Educational Technologies and Social Inequality in Brazilian Public Schools

Julie Remold

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Abstract

This work examines how technology use in Brazilian basic education is influenced by cultural context. I examine how context shapes the capacity of technology to improve educational quality and equity. I describe the impacts that educational technologies have on the settings in which they are used. This research focused on the widespread educational initiatives that propose to improve equity in public education through increased technology use. I use a combination of participant observation in classrooms, interviews with educators and administrators, and analysis of public discourse on the relationship between technology, education, and social inclusion to analyze patterns of technology use in Brazilian schools and their impact on equity.

1. Introduction

It has long been argued that educational technology can be designed and used in ways that promote equality of opportunity in education (Sutton, 1991) . But that it is also possible to design educational technology and launch technology programs that further divide the privileged from the underprivileged (Attewell, 2001) (Warschauer, 2003). An investigation of common differences between school technology use in low and high income areas shows, in addition to unequal access to resources, that underlying inequities in educational method and expectations influence educational technology policy and the implementation of technology programs. Programs developed within the framework of these inequalities have unequal outcomes. The promise of technology to improve educational equality is limited by the social context in which it is used and the set of expectations under which programs are designed. This work discusses the introduction of new technologies in education, their influence on equity, and the ways that their use is influenced by social context.

Optimistic predictions about the future of information technology in public education often include claims that IT brings improvements to equality of educational opportunity (Carvin, 2000). Unlike traditional educational tools, the importance of context is downplayed in as technological solutions are applied to education problems. Differences in quality of infrastructure, teacher training, student preparedness, and administrative goals are generally disregarded with with assumption that similar technology will yield similar results in a variety of contexts.

The promise of technology in overcoming some traditional barriers to equality, such as geographical isolation and language barriers, has contributed to a high level of optimism concerning the future of technology in education, and has helped prioritize public investment in educational technology programs (Ravenaugh, 2000), including substantial investment in educational technology in international development programs. But the relationship between technology and equality is not straightforward, and evidence supporting policies that rely on increasing access to technology as a vehicle for improved equity is limited.

Sociologists of education abroad, mainly in the U.S., have found that, in practice, technology does not lead to improvements in equity of opportunity, and sometimes actually increases inequality. They argue that the uses and impact of technology is shaped by the social context. They draw on social research in education in general to demonstrate that educational technology is similar to other education initiatives in that it can reproduce inequalities. As with public education in general, the capacity of technology to bring about social change is limited by the constraints of the social and cultural context.

The constraints of cultural context on technology use in schools has been described since the 1980s (Schofield, 1995). Natriello (2001) has applied theories concerning inequality in education in general to the case of technology. He argues that technology is not different from other educational initiatives and that in addition to institutional context, opportunities for learning are shaped by children's' backgrounds, the nature of the technology use, and by the content itself.

> “Technology initiatives that ignore the complexity of educational institutions will contribute to inequity just as other elements in schools have done.” (2001)

Agalianos (1996), Attewell (2001), and others have shown that technology created and implemented within existing social contexts is unlikely to bring about revolutionary change on its own. Warschauer (2003) has reiterated the claim that context is important; adding technology does not necessarily bring about educational improvements and is “as likely to exacerbate inequality as lessen it.” These authors claim that differences in the way technology is used are influenced by the social and cultural context and that the impact of these uses is mediated by student backgrounds.

Others (Bromley and Apple, 1998) have argued in more general terms that technology itself, not having been created in a vacuum, has bias, some of which is a consequence of the social context in which it was created. For these authors, even if we could control for differences in how technology is used, results will vary as a result of that bias.

For the critical theorists, market oriented education programs are problematic as well. They argue that education is increasingly framed as an act of consumption and preparation for participation in the labor market, and claim that market-driven education does not prepare children for citizenship responsibilities, especially resistance to social inequality.

> "We should remind ourselves that [...] market-driven knowledge should not be the only discourse that schools offer young people, that citizenship is not entirely a privatized affair, and that capitalism and democracy are not the same thing." (Giroux, 2001, p. xxvii)

Freire and others have written extensively about the importance of critical pedagogy in education with special attention to changes brought about by the new Information Economy (Castells et al., 1999). They argue that critical pedagogy is necessary for developing a citizenry with the freedom of thought necessary to confront social inequality and injustice. Freire called this type of education *conscientização* and described it in opposition to education that is carried out like banking, with teachers depositing knowledge into the heads of learners.

