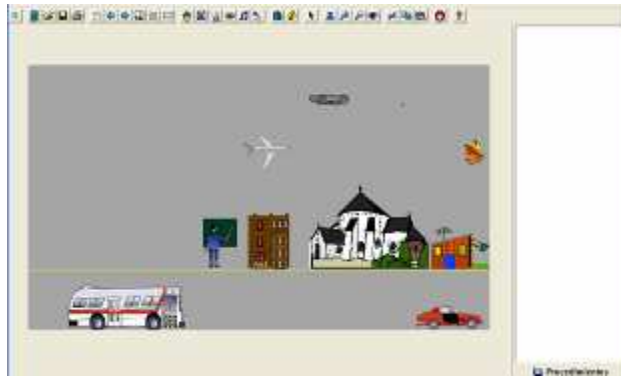


Figure 100. Carlos Wilson's community project

He enjoyed initiating projects about diverse topics; he actually was one of the students with the highest number of projects and folders, throughout the program. By the end of the first semester, he had created 117 Micromundos projects, which he organized on 42 folders. His projects weren't sophisticated, but most of them reflected the topic he wanted to explore. I think he kept repeating again and again the same the same set of commands, and gaining the fluency others were gaining more quickly but he just needed to do it his own way and his own pace.

By the end of the semester Carlos Wilson was creating more sophisticated projects. For example, he created a project about Natural disasters (see Figure 101). It was the first project in which he included a procedure. He also integrated images from other sources.

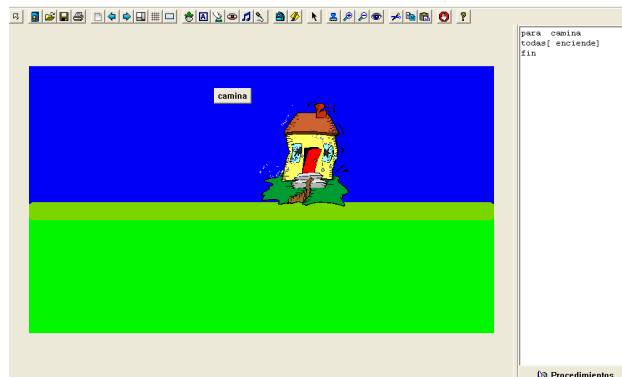


Figure 101. Carlos Wilson's natural disasters project

It was hard to get Carlos to talk about his experience, but he was better writing about it. By the end of the program he wrote...

“I like to work with the computer. I was very happy when I work with the computer during my vacations. I like to study in my school, and I also like playing with my friends. When I arrived at the community, I didn’t want to go to school, I was 8 years old, at second grade. In third grade I am feeling very happy”

Carlos Wilson really seemed to have benefited from this program. He liked coming to school and working with his friends. He also started to be more social. He had two or three students he liked to work with and ask for help. By the end of the program he was creating more sophisticated projects. The last project he created was about the Skeleton (see Figure 102). He included text and included animations. It was the first project in which he included his voice. He actually recorded himself reading the text he had integrated on his project.

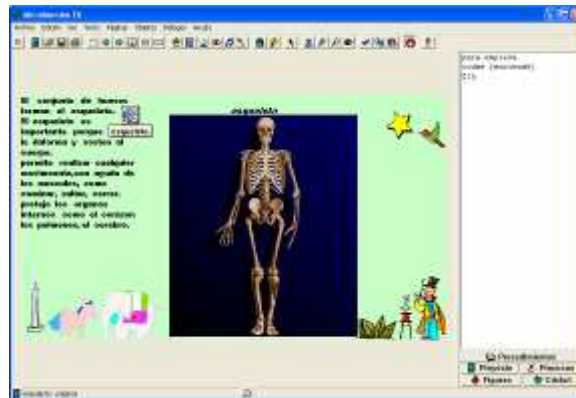


Figure 102. Carlos Wilson's skeleton project

5.3.4.2 Fabian

Fabian started the program as a third grade student, and continued as a fourth grade student. Fabian was a great tinker. I noticed Fabian’s great imagination and creativity. Even at the beginning of the program, he had concrete ideas of what he wanted to do with the technology; he wasn’t always able to create everything he imagined, but he wrote

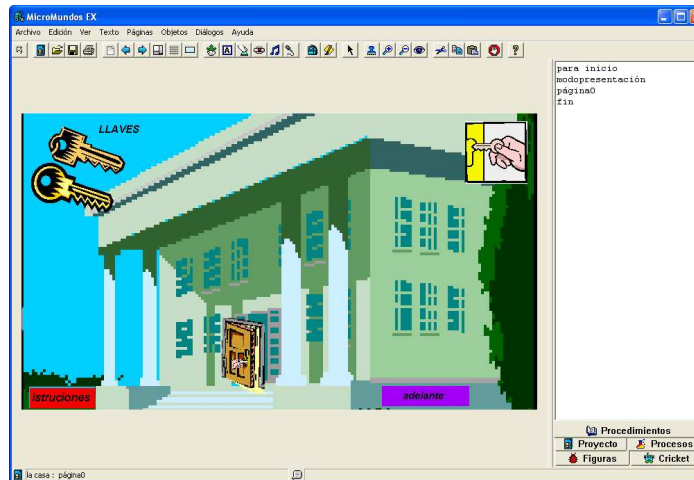


Figure 104. Fabian's game

He not only created games, but he also integrated game-like features into his projects. For example, in a project about a national celebration, he programmed a window to appear asking people to guess where a battle had happened and included a window message to congratulate you, if you clicked on the right province. Fabian was interested in exploring his computer, but he was also interested on using it to learn about many things. He was always looking for ways to improve his projects, by integrating information from different sources, including the Internet.

By the end of the first semester Fabian had created 146 files organized in 7 folders. His reflections on his experience during the program also reveal his passion about technology. In his reflections he talked about his learning with the computer and about the computer. Fabian learned a lot by exploring and making things with his computer. For example, students kept having problems with the displays. One day, Daniela, a 4th grade student at the school, asked me to fix her machine. The screen resolution was really high; it only showed part of the image. I tried to change it, but the problem was not as obvious, and I couldn't fix it by changing the setting on the control panel. Fabian overheard our conversation and said, "I know how to fix that problem. My computer was doing the same thing and I fixed it." I don't remember the steps he followed, but it worked, he was able to fix Daniela's problem.

Fabian was one of the few students who downloaded projects from the Micromundos website. He not only modified the projects he downloaded, but he also integrated in

subsequent projects the programming skills he learned by looking at those projects. For example, one of the last projects he created was about the human digestive system (see Figure 105), and he made inspired on a project he found in the Micromundos website.

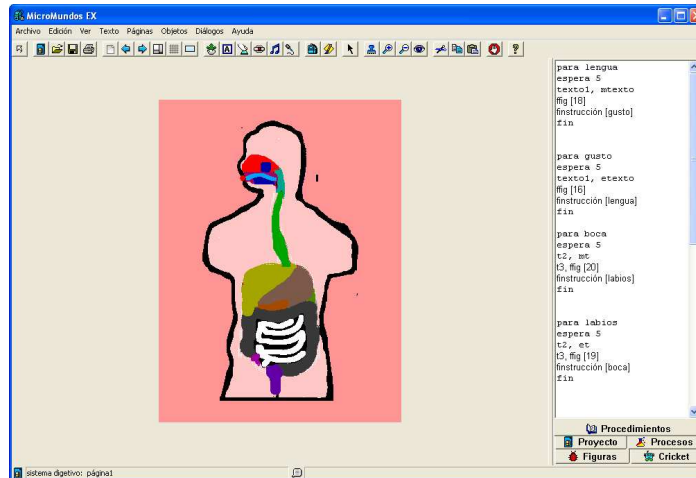


Figure 105. Fabian's digestive system project

One of the things that I notice about Fabian was how his logic and way of thinking evolved during the program. His projects reflected how he handled problems or approached an investigation. He typically created projects with many pages, and each one of them enclosed a topic or a specific part of the problem.

5.3.4.3 Meryanne

As described on Chapter 3, Meryanne was a very talented girl. I worked very close with her in several occasions. She had previous experience working with Micromundos, and showed a lot of fluency during the beginning of the program. Her first project about the Community was very sophisticated and accurate (see Figure 106).



Figure 106. Meryanne's community project

She was very quiet at the school, but she was fluent when she wrote and reflected about the program. I was fascinated reading her reflections about the program. She described in detail many differences in the way of they were learning before and after the program. She also wrote about how she noticed other students' interest in learning.

“Before [the program] started at the school, the only thing we did all the day was to write and write during 5 hours and 20 minutes. We were always looking forward to go to break or to go for lunch. We also had a fixed schedule; we knew the exact time when we had to move to the next subject. The learning is different. We were not interested in what we were doing, only when we had to prepare for the test, we studied the material we had copied [on notebooks]. The subjects were also different for each grade. Now that teacher Claudia, brought the program, we write some times to not forget how to do it. At the beginning, nobody wanted to go out to break... We only wanted to be in front of the computer. It is very exhausting to work on the computer, but nobody seems cares. I have noticed how the children are more interested in doing things, and they are easier.”

In the middle of the first semester, Meryanne was taken out of the school for few weeks. He mother moved temporarily to a different community a few kilometers away, and took Meryanne to a different school. She almost drove her mother crazy, to the point that her mother decided to send her back to the community and asked one of the neighbors to take care of her. The mother was concerned because Meryanne refused to go to a different

school, and she only had one more year at the school before she had to go to secondary school. Meryanne's mother worried that her daughter wasn't going to be prepared for the transition. Quite the contrary; she used the computer in a fluent way, to explore and learn about many things. By the end of the first semester she was creating elaborated projects (see Figure 107).

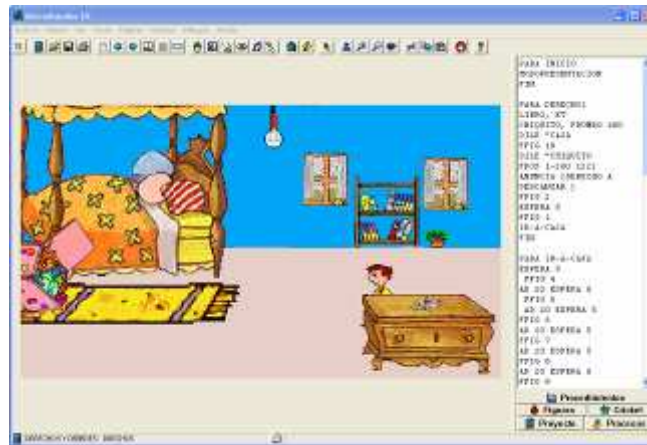


Figure 107. Meryanne's rights and duties project

This project was about children's rights and duties. Meryanne integrated images she downloaded from the Micromundos website, and wrote long procedure to animate her story. She acquired the fluency and the knowledge about the technology. She also enjoyed teaching their siblings and his peers at school, but she didn't initiate any projects at home, and sometime she left the ones she had initiates at school unfinished. For example, the last project she created about the human body (see Figure 108).

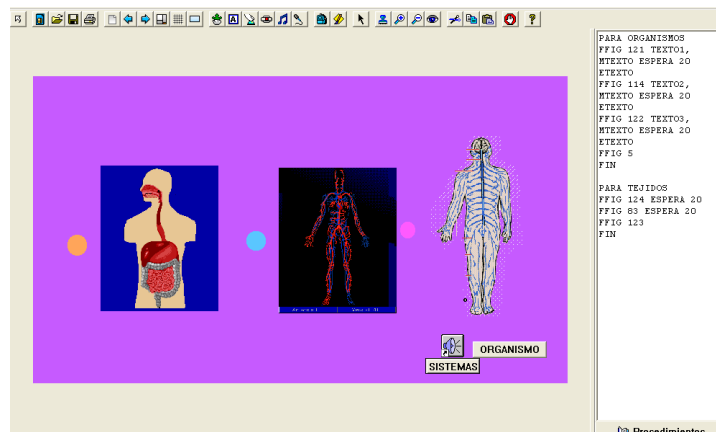


Figure 108. Meryanne's human body project

She copied images from Encarta, which she integrated on her project. The only code she wrote was to show the name of the digestive, the circulatory and nervous system. She did not seem to enjoy working with the technology, but making a project she was asked to do at school. This project did not seem to be created by a student who had made such powerful reflections about learning, had created elaborated project, and had helped her peer friend at school. I do not know for sure if her mother's attitude about the program and her working with the computer, affected Meryanne's motivation and development, or there were other issues I was not aware of.

6 Conclusions

6.1 Contributions

The main contribution of this thesis is to demonstrate a methodology to bring significant change to the school environment. In the thesis, I present a holistic model that extends existent models of rural education in Latin America and introduce that model into one one-teacher school in Costa Rica. The model introduces a 1:1 computer infrastructure and restructures the learning framework around the idea of whole project learning. The thesis provides a detailed longitudinal study of the transformation and appropriation that occurred b students, the teacher and the parents in the school. Specific contributions of this thesis include:

- The first experience in which 1:1 computer infrastructure is introduced in a one-teacher school in a developing country. This implementation builds on my observation that the one-teacher school provides fertile ground to implement new models of learning that are significantly different from the typical models in use today. Qualities of the one teacher rural school include: learners of different ages share the same physical space; the organization of physical space and time is flexible; family and community members live in close physical proximity making it relatively easy to take advantage of community knowledge and expertise; teachers are sensitive to what students know and are interested in.
- The “whole-project learning” approach. Whole project learning serves as a strategy for integrating aspects of the model into the learning environment including a structure that is inclusive and negotiable:
 - the teacher facilitated activities that took into account the students’ lives and interests;
 - these activities integrated concepts from different disciplines;

- students developed projects that allowed them to become fluent with the technology, as they learned about other things. They learned to express their opinions and interests, and became able to make decisions about their own learning;
- students worked in groups as well as individually. Students from all ages participated in projects of interest to them;
- parents observed, learned and participated. The fact that this learning approach was significantly different from what they knew and experienced before caught their attention, but in the beginning also created tension. The tension dissipated as they were able to understand that this “whole project learning” was a different way of learning, not just a computer class. Parents became one of the main advocates of the learning that happens at the school.

What is important about the “whole project strategy” is that it becomes a vehicle to introduce significant and sustainable change. That said, it is not important that the whole project learning activities be followed exactly as they were introduced. However it is important that the conditions mentioned above (1:1 computing, computers going home with the children, whole project learning, the parents becoming comfortable and supporting the use of the technology) are present.

- The longitudinal year long study of the evolution of the experience at the one-teacher school in Costa Rica. In the study I identify aspects of the work that had greatest impact on students’ learning. I examine the conditions that emerged during the time frame including the impact of elements that were not present from the beginning or that were not considered as part of the model.
 - Student owns computing technology that is mobile and accompanies them as they interact with their families at home and the broader community. One of the greatest shifts in students’ learning, and parents’ participation and understanding of the program, happened when the students were able to take the computer home. The computer was the object of attention and the carrier of ideas about learning that were shared between the students and their families.

- Students, parents, siblings and teachers share the learning experiences. In his book *the Connected Family* (Papert 1996), Seymour Papert talks about the importance of the family adjusting their learning culture to incorporate the new technological tools. I observed a new learning culture emerge as students, parents, siblings, and also the teacher, share learning experiences using the computer which gave a value to the computer that went beyond learning about the computer itself.
- Access to resources, including information and materials students found on the Internet, which they used to make their investigations, and to build projects richer in performance, content and aesthetic appearance. Students independently found ways to use the available resources, and to integrate the information in their projects. As described in the *Stories of Change* chapter, most students used Encarta to find information about different topics, and Microsoft Word and the Internet to find images that they chose to integrate into their projects. A few students accessed the Micromundos website and used the examples folder to download projects; they analyzed those projects and integrated new commands and program strategies into their projects.

The Internet was also an important asset to the project, but it was limited due to the school's location and the available infrastructure. Even though the school had access to the Internet when we started the program, the connection was not powerful enough to support and provide access for all of the students. The teacher was the main user of the Internet during the first half of the program. Since the group was small, the teacher was able to support their demand for information and materials. By the third month, we got a more powerful connection to Internet. Students were very excited. They started to communicate with other students in the country, and to exchange projects and ideas with them. They also looked for information on the web and downloaded animations and projects from the Micromundos website, which they used in their projects.

Even though I do not have enough evidence to determine what would have happened if we had access to the Internet from the beginning, I can speculate about it. One dimension relates to what was important for the students; by the time the students had access to Internet, they were engaged in their projects and investigations, and decided to use the Internet to improve what they were doing. Another dimension reflects the pervasive technology practice in Schools in Costa Rica. Understanding Constructionist learning research and its appropriation in Costa Rica, I can confirm that technology practice in schools is strongly associated with programming and using the computer as a learning tool. Those pervasive uses may have had an effect on what happened with the one-teacher school I worked with in Costa Rica. This contrasts to some extent with the findings of Savalai Vaikakul who studied pervasive technology practices in schools in the US (Vaikakul 2005), and found what she called the mental model of computers as information technology and multimedia machines. “In this mental model, computer technology is viewed as a means to provide students and teachers with Internet connectivity and access to extensive, up-to-date information.”

- A study of appropriation by students, parents and teacher. Although this thesis takes into account the dimension of students, parents and teacher; it mainly concentrates on students’ appropriation of technological tools in the context of the learning; and how parents’ and teacher participation influenced how that happened.
 - Students gained a level of fluency with the technology that put them in a better position to actively learn what might be impossible or at least a great deal more difficult to learn in a traditional academic way. I observed that students appropriate the technology as they different levels of appropriation by the students: appropriation of the object (technological tools) and its functionality, and appropriation of new ways of learning.

Contrary to what happen in many initiatives that bring laptop computers into the classroom by teaching some kind of technology class previous to any work

(Fouts and Stuen 1997; Peterson 1999), students explored the technology and acquired the knowledge and skills they needed, as they needed them; reflected on their own learning; and, found independent ways to knowledge.

- The teacher had previous experience working with Micromundos and also with Microsoft Office. He was very supportive of the ideas behind the work and committed to carry out the innovations. We worked together as teachers, designing and facilitating activities for the students. Teaching a group of 15 children from 1st to 6th grade was one of the most challenging aspects of the project. Showing the teacher that I was able to include all students as I facilitated was crucial for gaining his trust.

The collaboration and communication routine I established with the teacher provided strong foundation for the sustainability of the change introduced by the implementation of the model. The teacher was able to design and facilitate activities that integrated concepts from different disciplines, and invited students from different grade to work together, but he was not able to facilitate a deeper connection with mathematical ideas, the way I had anticipated. For example, he did not develop any activity that engaged the students on the design and construction of physical models using robotics technologies. Creating project in the physical world adds an important dimension to the students' learning experience and often connected to the acquisition of powerful ideas. As Papert says it (Papert 2002), "what gives the idea a high rating in a more intellectual dimension of idea power is the diversity of its connections."

A big challenge was getting the teacher to communicate with me about the activities he was planning when I was no longer at the school in time for me to give him feedback on his proposed approach and implementation. Initially I hoped he would be able to communicate with me in a similar way as I was able to communicate with Seymour (and David) when I was beginning the program. It is not clear whether the teacher's hesitancy came from laziness, habit, or time pressure arising from no advanced planning.