Social scientists have also discussed the limitations of a market-driven approach to education. Bartlett et al. (2000) have demonstrated how market driven educational programs are replacing citizenship oriented programs in the U.S., and shows how these goals have constrained public education and limited its capacity to fully prepare students for citizenship. Technology education initiatives have often been tied to market driven educational planning as they are so often justified in terms of preparation for labor force participation.

A strong critique of the banking model has impacted the discourse on teaching and learning in Brazil with constructivist theories of learning taking center stage at educational conferences and meetings. Within the field of education, there is therefore a strong will to move away from passive learner approaches to education and this interest has shaped the discussion of educational technology use.

The impact of learning theories on day to day practice is somewhat limited. This is in part because of views about what learning is and what schools should teach. Both students and teachers focus primarily on what are considered the less complex cognitive skills according to Blooms taxonomy of the cognitive domain (Anderson et al., 2001). They evaluate the success of teaching and learning efforts according to student's abilities to remember and understand knowledge. When teachers apply learning theories and experiment with new approaches to teaching, their success is often measured solely on the basis of students' abilities to recall and at best comprehend knowledge. In the rare case that students are asked to apply, analyze, evaluate, or create knowledge, the educational value of such exercise is often measured by student's abilities to recall information.

This dissertation looks at how social, political, cultural, and organizational factors information influence technology use in Brazilian public schools and how this affects the capacity of technology in improving educational equality and education in general. In advancing this idea, I make extensive use of comparison with technology use in education in the United States. I investigate technology use in schools with attention to stated goals and technology use outcomes predicted by educational research. My research suggests that social and cultural context have a central role on the impact of technology programs in schools. I examine how the technology initiatives found in Brazilian schools facilitate or constrain their stated educational and social goals, especially the goal of improving equality of opportunity.

Organization

This dissertation is organized in the following way. Chapter 2 is an overview of the literature related to educational technology and social change, especially equality. I will discuss the widespread optimism, both in Brazil and internationally, with respect to the promise of technology in improving educational equity. I draw from examples from the Brazilian and international press, research studies, and the remarks of educators and education officials - both publicly and in interviews and conversations.

Chapter 3 is a description of Brazilian public primary and secondary education. The description of Brazilian public education will focus on those factors that contribute to greater equity, such as obligatory primary and secondary schooling, as well as those that present additional challenges to equity, such as long school vacations, teacher shortages, extremely high failure rates, and a three-shift scheduling system. I will discuss the differences between educational goals among more elite schools with those in low-income areas including differences in technology planning and goals. I give an overview of availability and use of IT in schools including predictions for the future based on current initiatives. Finally, I will discuss the literature concerning the role of private interests, specifically the educational technology industry, in the growth of educational technology in schools.

Chapters 4 describes the impact of existing inequality on the success of technology programs, highlighting, for example, the impact of literacy levels on students' abilities to make use of computer technology and the difference that qualified teachers make in helping students make effective use of technology. It has been argued that teacher qualification levels are the single best predictor of the effectiveness of technology use, and my observations in Brazilian classrooms bears this out. This chapter will also describe the impact that technology initiatives can have on schools with very limited budgets and the consequences of answering to technology pressures with hardware purchases that are rarely accompanied by the needed training and maintenance investments.

Chapter 5 discusses inequalities of access to technology. While the statistics indicate that Brazilian schools serving higher income students are more likely to have computers than schools serving low-income students, the differences in access are often much more comlex and the inequalities of access may be even greater than they appear. In this chapter I will discuss my field experience showing that access to the technology is determined by a number of factors including the adequacy of the computer lab space for the number of students in a class, the staffing available to keep labs it open and keep machines running smoothly, quality of hardware, software, and connectivity, and the availability of a selection of educational material. I claim that these factors pose difficulty for many schools but that they present more of a challenge for public schools.

Chapter 6 describes the effects of institutional bias on the outcomes of technology programs, and categorizes them according the types of institutional bias outlined in the anthropological research. According to Diamond (Diamond et al., 2004) concentrations of low-income or African American students in U.S. schools "is deeply coupled with a leveling of teachers' expectations of students and a reduction in their sense of responsibility for student learning." My observations showed similar patterns in Brazil. Students in low-income areas were more likely to use computers for single step task-completion assignments contrary to the importance given to active learner participation in the educational computing literature. They are more likely to spend time learning specific technical skills through practice that, unlike knowledge gained through exploration, cannot be easily carried over to other technologies. Their educational materials are more likely to feature motivational tools that are not connected to the content, doing little to increase their long-term interest in the material they study. Finally, low-income schools are more likely to use computers as remedial tools, providing no new material. As educational objectives shift from developing independent learning skills to an orientation toward specific technical skills and simple task completion, there is a reduction in the quality and outcomes of technology use (Selwyn et al., 2001)