I can only think now what I could have done differently: 1) first, I believe that having at least a second teacher or a similar intervention would have made a difference. While I served the function of the second teacher for a time, I could not maintain the type of long-term partnership and critical culture that could develop between two or more teachers, a culture in which innovation, sharing and critique would become on-going activities in the community of teachers; and 2) Having access to materials could have encouraged the development of physical activities. As described in the stories of change, students took creative advantage of resources they found on the Internet to download Micromundos projects, and also used the example projects they had on their computers. These were available and did not require extra purchase by the school.

The teacher also supported my work as researcher. He helped me with the process of gathering data by recording video, taking pictures, making copies of children's folders, and giving parents questionnaires. He even modified the questionnaire I have designed for parents; he argued that the changes he made helped the parents communicate the ideas I was trying to document. He seemed to be engaged in understanding students and parents' learning processes. I don't have enough evidence to backup this finding as if what something that emerged from the interactions we had during the time we worked together, but researchers in the "collaborative knowledge building" field have identified similar conditions on teacher (Scardamalia and Bereiter 1999) , "the teachers who remain continually fascinated and involved are ones who have a dual interest. They are interested in advancing their understanding of history, geology, biology, cultural anthropology, and so forth; and each year they experience some advances themselves as they work with students on problems in those areas. But they are also interested in understanding the process of understanding itself."

The greatest shift for the teacher happened as he realized that the project had become his alone. The transition from having me and/or the Omar Dengo foundation tutors there to support his work, to not having anyone was very

hard. Even though I kept calling him and communicating with him and with the students, he started to pay less attention to the work that the students were doing with the computer. I described in chapter 5, how some of the students started to create more presentation-like Micromundos projects as they created the human skeleton, but at the same time, I was convinced (and I have shown through the examples) that he was capable of designing and facilitating rich activities. We had a long conversation about his role with the program, he was concerned with the technical support, but he understood that continuing the project was his decision alone. Today, when I talked people at the Omar Dengo Foundation about El Silencio, they refer to the students as “your kids,” meaning Claudia’s kids, but when I talked to the teacher, he talks about being proud of how much “his kids” have accomplished, or the wonderful projects “his kids” are creating at the school and how advance they are compared with other children in the country.

- Parent participation and understanding of the program changed dramatically over the course of the program. At the beginning, parents supported the program because they considered it a great opportunity to learn about the computer. They struggled a lot at the beginning as they expected their children to take a computer class, but not to use it extensively over the day and at home. The biggest shift happened as the parents started to observe the learning and the use of the computer by their children at home; they realized that their children were learning about many things that had nothing to do with the computer, and they were also amazed to see how fluent their children were with the computer.

The participation of the parents had a domino effect, which I was able to observe given how small the community was and how close I became to some of its members. When one of the first parents started to learn Micromundos with her daughter, the rest of the parents decided to do the same. All of the parents reported that they used the computer, and learned from his/her child how to create a Micromundos projects and two of them also reported that they also used Microsoft Word. A few parents also became involved with school

activities; they came to the school for different reasons, but ended working with the students on activities.

The endorsement and appropriation by the community was very important for the project. Even though not all parents participated or appropriated the ideas in the same way, the effect of a few becoming involved had a positive effect on the rest of the community members. An interesting fact, which I can not support with data, is that there was no negative effect on parents who did not fully support the program. Research on social networks such as that done by Juan Carlos Barahona (Barahona 2007), would be useful in understanding the influential members of a community. Barahona found that patterns of advice and use of media provide an effective way to identify the influential members of a community.

It is known that parent involvement is one of the conditions that affect students' performance at school (Coleman 1998; Fullan 2001), but the significant aspect of this outcome is that, in fact, parent involvement and participation emerged as a result of the program.

- My study provides some evidence to suggest a reversal of the stereotypes often associated with the rural school. One-teacher schools, located mostly in rural areas, are often associated with poor quality of education, great levels of dropout and low performance. Although the model was implemented only at one one-teacher school, the data collected through the experience, and also at the end of the experience revealed powerful indications of significant improvement in academic engagement that are worth mentioning.

The teacher was able to assess students' learning using the projects and activities developed at the school. Three students have graduated since the program began³¹. The first student graduated at the end of the first semester, and even though he participated in the program for more than three months (instead of preparing for the exams), he passed the national exams with high scores, especially in math and

³¹ In the context of the one-teacher school, only a few students may graduate every year, depending on the enrolment.

sciences. The Two other students graduated a year after with similar results. The three students attend now the middle school in the nearest town. The teacher and their families report that they are as well, or even better than their classmates, who graduated from a traditional urban school. I am not claiming that these results are just the effect of the program, but at least it shows that the program did not have a negative effect on the students' performance

The teacher reported perfect attendance during the two semesters (fall 2005 and spring 2006) of the program, and increase on enrollment during the second year of the program. According to the teacher, one of the reasons for the two new families to move to the community was to find a better educational opportunity for their children. He said this increase in enrollment is not normal for this type of school, but quite the opposite, "students usually leave"³².

6.2 Future directions

This thesis presents the first experience that brings 1:1 computer infrastructure into a one-teacher school in a developing country. The proposed model as well as the results of this practical experience raised questions and opened up possibilities for future research on school reform and also on learning (by students, teachers and parents). In this section I list a few if these directions that I think are more interesting:

- Students appropriation and learning – I have laid the ground for a research initiative that examines the impact of appropriation on students learning. While I developed a close relationship and understanding of the students, and the teacher that allow me to reflect upon their learning, more observational studies are needed to fully understand how the model conditions affect children's learning process.
- Impact on parents' lives – In this thesis I examine how parents engaged and supported changes to the learning environment. However my study was limited participation and involvement of the parents in the school related activities. Parents started to report about their participation and use of the technology at home. They started to

³²According to the Department of Statistics at the Ministry of Education, the dropout date for one-teacher schools in the country is 8.7 percent.

learn about Micromundos, which was an important thing that brought them closer to their children's learning. A study that focuses on the effect of the program on parents and other community members outside of the school context would help us understand the real consequence of this kind of initiatives on the community as a whole.

- Scalability of the holistic model – One of the most appealing future research initiatives will be to think about the implementation of the model at a larger scale.

Building on what I have learned, I propose:

- Establish a good network of support at the local and international level. I would make sure to get everyone involved from the beginning, and to get everyone to agree on the goals and expectations of the experience, as well as the scope of the activities and learning approach.
- Select a key group of teachers. I suggest selecting a group of teachers that are located in the same region. In the one-teacher school, teachers work in isolation, so having a group of peers who meet face-to-face to work together is very important. I would also take into account any teacher collaboration system already in-place in the country. In Costa Rica, teachers work closely with colleagues who are located in the region; they get together on a regular basis to talk about the curriculum and the activities that they are facilitating in class. Taking advantage of this existing mechanism would be a helpful element for the sustainability of the initiative. In Chile, the Enlaces Rural program implements its computer program through similar organizations called Microcentros (Microcenters; Chile 2001).
- Develop the whole-project learning approach together with the teachers, and the local member of the support team, in the design of an initial collection of rich activities that make connections to powerful ideas. A key aspect of the initiative would be on building the capacity of the teachers to design their own activities.
- Establish good practice for the knowledge network of support. One of the biggest challenges of the experience reported on this thesis was to get the

teacher to report about his activities on time for me to give advice on how to approach a problem or make a deeper connection with powerful ideas. Learning about what others have done in those regards would be ideal for the sustainability of the program. For example, the work done by Deirdre Butler with a group of teacher from rural areas in Ireland would be important for this initiative (Butler 2003). Her work shows the importance of establishing a good community of teachers both, at the physical and the virtual level.

6.3 Concluding remarks

As stated at the beginning, the fundamental aim of this thesis is to study the potential of the one-to-one computer infrastructure for changing the culture of learning in rural one-teacher schools in LA. I engaged in an exercise that was both theoretical and practical. First, building on a rich body of research on Constructionist learning, I proposed a holistic model which involved rethinking the elements of the learning environment including physical space, content and methodology. The goal was to design an approach to introduce digital technologies –one to one computer infrastructure – in the rural one-teacher school. Second, I engaged an educational community (students, parents and teacher) in a change process using the proposed model as a reference. This experience allowed me to observe the feasibility of the model in the context of learning and social change that emerged, not only at the school and, but also the family and community. The results of the experience suggest that in order for appropriation to occur, three conditions are salient: computational technology must be mobile and owned by the students so that the learning it encourages integral to the culture of the community; activities need to be of a scale and quality that children and teachers can make rich connections to powerful ideas; and, participation and voice must be inclusive. In light of the results, let's reflect what would be the effects of not including one of these elements:

- 1-to-1 computer infrastructure alone would not have made the difference. Studies have shown that the computer presence alone only resulted, in a higher level of motivation and engagement in classrooms, but delivered no significant changes in student performance (Russell, Bebell et al. 2004). Other experiences also reported improvement in writing as the most salient achievement (Yang 2002; Lowther, Ross

et al. 2003; Silvernail and Lane Dawn 2004). These studies show the importance of full access to technology, but they show no connection with students' lives or interests, and powerful ideas in the way that it was proposed and facilitated during the work reported in this thesis.