Chapter 7 compares the technology education programs aimed at teaching specific computer skills with educational technology programs aimed at integrating technology use with the regular curriculum. Several schools, especially those in low-income areas, lacked teacher training, infrasctructure, staff, and planning time for computer uses that were integrated with the curriculum. Computers in these schools were often funded with the explicity intention of supporting the existing curriculum but teachers often reluctantly settled on using computers to teach computer skills. Despite the advantages of specific computer skills for students immediately entering the job market, research suggests that students who learn to use technology incidentally, through the course of normal use as a tool, may be better able to transfer this skill to new situations as they emerge (Strauss, 1984). Thus for the majority of children, who are predicted to enter the workforce after today's software has become obsolete, computer classes may not be the best way for building computer skills.

In my conclusions I summarize the constraints that context brings to technology use and the outcomes of technology programs. I discuss the limitations os technology as a catalyst for social change and theimportance of maintaining educational technology programs in parallel with initiatives aimed at improving equity. Technology can do a lot to improve education overall, but it cannot be expected to solve problems of social inequality.

Methods

Research for this dissertation was carried out in the States of Rio de Janeiro and Minas Gerais at primary and secondary schools. Much of the field research was carried out in visits to municipal, state, and private schools where I observed technology in use and interviewed teachers and administrators. Most of the teachers I spoke with and schools I visited were in the minority in that they were currently using computers on a regular basis. A smaller number of teachers who were not using computers on a regular basis agreed to interviewe with me as well.

Much of my first contact with teachers was through the *Mostras de Informática na Educação* organized by the ProInfo *superintendencia* in Juiz de Fora and the Juiz de Fora *Sectretarias de Educação* at the end of the 2003 and 2004 school years. These events ranged from two to three days and were opportunities for enthusiastic teachers from both public and private schools to present their use of computer technology to peers Many teachers brought examples of student work or students themselves to illustrate their work with technology.

Some additional contacts were made through acquaintances who work in schools in the states of Rio de Janeiro and Minas Gerais. I also attended additional events, talks, and conferences focused on the use of technology in education included higher education conferences and workshops. In the case of higher education, I limited my research to programs aimed at preparing pre-service teachers enrolled in *licenciatura* (teacher education) programs for technology use in their classrooms.

It bears mentioning that I am not a native speaker of Portuguese. As an American conducting fieldwork in Brazil, my Portuguese language skills have limited my ability to take long direct quotes from teachers and students. I chose not to use recording devices because I found them conspicuous in classrooms and because the background noise levels in most classrooms would have rendered the recordings useless. I have made every effort to collect key quotes from reconstructed conversations but to maximize the speed of my note taking, I have mixed English language observations with Portuguese language quotes. These quotes tend to be short and I have tried to provide as much context as possible to help make sense of them.

This research includes some comparative observations with the experiences of countries with longer histories of computer use in schools. My background includes several years of work in education in the Silicon Valley region of California where computer use is both widespread and well documented (Cuban, 2001). My field observations are likely influenced by this point of view. I have included some research literature from other countries where computers have been used in schools on a large scale basis for decades.

As I compare the relative academic acheivements of students in low-income areas with those from more priveleged backgrounds, it should be clear that I believe it is possible for schools to be successful with students from varied backgrounds. Acknowledging the advantages for students from more affluent backgrounds, for example those who begin school with some basic reading skills, or those who learn formal Portuguese language skills at home, I believe that a school system designed to provide the same curriculum for all students must be accessible to those without these advantages. While I do not argue for compensatory education, I do think that schools need to do as much as possible to ensure that inequalities occurring outside of school are not compounded by further inequality in school.

Two factors make the Brazilian case particularly interesting for a comparative study on the relationship between educational technology and equality. First, Brazil's relatively short history of computer use in schools gave policy makers and educators an opportunity to benefit from the experience of countries that had been using computers in school for decades, especially the United States. Second, as a country with extreme social inequality, the impact of technology on educational equality is considered important here and technology policies are often specifically drafted with equity goals in mind.