- The quality and scope of the activities were not only enabled and facilitated by the 1:1 computer presence, but also a necessary condition for appropriation and for the transformation that took place at the school. Building on Constructionist ideas, I proposed “whole project” approach for learning, in which I emphasize the role of the teacher as facilitator of the meaning activities that engage the students in the creation of meaningful projects (Papert and Harel 1991), and by programming the computer to create those project, the student “establishes an intimate contact with some of the deepest ideas from science, from mathematics, and from the art of intellectual model building” (Papert 1980).
- I took a participatory approach to facilitate and mediate change at the one-teacher school of El Silencio. The underlying principles have been reflected on the work reported on this thesis, but let me summarize some of the important points:
 - I found an organization(s) that supports the initiative at the local level. One of the reasons that took me to implement this first experience in Costa Rica was the fact that the group at the MIT Media Lab had a history of collaboration and work with them, and with other people in the country. It was important to have an organization you trust to support and continue the ideas.
 - I had the approval from the local authorities: I contacted not only the Omar Dengo Foundation, but the Ministry of Education, especially those in charge of the rural school in the country. I presented my ideas to them and kept them involved as a support team during the practical experience.
 - I involved stakeholders on the decision-making process: once the decision of working with EL Silecio School was made, I started to work with the teacher and with people from the Ministry of Education and the Omar Dengo Foundation. We made decision about the learning activities, the strategy to get parents involved, the curriculum framework, the report to local authorities,

among other. In particular, I made a lot of decision with the teacher about the dynamics of the school. For example, what activities we were going to do next, when to stop and move to the next activity, how to respond to parents' concerns, how to address a problem an issue with the students, etc. I also found a teacher that was willing to learn, innovate and change the dynamic of the classroom.

- I gained the trust of all the stakeholders and involving them on the decision-making process. For example, putting myself on the teacher position was very important for the teacher and for me; by experiencing the complexity and the effort required to facilitate the kind of learning approach I was envisioning, I could collaborate and community with the teacher; listening to the parents as they express concerns about their students' learning progress and the implications of the program on their future education, and finding concrete ways to help them understand the program; and showing the students that I trust them to make decision about learning and about the ways they used the computer.

As students, teacher, parents and siblings used the computer to engage in this process of exploration, creation, and construction, I started to see a community learning culture emerge!

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Appendix A. Students' testimony

1 Andrea (Third grade)

1.1 (September)

MIS EXPERIENCIAS

Me pareció muy bonito este proyecto además la profesora Maida y la profesora claudia son muy buenas, pero nosotros (a) las volvemos locas por que llegamos a la escuela y de una vez queríamos ir a la computadora pero primero teníamos que pensar lo que íbamos hacer.

ATTE: Andrea Johanna Vindas Ugalde.

1.2 (November)

Mis Experiencias de la computadora

Mis experiencias en el proyecto Encuentro de culturas Fueron muy lindas por que aprendí nuevos procedimientos. Lo que más me costo fue programar el color El barco tocara el color apareciera la pagina llamada América bueno este proyecto encuentro de culturas Yo ice 9 paginas todo mundo dice eso es un poquito, Pero eso para mí es mucho por que algunos De mis compañeros, él proyecto era de 4 Paginas vez por eso es que yo digo que mi Proyecto es muy grande y usted sabe Cuantos días me lleve en este proyecto Una semana y el martes que no pudimos Terminar entonces como el Profe.tenia Un congreso los demás días nos dijo Sí dios quiere de fijo el lunes pero él Lunes ala hora de presentarla algunos Compañeros les faltaban mucho. Lo que más me gusta

1.3 (December)

Mis experiencias que tuve con mi computadora.

Mi experiencia fue muy bonita.....

Todo empezó cuando nos dijeron que nuestra escuela sería parte de un proyecto que tendría que trabajar con unas computadoras portátiles las cuales tendríamos que usar los alumnos, yo en lo personal me asuste mucho ya que no sabía usarla pero gracias a la ayuda de la profesora Maida, Claudia, y por supuesto la ayuda de mi maestro Edgar todo fue muy fácil y divertido.

Luego empezaron las tareas los proyectos y todo fue más fácil día con día empecé a descubrir cosas nuevas que me facilitaban mis tareas al igual que a los proyectos. Todas fueron muy divertidas en lo personal lo que más me gustó fue haber participado en el proyecto de la maqueta de un croquis de mi comunidad, en el cual pude trabajar con todos mis compañeros.

1.4 (May)

Mis vivencias.

Mis vivencias son muy importantes habla porque mucho de las materias tenemos un proyecto que habla sobre las desventajas y las ventajas de América otro sobre niveles de organización también tenemos otro proyecto en el cual nos metió la niña Claudia y también el profesor Edgar

Se trata de hablar por Internet con la niña Claudia que vive en Estados Unidos y también con Sigifredo es muy bonito pero lastima que hoy lunes 27 de Marzo del 2006 no pudimos trabajar en Internet por que el sistema estaba caído entonces no pudimos revisar el correo y también tenemos un problema hay dos computadoras malas una que se queda trabada y otra la pantalla esta mala por eso tenemos que trabajar en grupo no es feo trabajar en grupo pero los compañeros que no tiene computadora por que esta mala desean tenerla buena.

2 **Brandon (Third grade)**

2.1 (September)

Mis experiencias.

En estas dos semanas que e estado trabajado con la niña Claudia, Mayda.

Ellas nos enseñaron muchas cosas bonitas.

Trabajamos en micro mundos pro y en gogo.

Hicimos un croquis de mi comunidad.

Después trabajamos haciendo una maqueta con alumbrado eléctrico.

Brandon Johan Gutiérrez Vargas

2.2 (November)

Encuentro de culturas

Tengo una semana y tres días de estar haciendo un proyecto llamado Encuentro de Culturas donde he aprendido muchas cosas como: programar un color que cuando un barco le pase por encima vaya a otra página.

A trabajar en la computadora a programar un color que cuando yo le diera clic apareciera una imagen.

Lo que me costó fue programar un color que cuando un barco le pase por encima vaya a otra página.

Hacer unos procedimientos que fueron siguientes:

```
Para acción
todas[enciende]
espera 200
todas[apaga]
Fin.
```

```
Para navega
fpos[-14 -22]
t1, mt
Frumbo 260
repite 9[ad 20 espera 3]
Cuándo [tocando?"t1 "rosa]
T1, ET
Fin
```

Lo que más me gustó fue hacer el proyecto.

Después de almuerzo trabajábamos en Go Go board.

Haciendo procedimientos para que funcionen sensores o motores los procedimientos fueron los siguientes:

```
Para recoge
a, enciende
b, enciende por 20
Fin
Para camina
a, enciende
Espera hasta [sensor1 = 0]
a, apaga
Fin.
```

Un día que mi computadora se jodió el maestro nos dijo que hicieramos un carro con robótica.

Le montamos dos motores uno en cada llanta de atrás.

Duramos como una hora pensando como hacerle la carrocería unos chiquitos le hicieron un ancla y se la pusieron.

2.3 (December)

Experiencias

Con la llegada de las computadoras hemos dejado de escribir tanto en los cuadernos, ahora lo que realizamos es un resumen sobre lo que se va a elaborar en la computadora lapto.

Nos costaba un poco controlar el mouse, gracias a la niña Claudia y Mayda, nos trajeron mouse de las computadoras grandes, por lo que así nos facilitaron un poco el uso de ellas.

Teníamos muchos nervios de que le tocáramos un botón o alguna tecla que las dañara, pero aun así todos estábamos muy contentos con la llegada de la computadora. Hubo un estudiante que no despegaba los ojos del reloj, de la alegría que sentía porque iban a traer las computadoras.

Las computadoras llegaron en los días que se celebraba el encuentro de culturas, por lo que realizamos un pequeño proyecto sobre este tema.

Ante de dicho proyecto hicimos el de mi comunidad, el que consistía en hacer un croquis en una hoja y luego representarlo en micro mundos pro, el profesor Edgar nos aconsejo que nos hiciéramos saliendo de nuestra casa a la escuela, a la vez hice que un bus saliera de la plaza a la finca de doña Yolanda.

Cuando vimos que nuestros proyectos ya estaban terminados nos sentimos muy alegres, todavía nos alegramos más por la noticia de que un periodista nos iba a visitar, el se llama Juan Pablo Barquero, del periódico Altura, ese periódico pertenece a Tilarán.

Cuando estábamos haciendo una maqueta, con alumbrado público vimos que llegaba una buseta y era un señor y su familia; este señor es el que elabora el periódico Tico Time, a mí me hizo una entrevista y la niña Claudia me dijo que le mostrara los proyectos que había elaborado.

Melvin, Byron y yo hicimos una presentación al frente de todos los padres de familia.

Luego realizamos varios proyectos, entre ellos el del sistema solar, el del relieve y el de desastres naturales.

2.4 (March)

Mis Vivencias

En este inicio del curso lectivo 2006, hemos hecho cuatro proyectos:

El primero se trata de los hábitos de higiene, las partes y el recorrido de los alimentos.

Aprendí una indicación nueva, fpos posraton, la cual sirve para que cuando demos clic a la tortuga, esta haga el recorrido que realiza el mouse en la pantalla.

El segundo es sobre ventajas y desventajas de Centroamérica.

- El tercer proyecto se trató sobre los niveles organización del cuerpo humano donde se resalta los siguientes niveles: célula, órgano, tejido y organismos.
- El último proyecto que hemos realizado se trata sobre la campaña nacional donde se representa todo lo que tuvieron que hacer para poder sacar a los filibusteros de nuestro país.
- En estos últimos días hemos estado haciendo practicas en Internet donde tenemos una página.

3 Byron (Fifth grade)

3.1 (September)

Mis experiencias

Gracias a Dios me siento muy bien porque la
niña Claudia , y la niña Maida
Nos enseñó a trabajar con las computadoras
y a usar y aprender sobre
Robótica y mas sobre la computadora
que Yo no sabia no havia
Aprendido y sobre micro mundos
Y trabajar en la maqueta
Y trabajar en grupo haciendo
La maqueta y que Dios la
Bendiga y que le baya bien
En su viaje .

Byron Antonio Chávez Jiménez.

Que Dios le bendiga niña Claudia.
Y que le bayabien.