2. Background, Educational Technology and Social Change

This chapter discusses several areas of social research relevant to a discussion of the relationship between educational technology and social change in Brazil. I begin with a section discussing the limitations of a technological determinist view, the importance of recognizing technology use as social practice, and the impact of social context on technology use. The next section describes the relationship between one area of social life, religious thought, and technology use. This is followed by a section reviewing social science theory describing education as a form of cultural transmission and legitimation, outlining the sometimes conflicting role of education in offering opportunities for social mobility while at the same time reproducing some existing inequalities. In the last section, I will discuss the widespread optimism concerning the power of technology to bring about social change contrasted against research indicating limitations to this potential.

Since the earliest wave of developments in educational technology, it has been suggested that technology has the potential to bring about radical changes to teaching and learning. Seymour Papert, a pioneer in educational computing whose work with the Logo programming language for children has influenced some of the most research driven educational technology design over the past three decades, argued that new technology had the power to bring abour radical changes in education (Papert, 1980). Papert himself recognized education takes place within a cultural context and that technology alone does not shape changes to in learning process without the interaction of the social context.

> The context for human development is always a culture, never an isolated technology. In the presence of computers, cultures might change and with them people's ways of learning and thinking. But if you want to understand (or influence) the change, you have to center your attention on the culture -- not on the computer. (Papert, 1987)

Technology use itself is also shaped by social context. The technological determinist notion that technological innovations alone bring about social change overlook the impact of social context on determining which technologies will be developed and how they will be used. Educational technology itself is unlikely to bring about revolutionary changes to classrooms

> [O]ur research in the classroom suggests that it would be inappropriate to conclude that the computer, in and of itself, is the agent of change. When used in educational settings, the microcomputer is always a part of the larger social system, which includes the students, the teacher, their history of past relationships, the history of ways of teaching, the history of ways of organizing the classrooms, the relationship that the classroom curriculum has to the classroom surroundings, and the relationship between the classroom and the school community, and agencies beyond. (Mehan, 1989)

Using the example of Logo, a programming environment for children developed at MIT in the seventies and eighties, Agalianos (1996) has discussed how technology use "affects and reflects the surrounding social conditions" with examples from both the United States and Britain. He argues that the student-centered kinds of use intended by the authors of Logo were embraced early in Logo’s history because these uses were consistent with the social and educational trends in the U.S. and Britain at the time. Logo was used as a tool for exploring abstract concepts independently during a time when teachers were encouraged to allow students to explore concepts independently..

Later, as educational reforms began to focus on increasingly subdivided curriculum areas, Logo was used in way’s unanticipated by it’s designers. In many schools it became a tool for demonstrating basic geometry concepts like angles, in others it became a subject in it's own right, some students were taught Logo programming as a subject in it's own right rather than a tool to help uncover abstract mathematical ideas. As schools began to focus increasingly on accountability and testing, much to the chagrin of Logo's original authors, some students were even tested on their Logo programming knowledge. Agalianos quotes one of Logo's original developers discussing how the changing social climate in schools impacted the way the software was used; "Schools... just ate up Logo and spat it out as just another little school thing". (Agaliamos, 1996, p. 27)

This chapter discusses the relationship between technology use and the social context in which technology is used. Like the Logo examples illustrated above, the way a technology is used in Brazil and it's effectiveness in supporting teaching and learning is influenced by the social context of schools. This influence limits the capacity of technology to be a catalyst for social change.

Technology Use and Religious Thought

Technology development and proliferation is often considered to be among humankind's most rational pursuits. Since much technology exists as a consequence of scientific thought, it is often taken for granted that the way people interact with technology is based in similar thinking, and that decisions about technology use are made on the basis of rational calculation. But people do not always adopt technologies with careful cost benefit evaluations. There are examples of these apparent contradictions between rational use of technology and actual use in educational technology uses, as indicated by the gap between educational research and the discourse surrounding technology use and technology implementation.

In the case of educational technology, the kinds of use that are supported by educational research are not adopted by public education agencies with any greater likelihood than technology that is contraindicated by educational research. Decades of research in educational computing has had little impact on some of the ost popular educational titles on the market. It appears that educational goals alone cannot be the sole basis of technology use decisions. This leaves open a number of questions about what additional factors are influencing technology adoption in schools and if they are based in scientific thought.

Noble's Religion of Technology

David Noble (1999) has argued that religious thinking plays a role in technology development and adoption, and that it is not always possible to encounter scientific rationale for the course of technology development and adoption. He believes that religious thought permeates decisions concerning technology development, largely considered mankind's most scientific and rational enterprise, claiming that this is among the reasons why technology is often implemented in society irrationally.