3.2 (November)

Mis Experiencias del proyecto
Encuentro
De Cultura

Este proyecto consiste por el día del Encuentro de Culturas que el maestro nos dijo que lo hiciéramos primero nos asignaron una provincia a cada niño a mi me toco San José primero que todo teníamos que hacer que un barco que saliera de España y que llegara a América pero un barco tocaba un color y pasaba a otra pagina en la otra pagina estaba otros colores en esos colores tenían el escudo de San José la provincia el mapa

de América pasamos a otra pagina donde estaba lo que trajeran los Españoles a América los Españoles trajeron muchas cosas como ganado vacuno caña de azucar

3.3 (December)

Mis experiencias con el Computador

El primer día me daba miedo tocar el computador por que después se descomponía y después agarre practica y lla no medaba miedo tocar el computador así fui aprendiendo a usarla un poco más asta que fuimos haciendo proyectos más grandes asta que fuimos haciendo cosas más grandes y más bonitas el sistema solar encuentro de culturas problemas de mi comunidad desastres naturales es muy bonito porque uno aprende a usar la tecnología y lla no nos cuesta tanto manejar tanto la computadora y aprendemos más de la tecnología así fuimos agarrando más practica y fuimos unos niños hicimos hacer un barco y nos salió un carro después hicimos otro carro para el proyecto de los deberes y delos derechos que el carro tenia que atropellar aun chiquito pero el muñeco era muy grande y el carro no la pudo atropellar porque más bien el carro no movía la muñeca de tan grande que era ni la movió el carro era muy chiquito para el muñeco pero por más fuerte que iba no la movía pornada.

3.4 (May)

Mis Vivencias

En mis vacaciones yo hice muchos proyectos en mi computadora hice proyectos en micromundos Pro Word y oí música

Lo que yo hice en vacaciones con la computadora fue:

Hacer juegos, encontrar juegos, hacer proyectos con las cosas de micromundos que encontré esas cosa en Micromundos Pro De importar:

1. importar figuras.
2. importar sonido.
3. importar dibujo.
4. importar texto.
5. importar música.
6. importar video.

Exportar Figuras

Exportar Sonido

Puse trabajar a mis papá y mi mamá pero mi mamá ledaba miedo tocar la computadora en cambio mi papá no le daba miedo tocar la computadora y trabajo en micro mundos pro y también trabajo en Wodr pero medaba risa que se ponía hacer procedimientos pero no los podía hacer.

4 Carlos Wilson (Second grade)

4.1 (September)

Lo que mas me gusto fue aprender con la computadora exponerles mobiento
amiloce megusto ponerle mobimito alabisieta y tambien
ponerle mobimien amiloquemegusto pomele mobimien alamoto carloswilson
espinoza lopez:

4.2 (November)

Mis expericias del proyecto
encuentro de culturas.

Des de que empemos este proyecto de el encuentro de culturas
hicimos un barco con.

4.3 (May)

Ami megusta ayudarle a mi papa trabajar en la lechería y tambien
Le ayudo alabarles los trastes y lloloseco y tambien Megusta
Trabajar en la computadora y ami tambien ami megusta trabajar
En la computadora cuando estaba en vacación llomesentia
Muy feliz cuando llobra bajaba en la computadora y tambi en
Megustaba estudiar en la escuela y estudiar en miescuela
Y me gustaba jugar con Mis compañeros cuando llolege
Llo no que ría ir a la escuela cuando llotenia 8 años y tambien
Cuando llaestaba en segundo grado y tambien llacuando estaba
En tercero llamima sesenti muy feliz y tambien llomesentia muy
Feliz cuando

5 Daniela (Fourth grade)

5.1 (September)

Mis experiencias de robótica y computo

Estas dos semanas han sido muy especial para mi, e aprendido mucho sobre robótica y
a manejar muño mas la computadora .Este proyecto a sido muy especial para mi, nosotros
hemos aprendido mucho y queremos aprender mas de lo que no sabemos.

Estas dos maestras son muy especiales para mi porque si uno no entiende algo ellas se lo
vienen a explicárselo. Yo e conocido mas a la niña Claudia, ella es muy especial para mi
y es muy cariñosa ,gracias a la niña Claudia que esta este proyecto a qui en el Silencio.

Este proyecto de robótica es muy lindo y divertido, me emocione cuando pude
Utilizar el gogo y el motor.

Estas semanas son muy especial para mi y gracias a la maestra Claudia.

ATTE:

Daniela Sevilla Ugalde

5.2 (November)

Mis experiencias de la computadora

Este poquito de meses que e estado aprendiendo muchas cosas de la computadora

Como :yo Maria Fernanda la compañera Daniela a mi gusta la computadora porque me sirve para

Hacer trabajos ,para aprender cosas que no savia antes .

A nosotras cuando el profesor nos contó que una muchacha tiene una carrera de

Profesora de computación quiere traer unas computadoras portátil para cada alumno, Nosotros los estudiantes de esta escuela estábamos tan emocionados que no lo creíamos,

Y el día que venían las computadoras un niño no parada de ver el reloj, y un ratito que no vio el reloj llegó el carro que traían las computadoras y nosotros estábamos tan contentos .

Cuando vimos las computadoras nosotros no pusimos feliz.

Esta semana que hemos estado solos sin la niña Claudia y la otra niña Mayda.

Esta semana hemos aprendido sobre hacer instrucciones a un objeto que quiere caminar

Tanta distancia a la izquierda o cualquiera de las otra direcciones,

También hemos aprendido a utilizar más la computadora y a utilizar el teclado que antes nos costada más.

Estas instrucciones que les voy a presenta nos sirvieron para muchas cosas en rebotica estas son las instrucciones:

Pero primero que todo uno siempre a la instrucción que vas hacer

Tiene que llevar para y fin hocino no le funcionar como usted lo quiera

Ahora si son las instrucciones

Para luz

Siempre [

Si (sensor 1 > 200)

[a, enciende]

si (sensor 1 < 250)

[apague]]

fin.

Y recuerde que después de para tiene que ponerle un nombre

Para que la tortuga sepa a quien le va a dar la instrucción.

Estas dos semanas han sido muy linda , hemos aprendido muchas cosas de la computadora y de robótica que eso me gusta mucho ,y de eso hemos aprendido más de Lo que pensábamos.

Esta semana para nosotros a sido muy espacial con estas computadora, que han sido lo más especial de este año.

5.3 (March)

Mis vivencias

He pensado que estos días e aprendido muchas cosas.

Aunque mi computadora esta con problema en la pantalla, e aprendido un procedimiento que un niño sierre los ojos y los abra y muchos más.

6 Douglas (Second grade)

6.1 (November)

Yo trabaje encuentro de culturas

Y me costo,

Y también le ayude,

Alos con pañeros,

Y me costo,

A ser que el barco

6.2 (December)

Mis experiencias

Cuando llegaron las computadoras a mí me costo mucho aceptar que yo podía trabajar con una de ellas pero cuando inicie vi que si podía trabajar con una computadora, aunque me costara un poco pero e ido aprendiendo con el paso del tiempo y espero poder aprovechar esta gran oportunidad que me han dado.

6.3 (March)

Mis Vivencias

A mí se me jodio la computadora al inicio del curso lectivo, ella me encendía bien pero en la pantalla me salía un texto, dicho decía que le presionara f8 para que me pudiera encender bien.

Mario y yo hicimos el esqueleto.

- Brandon, Norman, y yo realizamos el proyecto de campaña nacional.

6.4 (May)

Mis experiencias

Cuando llegaron las computadoras a mi me gusto mucho porque aprendimos más y en Navidad a mi me gusto mucho por a mi papa le enseñe a trabajar en la computadora y a mi mama decía que después sé podía descomponer.

Y también a mi hermana cuando utilizo la computadora dijo que iba a ser el de sistema solar . y cuando puso el sol trayecto planetario se escondía y Suamy no savia hacer nada pero le dije que puniera el rastrillo y pudo hacerlo.

7 Eduard (First grade)

7.1 (May)

Vivencias de Eduard

En semana Santa hice un proyecto con Daniela.
Se trataba sobre la Batalla De Santa Rosa.
De problemas no tuvimos nada pero si tuvimos muchas cosas buenas como que hicimos el trabajo muy bonito recordamos que Juan Santamaría es un héroe nacional que nos libro de los filibusteros.

8 Fabian (Third grade)

8.1 (September)

MI ESPERIENCIA CON LA COMPUTADORA.

Gracias a Dios pude aprender mas cosas sobre la computadora.
Y los programas de Micro mundos Pro , robótica y etc.
También icé una maqueta de mi comunidad con muchos materiales.
También pude usar los instrumentos o legos de robótica icé un alumbrado publico eso fue lo que mas me gusto.

Jeffrey Fabián Chávez Jiménez

8.2 (November)

“MI EXPERIENCIA CON EL PROYECTO ENCUENTRO DE CULTURAS”

El primer día nos costo empezar ha hacer el proyecto en Micro Mundos Pro.
Pero después fuimos mejorando el proyecto y nos gusto mucho como

nos estaba quedando el proyecto Encuentro de Culturas abecés cuando poníamos las indicaciones salían las tortugas casi sin descontrol en la programación puse algunas de estas indicaciones adelante 1 espera 10 atrás 1 espera 10 también puse otras indicaciones en procedimientos

8.3 (December)

Mi Experiencia con el Computador

El primer día me costo muy poquito empezar ha hacer los proyecto en muchos programas.

Pero después fui mejorando mas los proyectos y me gusto mucho como me estaba quedando los proyectos .

Esto es lo que yo ago en Micro Mundos Pro:

Pongo indicaciones en las tortugas.

Pongo cajas de texto.

Pinto las figuras páginas de colores.

Hago o dibujos.

Pongo tortugas.

Esto es lo que yo ago en Microsoft Word:

Escribo mucho en las páginas.

Inserto imágenes o pongo dibujos.

Esto es lo que yo ago en GoGoMonitor:

Pongo indicaciones en el gogo.

Para que los sensores hagan como medir la temperatura y mas.

También puedo hacer graficas guardando el proyecto de gogo en el y en Micro Mundos Pro.

Esto es lo que yo ago en Internet Explorer :

Entro ha WWW.HOTMAIL.COM

Pongo mi nombre que es en Internet Explorer:

J.F.Chávez@HOTMAIL.com

Y mi contraseña que en Internet Explorer se escribe así *****

Pero no la puedo escribir bien por que es secreta.

Yo también mando correos o cartas en WWW.HOTMAIL.COM

Hago muchos programas mas:

Esto es lo que yo ago en Mis Sitios De Red:

Me contacto con otros computadores ellos me mandan cosas y yo también les mando.

Y ME SIENTO MUY BIEN POR TODO LO QUE HE HECHO.

9 Fernanda (First grade)

9.1 (March)

Mis Vivencias

En las vacaciones hice un proyecto que son las montañas eso lo hice yo en la computadora de Paula Mayela Campos Zúñiga y por eso aprendí mucho en la computadora porque se tamaño poco en la computadora y me gusto trabajar en la computadora y estuvo muy bonito. Los problemas que tuve fueron que hice el proyecto pero la computadora se estaba haciendo muy lerda entonces mi hermana tubo que borrar mi proyecto y el de ella.

10 Graciela (Preschool)

10.1 (May)

Las vivencias.

Mis vivencias han sido muy pocas pero estoy muy orgullosa de estar aprendiendo cada día mas de lo que sabía y también hoy jueves 27de Marcho del 2006 ISE un Proyecto llamado campaña nacional. También e aprendido a vestir la tortuga Con animales o personas.

Graciela Vindas Ugalde.

11 Jean Carlo (Second grade)

11.1 (May)

Esta semana e estado aprendiendo de los proyectos muchas cosas. A sido muy complicado para mi el proyecto de la campaña nacional. El de el sistema digestivo a sido para mi el más fácil, pero no deja de ser dificil por estar aprendiendo a usar la computadora. Este proyecto es muy costoso porque tenemos que poner mucha animación y atención en lo que se esta asiendo. A esta computadora lea pasado que se me ha ido la pantalla y e tenido que trabajar en la computadora viejita de la escuela.

En estos fin de semana e arreglado muchos proyectos como el de campaña nacional ese fue uno que arregle.

Yo me siento feliz con estos proyectos el proyecto de los padres ellos han aprendido a poner tortugas y a vestir también han puesto movimientos han hecho sonidos y etc. También pienso que estos proyectos son importantes porque a los padres les enseñan a aprender mejor las cosas.

12 Mario (Second grade)

12.1 (November)

“MI EXPERIENCIA CON EL PROYECTO ENCUENTRO DE CULTURAS EN EL PROGRAMA MICRO MUNDOS PRO”

El primer día nos costó empezar a hacer el proyecto en Micro Mundos. Pero después fuimos mejorando el proyecto y nos gustó mucho como nos estaba quedando el proyecto Encuentro de Culturas abecés cuando poníamos las indicaciones mal salían las tortugas casi sin descontrol yo me puse muy feliz y yo le llegué a contar a mis papás.

Y

Escribí las indicaciones para la tortuga para disfrazarla como caballo. Mi papá y mi mamá me felicitaron y tan bien mis Abuelos.

13 Maryanne (Fifth grade)

13.1 (September)

Mis experiencias

En estas últimas semanas estoy muy bien con estas nuevas computadoras portátiles y los trabajos que hemos realizado durante este tiempo con los profesores. Hemos aprendido a usar robótica y micromundos pro y hasta hicimos una maqueta del pueblo de El Silencio y queda muy linda hasta con iluminación, y otras cosas más lindas. Fue muy lindas estas experiencias, por que hasta aprendimos sobre motores, sensores, y gogo.

También me gustó conocer a la niña Maida y Claudia.

Gracias

Atte:

Meryanne Bolaños Alvarado.

13.2 (December)

Experiencias antes y después de que llegaran las Computadoras

Antes de que el proyecto de las portátiles llegara a la escuela lo único que hacíamos todo el día era escribir y escribir durante 5 horas y 20 minutos, además se estaba deseando salir al receso o ir al comedor también teníamos un horario fijo sabíamos a que hora para

pasar a la materia siguiente, el aprendizaje es diferente por que no le tomábamos interés y lo que hacíamos era que cuando nos tocaba los exámenes estudiábamos la materia que copiábamos todos los días también la materia es diferente para cada nivel.

Ahora que la profe Claudia trajo el proyecto debes en cuando escribimos para no olvidar como se escribe pero tampoco hartarnos de escribir, al principio nadie quería salir al receso o ir al comedor solo queríamos pasar en la computadora, como el profe, la profe Claudia y la profe Maida notaron eso un día se sentaron con nosotros a explicarnos que no era debido que estuviéramos todo el día por que apenas llegábamos en la mañana le preguntábamos a los profesores que si la podíamos encender la computadora, usar la computadora es muy agotador pero eso a ningún niño le importa eso por la curiosidad o por la tentación.

Ahora yo he notado que los niños le toman mas interés a las cosas y son mas fáciles. Las cosas que hemos hecho son: Aprendimos a usar un GoGo y MicroMundos Pro también hicimos algunos proyectos que son: Encuentro de Culturas

Mi Comunidad

Sistema Solar

Desastres Naturales

Problemas de mi Comunidad

Formas de Relieve

13.3 (May)

Mis Vivencias

NIVELES DE ORGANIZACIÓN DE LA MATERIA VIVA:

En el proyecto niveles de organización de la materia viva me paso algo muy extraño e interesante al mismo tiempo porque cuando nos llevamos la computadora para la casa la iba a encender algo muy extraño paso aparecía que la imagen de la pantalla se había corrido hacia el extremo inferior derecho no se veía la barra de inicio ni algunos programas entonces la apague y la encendí de nuevo y incendio bien.

MASAS CONTINENTALES Y OCEÁNICAS:

En el proyecto masas continentales y oceánicas realmente la animación de proyecto no muy buena .

CAMPAÑA NACIONAL:

En el proyecto campaña nacional me costo mucho la animación pero al final logre hacer el recorrido de los filibusteros y de los costarricenses, la batalla de Santa Rosa y la portada que no tiene animación.

En el recorrido de los costarricenses me paso algo muy gracioso active un color mal pero luego lo hice en los procedimientos entonces la tortuga hacia lo que le había indicado en los procedimientos y luego lo del color.

INTERNET:

El martes 21 de Marcho intentamos ingresar a Internet pero no lo logramos el miércoles 22 de Marcho no asistí a clases es e día la profesora Damaris Aguilar asistió a la escuela para explicarle a mis compañeros el jueves lo probaron para saber si funcionaba pero no sabia que hacer así que algunos compañero me ayudaron.

En las vacaciones me fui a quedar donde Fran a el bajo de Heredia, al tercer día de estar allá mi papá me llamo para preguntarme si tenia que encender la computadora y le explique como hacer todo por teléfono la encendió estuvo viendo un rato unos mapas en Encarta como 10 minutos. Yo volví el domingo y la encendí la tuve que encender un ratito, pero pronto la tuve que apagar, otro día intente encenderla pero solo encendía una de las figuras que se encienden cuando uno prende la computadora que es así : no volvió a encender hasta que un día mi hermana Jemelyn me pidió que intentará encenderla unos días antes de volver a clases y sorprendentemente la computadora encendió al segundo intento por ese motivo no pude hacer nada en la computadora en las vacaciones.

EL LIBRO: En el libro realmente no me costo casi nada por que la programación es muy fácil lo que me costo fueron los dibujos por que soy muy mala en eso.

14 Melvin (Sixth grade)

14.1 (September)

Mis experiencias

En estas ultimas semanas e estado muy bien con estas nuevas computadoras portátiles y los trabajos que hemos realizado durante este tiempo con los profesores.

Hemos aprendido a usar robótica y micromundos pro y hasta hicimos una maqueta del pueblo de El Silencio y queda muy linda hasta con iluminación, y otras cosas mas lindas. Fue muy lindas estas experiencias, por que hasta aprendimos sobre motores, sensores, y gogo.

También me gusto conocer a la niña Maida y Claudia.

Gracias

Atte:

Meryanne Bolaños Alvarado.

14.2 (November)

MIS EXPERIENCIAS DEL PROYECTO

ENCUENTRO DE CULTURAS .

Desde que empezamos este proyecto de el encuentro de culturas, hicimos un barco con los legos del programa de robotica, también usando el GoGoMonitor indicando dos motores para que se desplace hasta que un tiempo indicado se termine esto lo hicimos en la computadora de Brandon, para hacer el barco me ayudaron Byron, Eduardo, Daniela, Maria, Carlos, Brandon, Nicole, nos costaba mucho por que a la hora montar los motores se desarmaba, aunque al final nos resulto aunque pero se iban yendo uno a uno por que éramos muchos y porque la computadora había cargado ya sus baterías, esto nos costo mucho porque cuando le decíamos al Prof. que viera el barco no caminaba entonces teníamos que ir a la computadora a revisar pero todo estaba bien, era que los motores estaban mal conectados. Todo esto lo hicimos por un montón de tiempo .

Con mi compañero de trabajo Carlos Wilson otra de las cosas que hicimos fue poner a navegar un barco desde España hasta América cruzando el mar y que cuando tocara un color pasara a otra pagina que estaba el mapa de América, el de Costa Rica, el de Limón pasando al escudo con un color que cuando lo tocara apareciera cada una de las tortugas, igual ala primera que pasara de pagina.

En esa otra pagina estuviera el mapa de Costa Rica señalada la provincia de Limón con un poco de información de esta provincia, ese mapa estaban señaladas las provincias pero pinte a Limón de un color verde oscuro para que se resaltara más que las otras y pero también programamos otro color para pasar de pagina.

Que en esa otra pagina estaba dividida en dos partes una de esas partes tenían los productos que se llevaron los españoles de América a España y la otra parte estaban los de productos que dejaron los españoles en América y también la religión que traían de España.

En este proyecto yo aprendí a pasar de pagina sin tener que hacer un botón solo con un color.

14.3 (December)

Vivencias en la computadora.

Todo antes era diferente solo usábamos los libros. Desde que yo entre a primero, el Prof. empezó a hacer gestiones para que nos donaran una computadora. Todos los de la escuela nos sentíamos felices. Cuando llego todos queríamos trabajar pero no sabíamos como. Entonces el Prof. nos empezó a dar clases sobre computo.

En vacaciones el maestro entro a un grupo de capacitaciones de un proyecto llamado: INTEL Educar para el Futuro.

Ahí nos donaron una computadora más, con esa computadora aprendimos a como usar micromundos 2.05.

Gracias a las capacitaciones que tubo el maestro durante las vacaciones donde le enseñaban a usar la computadora para que nos enseñara a nosotros.

Después al final del proyecto nos donaron 2 más.

Desde el momento que nos desintegramos del proyecto pasamos a ser de otro proyecto con la FOD (Fundación Omar Dengo). Que nos invito a ir a capacitaciones.

Después llegó la noticia que a la escuela iban a traer 12 computadoras portátiles desde ese momento nos sentimos felices.

Yo me e sentido muy bien y me a gustado mucho trabajar en grupo e individual.

La parte de la tecnología en el aula nos a beneficiado mucho en la parte del aprendizaje de diferentes materias y temas, por aprendemos trabajando. También podemos aprovechar el aporte de la niña Claudia, Maida y el maestro.

Yo estoy muy feliz por que podemos trabajar en robotica con el aporte de aprendizaje de la niña Claudia, Maida, el maestro y don Efraín que nos acompañan cuando puedan venir a enseñar más sobre robótica.

Gracias a este proyecto hemos aprendido y fortalecido a trabajar en grupos.

14.4 (May)

El Colegio

La informática del colegio no me párese muy avanzada como la de la escuela el silencio, porque en lo que llevamos del año solo como 10 lecciones (cada lección de 40 minutos y dos lecciones a la semana).

Lo que hemos hecho es solo hacer círculos, buscar información en encarta y aprender a hacer sumas

15 Nicole (First grade)

15.1 (May)

Experiencias de Nicole

Yo en mis vacaciones hice trabajos en la computadora de Paula sobre la navidad fue divertido y aprendí mucho sobre la computadora y me gusto mucho trabajar en la computadora de Paula.

16 Norman (Preschool)

16.1 (March)

Mis Vivencias

He aprendido a realizar figuras en micromundos pro también a pintar, a poner tortuguitas, a pintar las figuras, a hacer textos, a buscar imágenes en Word, a agregarle sonidos a los proyectos que he realizado en compañía de Brandon.

Me acostado usar el mouse que trae la lapto

17 Paula (Third grade)

17.1 (November)

Mis Experiencias en la computadora

Yo aprendí mucho de la computadora
Como

Algunas primitivas .

Lo que más me gusto fue trabajar en Micro mundos pro yo
Quisiera aprender más.

Yo hice muchas cosas en la computadora todas muy divertidas bonitas y algunas partes
costosas pero yo trato de hacerlas, y así aprendo más porque hago las cosas sola y no
tengo que pedirle ayuda a mis demás compañeros molestarlos o desconcentrarlos
De su trabajo.

Con la computadora aprendí cosas que nunca creí aprender jamás.

La semana pasada y hoy pasamos trabajando en un proyecto en la computadora
llamado encuentro de culturas hay en ese proyecto aprehendí muchas cosas.

En ese proyecto aprendí que culturas habían dejado los Españoles en América
y cuales se habían llevado de América por eso estoy muy contenta. También estoy
contenta porque ya termine mi proyecto de encuentro de culturas.

Junto a ese proyecto incluí un proyecto que el profesor nos hacinó que se llama
Heredia una provincia de Costa Rica mi país lo que teníamos que hacer mi compañero
y yo era describir a Heredia con sus representaciones como el escudo y las flores.

17.2 (December)

Mis Experiencias en Informatica

Cuando llegaron las computadoras yo sentí una inmensa alegría por que yo quería
aprender de informática más de lo que ya sabia hacer como:

Vestir la tortuga .

Esta semana estuvimos haciendo un proyecto que se llamo Desastres naturales, la semana
pasada y todos los días que hemos pasado con las computadoras hemos hecho muchos
proyectos. En estos proyecto e aprendido muchas cosas.

Mis compañero también me enseñan muchas cosas, como: al llegar las computadoras yo
no sabia hacer muchas cosas y ellos si. Por eso yo les pedí ayuda y ellos me enseñaron.
Gracias al maestro y a la niña Maida y en especial a la niña Claudia Urrea.

17.3 (March)

Mis experiencias:

Esta semana a sido muy bonita porque los compañeros y yo hemos
hecho un proyecto llamado Campaña Nacional , y también hemos trabajado
en materias como español, matemática, ciencias, estudios sociales .etc.

En esta semana también hemos aprendido algo nuevo como las partes de la ORACIÓN .Porque siempre es bueno aprender algo.

También en el comienzo de las clases hicimos varios proyectos como:

desventajas de América Central, los sistemas del cuerpo y niveles de organización. Ventajas y

17.4 (May)

Experiencias de Paula

Desde que me lleve la computadora a mi casa seguí las recomendaciones del profe, las recomendaciones del profe fueron, encender la computadora tres días por semana. En las vacaciones hice algunos proyectos, pero la computadora se estaba haciendo muy lenta y entonces tuve que borrarlo, pero mi tita si hizo un proyecto y ella dice que aprendió mucho sobre la computadora. Los problemas que tuve no fueron tan problemáticos, como el problema de que se me trabo la computadora y los programas pero lo pudimos resolver.

En clases también trabajamos en las computadoras pero no tanto como en la vacaciones. Ya pasadas las clases de Semana Santa el profe dijo que se llevaran las computadoras para hacer el proyecto. Llego Semana Santa, trabajamos en el proyecto llamado Batalla De Santa Rosa, y como ahora no hay tantas computadoras en la escuela como antes , tenemos que compartirlas con los demás compañeros que se le jodio la computadora. Pero aun de que se le jodio la computadora pudimos hacerlo y aprendimos mucho. Luego de la semana santa el profe nos aviso que podríamos aprender mas de Internet y empezamos a trabajar pero no pudimos porque Internet estaba fallando mucho.

Appendix B. First Questionnaire for Parents

Nombres _____ Apellidos _____

Numero de teléfono _____ Fecha _____

Nota: Como parte de la iniciativa de computadores que se esta llevando a cabo en la Escuela, nos gustaría conocer su experiencia y opinión hasta ahora. Toda la información se mantendrá confidencial; sus nombres no serán utilizados en ningún reporte. Tal vez lo contactemos para hacerle unas breves preguntas mas adelante.

Información de la Familia

1. ¿Cuántas personas hay en la casa? Adultos _____ Niños _____
2. ¿Cuánto tiempo hace que su familia vive en esta comunidad? _____
3. ¿Cuántos niños de su familia van a la escuela el Silencio?

Nombre del niño(a)	Grado

Educación

4. ¿Es importante para usted la educación de su hijo(s)? Si _____ No _____
¿Por qué? _____

5. ¿Esta satisfecho con la educación que reciben su hijo(s) en la escuela?

Si _____ No _____

¿Por qué? _____

6. ¿Qué conoce del programa de computadores que se viene llevando a cabo en la escuela? _____

7. ¿Cree que el programa de computadores mejora la educación de su hijo(s)?

Si _____ No_____

¿De que manera? _____

8. ¿Cree que el comportamiento de su hijo(s) ha cambiado de alguna forma desde que empezó el programa de computadores en la escuela? Si _____ No_____

¿De que manera? _____

Uso de tecnología en el hogar

9. ¿Tiene computador en la casa?

Si _____ ¿Hace cuanto? _____ ¿Sabe usarlo? _____

No_____ ¿Ha pensado adquirir uno? _____

10. ¿Qué sucede cuando su hijo(s) lleva el computador a la casa? _____

11. ¿Su hijo le permite a otros miembros de la familia usar el computador?

Si _____ No_____

¿Por qué? _____

12. ¿Qué hace su hijo(s) en el computador? ¿Podría darnos algunos ejemplos?

Appendix C. Second questionnaire for Parents

Nombres _____ Apellidos _____

Numero de teléfono _____ Fecha _____

Nota: Como parte de la iniciativa de computadores que se esta llevando a cabo en la Escuela, nos gustaría conocer su experiencia y opinión hasta ahora. Toda la información se mantendrá confidencial; sus nombres no serán utilizados en ningún reporte. Tal vez lo contactemos para hacerle unas breves preguntas mas adelante.

Presentación final de proyectos

- ¿Qué piensa de la presentación final de proyectos que se realizó en la escuela? _____

- ¿Qué piensa de los logros de su hija(o) durante los meses de trabajo con los computadores?

Programa de computadoras portátiles en la escuela

- ¿Ha cambiado su opinión respecto a este nuevo programa de uso de computadoras portátiles en la escuela? _____

- ¿Todavía tiene algunos temores o dudas frente al programa? _____

- ¿Cree que ha habido un cambio en su hija(o) desde que comenzamos con el programa?
¿Cómo ha cambiado? _____

Participación

- ¿Considera que participa en el proceso de aprendizaje de su hija(o) y la(o) ayuda en las actividades escolares? Si _____ No _____
- ¿Ha cambiado esto desde que empezó el programa de portátiles en la escuela? ¿Podría dar algunos ejemplos? _____

- ¿Le enseña su hijo a usar el computador? Si _____ No _____
- ¿Cómo se siente cuando el le esta enseñando algo? _____

- ¿En que momento se decidió a aprender con el? _____

Sugerencias

- ¿Tiene algún comentario o una sugerencia que nos ayude a mejorar el programa?

Appendix D. Questionnaire for the Teacher

Programa de Computadores en el aula. Cuestionario para maestro.

Nombres _____ Apellidos _____

Numero de teléfono _____ Fecha _____

Nota: Como parte de la iniciativa de computadores que se esta llevando a cabo en la Escuela, nos gustaría conocer su experiencia y opinión hasta ahora. Toda la información se mantendrá confidencial; sus nombres no serán utilizados en ningún reporte. Tal vez lo contactemos para hacerle unas breves preguntas mas adelante.

Experiencia

1. ¿Cuántos años lleva enseñando? o < 5 o 6 - 10 o 11 - 15 o 16 - 20 o 21 +
2. ¿Cuándo (mes/año) recibió la primera computadora en la Escuela? _____
3. ¿Cuándo (mes/año) empezó a utilizar la computadora? _____
4. ¿Cual es su nivel de entusiasmo con el programa de computadoras en la aula?

Poco entusiasmado	algo entusiasmado	muy entusiasmado
1	2	3
4	5	6
7		

Responsabilidades y práctica de enseñanza

5. Llene el siguiente cuadro por cada nivel de estudiantes en la Escuela.

Grado	# de estudiantes	# de estudiantes por computador	¿Usa la computador a para preparar las clases o para enseñar a las estudiantes?	¿Los estudiantes usan portátiles? (si/no)	% de tiempo en la clase que los estudiantes usan computadora	¿Qué % de las tareas requiere el uso de la computadora?	¿Qué clase de actividades realizan los estudiantes con la computadora? (por ejemplo: toman nota, realizan simulaciones, presentaciones, proyectos, etc.).
1							
2							

3							
4							
5							
6							

6. ¿Cómo esta organizado un día en la Escuela? _____

7. ¿En promedio, qué porcentaje de tiempo los estudiantes pasan trabajando en grupos, trabajando independientemente o trabajando como una clase completa?

Escuelas con acceso a computadores portátiles:

Grupos _____ %

Independiente _____ %

Magistral _____ %

Escuelas sin acceso a portátiles:

Grupos _____ %

Independientemente _____ %

Magistral _____ %

Acerca del programa de computadores en el aula

Use la experiencia que ha tenido con el uso de las computadoras para responder las siguientes preguntas.

8. Marque la caja que indica si el uso de las computadoras para cada una de las actividades ha aumentado o ha disminuido desde que comenzó el programa de computadoras en el aula.

Actividad	Gran disminución -3	Mediana disminución -2	Pequeña disminución -1	No hay cambio 0	Pequeño aumento +1	Mediano aumento +2	Gran aumento +3	N/D
Tomar nota en clase	-3	-2	-1	0	+1	+2	+3	N/D
Escritura de reportes	-3	-2	-1	0	+1	+2	+3	N/D
Desarrollo de presentaciones	-3	-2	-1	0	+1	+2	+3	N/D
Búsqueda de información	-3	-2	-1	0	+1	+2	+3	N/D
Búsqueda en Internet	-3	-2	-1	0	+1	+2	+3	N/D
Trabajar en proyectos	-3	-2	-1	0	+1	+2	+3	N/D
Hacer tareas	-3	-2	-1	0	+1	+2	+3	N/D
Documentar trabajos	-3	-2	-1	0	+1	+2	+3	N/D
Construir juegos	-3	-2	-1	0	+1	+2	+3	N/D
Jugar	-3	-2	-1	0	+1	+2	+3	N/D

Otros (especifique)	-3	-2	-1	0	+1	+2	+3	N/D
Otros (especifique)	-3	-2	-1	0	+1	+2	+3	N/D

9. Marque la caja que indica si el acceso a la computadora ha dado lugar a un aumento o a una disminución en las cualidades de los estudiantes y del proceso educacional.

Cualidad del estudiante	Gran disminuc. -3	Mediana disminuc. -2	Pequeña disminuc. -1	No hay cambio 0	Pequeño aumento +1	Mediano aumento +2	Gran aumento +3	N/D
Atención	-3	-2	-1	0	+1	+2	+3	N/D
Problemas de disciplina	-3	-2	-1	0	+1	+2	+3	N/D
Interés en la escuela	-3	-2	-1	0	+1	+2	+3	N/D
Cantidad de trabajo terminado (clase)	-3	-2	-1	0	+1	+2	+3	N/D
Cantidad de tareas terminadas	-3	-2	-1	0	+1	+2	+3	N/D
# de fuentes de búsqueda en trabajos	-3	-2	-1	0	+1	+2	+3	N/D
Variedad de fuentes de búsqueda	-3	-2	-1	0	+1	+2	+3	N/D
Calidad del trabajo	-3	-2	-1	0	+1	+2	+3	N/D
Cantidad de pensamiento de alto nivel	-3	-2	-1	0	+1	+2	+3	N/D
Aprendizaje-entendimiento de contenidos	-3	-2	-1	0	+1	+2	+3	N/D
Capacidad de recordar el contenido	-3	-2	-1	0	+1	+2	+3	N/D
Resultado de las evaluaciones	-3	-2	-1	0	+1	+2	+3	N/D
Capacidad de hacer trabajo en grupo	-3	-2	-1	0	+1	+2	+3	N/D
Interés de los padres	-3	-2	-1	0	+1	+2	+3	N/D
Cualidad Educativa	Gran Disminuí. -3	Mediana Disminuí. -2	Pequeña Disminuí. -1	No hay cambio 0	Pequeño aumento +1	Mediano aumento +2	Gran aumento +3	N/D
Cantidad de contenido cubierto	-3	-2	-1	0	+1	+2	+3	N/D
Cobertura interdisciplinaria de contenido	-3	-2	-1	0	+1	+2	+3	N/D
Aprendizaje por proyectos	-3	-2	-1	0	+1	+2	+3	N/D
Instrucción individualizada	-3	-2	-1	0	+1	+2	+3	N/D
Aprendizaje cooperativo /Trabajo en grupo	-3	-2	-1	0	+1	+2	+3	N/D
Enseñanza magistral	-3	-2	-1	0	+1	+2	+3	N/D
Discusiones en clase	-3	-2	-1	0	+1	+2	+3	N/D

10. ¿En qué forma, si alguna, el programa de computadoras en el aula ha afectado directamente la planeación curricular? _____

¿Qué evidencia puede dar que muestre que ese cambiado? _____

11. ¿En qué forma, si alguna, el programa de computadoras en el aula ha afectado directamente la metodología de trabajo? _____

¿Qué evidencia puede dar que muestre que la metodología ha cambiado? _____

12. ¿En que forma, si alguna, el uso de las computadoras en el aula ha afectado directamente los resultados del trabajo de sus alumnos? _____

¿Qué evidencia puede presentar que muestre que el resultado del trabajo de sus alumnos ha cambiado? _____

13. ¿Qué resultados o habilidades académicas, si alguna, han sido afectados directamente a través del uso de las computadoras? _____

¿En que forma han sido afectados estos resultados o habilidades? _____

¿Cuál piensa que es la mejor forma de medir este cambio? _____

14. ¿Cuánto se ha beneficiado del programa de computadoras en el aula cada tipo de estudiante?

Tipo de estudiantes	No beneficio 0	1	2	Beneficio moderado 3	4	5	Gran beneficio 6	N/D
Rendimiento alto	0	1	2	3	4	5	6	N/D
Rendimiento promedio	0	1	2	3	4	5	6	N/D
Rendimiento bajo	a	1	2	3	4	5	6	N/D
Necesidades especiales	0	1	2	3	4	5	6	N/D

Niñas	0	1	2	3	4	5	6	N/D
Niños	0	1	2	3	4	5	6	N/D

15. ¿Ha notado cambios en la participación y el interés de los padres que pueda asociar con el programa de las computadoras en el aula? Si es así, por favor describa. _____

16. ¿Cree usted que el impacto varía con computadoras portátiles, con computadoras de escritorio o con laboratorios de computador? _____

Uso de herramientas computacionales

17. Por favor indique con que frecuencia y para que propósitos se usan cada una de las aplicaciones de computadores.

Continúe en el reverso de la página si es necesario (indicando el nombre de la herramienta computacional o aplicación).

Herramienta	Número promedio de tiempo que usted usa cada herramienta por semana para preparar las lecciones	Número promedio de clases que usted utiliza cada herramienta por semana para enseñar lecciones	Número promedio de clases que sus estudiantes utilizan cada herramienta por semana en clase	Número promedio de veces que sus estudiantes usan cada herramienta por semana para hacer tareas	Ordene las herramientas (1-6) de más a menos útiles para mejorar el aprendizaje de los estudiantes	Enumere las tareas que usted logra más frecuentemente con cada herramienta	Enumere las tareas que sus estudiantes logran más frecuentemente con cada herramienta
MicroMundos							
Robótica							
Power-Point							
Internet							
Word							
Excel							

Email							
Messenger							

18. Elija una herramienta de tecnología que usted utilice con frecuencia en el proceso de enseñanza con las computadoras, y DESCRIBA una lección o proyecto que usted haya ejecutado, en la cual el uso de esa herramienta de tecnología haya sido particularmente eficaz en lograr las metas educacionales.

Continué en el reverse de la página si necesita mas espacio.

Después de describir la lección o proyecto, responda por favor a las siguientes preguntas:

a) ¿El uso de las computadoras para esta lección o proyecto motiva a los estudiantes a usar las computadoras o desarrolla pensamiento de alto nivel? Si es así, ¿cómo? _____

b) ¿Cómo evaluó los resultados del aprendizaje para esta lección o proyecto? _____

c) ¿Qué ventajas, si alguna, las computadoras portátiles ofrecen para esta lección o proyecto diferente de las computadoras de escritorio, un laboratorio de computadoras y/o un lápiz y papel? _____