Noble argues that technology and religion have evolved together in western society, with religion providing the drive, motivation, and justification for further technological development. He begins with the european middle ages, when Christian belief shifted from viewing what he calls "the useful arts" with disdain to viewing them with dignity. Thus, crafts and, eventually, technological pursuits gained value among European Christians. Technology, he argues, came to be associated with transcendance; through technological development man could hope to regain what was lost in the fall and come closer to understanding God's plan.

Today's simultaneous flourishing of both scientific technology and religion, Noble argues, is neither coincidental not contradictory, it is the result of the relationship between scientific and religious thought. For Noble, technology is not only connected to religious thought, it has reached the status of faith in it's own right. The belief that technology will improve the human experience, he argues, is based not on careful selection of appropriate technologies geared toward meeting human needs but on religious ideologies that favor technology use and further technology development in support of Christian ideologies.

Considering technology as faith, Noble identifies a set of possible factors contributing to the use of technologies that do not appear well matched for their intended goal. He describes what he calls an obsession with technological development, what could be described as blind acceptance, the failure to think and act rationally with regards to technology. Noble argues that the religion of technology is a set of myths that have prevented us from using technology in ways that serve our rational needs and that instead, western society directs it's innovative energy and scientific advances at "other-worldly dreams." He cites several areas of technological innovation where technology has failed to live up to it's promise, but where there has been no reduction in enthusiasm about its pursuit. Technology's capacity to improve the human condition is therefore tempered by irrational planning, development, and implementation.

Classical Social Theory and the Religion of Technology

Noble's ideas surrounding the history and ideology of the religion of technology provide a framework for re-examining social thought on the relationship between religious and scientific with consideration to the impact of technology on social change. For example, Durkheim's view that religion serves several functions within society, including building social solidarity and providing a source for moral authority has new implications if we consider technological optimism as a form of religious thought.

> Une religion est un système solidaire de croyances et de Pratiques relatives à des choses sacrées, c'est-à-dire séparées, interdites, croyances et pratiques qui unissent en une même communauté morale, appelée Église, tous ceux qui y adhèrent. (Durkheim, 1922)

While the religion of technology does not satisfy all of Durkheim´s requirements for a religion (morality, for example, is not a key element), technology is an important source of unity among western societies; technology is even a means by which societies are categorized, for example “post industrialist” or “information societies”.

For Durkheim, religion was essentially a reflection of society itself, religion is social and through religion society worships itself. In this respect, the religion of technology could be seen as society praising its own accomplishments and historical singularity. One could explain societies that identify themselves according to the technology they have mastered, and the pride they take in their technology, as a form of self worship, especially when it involves the belief technology users and creators are brought closer to god through technological innovation. Noble illustrates this notion citing the example of the Apollo 8 astronauts who, during the first manned mission to the moon, read the first 10 lines of the book of Genesis aloud and broadcast it back to earth.

Like Durkheim´s view of religion, technology cannot exist outside of a social context. Cars are nothing without roads to drive on, telephones are useless without a network of users, and even the light bulb serves little purpose without a supply of electricity. Even the most common technologies do not exist within individuals who make or own them: they are shared within the whole society. Technology is completely woven within society and cannot be removed from this context. This interconnectedness makes technology a fitting symbol for progress within a society and an appropriate means for what Durkheim considered to be society worshipping itself.

Durkheim also argues that beliefs shared by a group make the group's unity. In a time when societies are identified according to the technologies they have mastered such as post industrialist, or information society, we could argue that these beliefs, not in the existence of technology and it’s development, but the beliefs that technology has transformed us and can define us, makes the religion of technology consistent with Durkheim’s ideas about religion in general. If members of a society define themselves and their society according to technological developments, these developments become a source of group unity.

Although Durkheim believed that scientific thought would eventually prevail over religious thought, he recognized that science did not have unlimited power over religion, and that, in some cases, authority and credibility could be disputed between them.

> L'opinion, chose sociale au premier chef, est donc une source d'autorité et l'on peut même se demander si toute autorité n'est pas fille de l'opinion. On objectera que la science est souvent l'antagoniste de l'opinion dont elle combat et rectifie les erreurs, Mais elle ne peut réussir dans cette tâche que si elle a une suffisante autorité et elle ne peut tenir cette autorité que de l'opinion elle-même. Qu'un peuple n'ait pas foi dans la science, et toutes les démonstrations scientifiques seront sans influence sur les esprits. Même aujourd'hui, qu'il arrive à la science de résister à un courant très fort de l'opinion publique, et elle risquera d'y laisser son crédit. (Durkheim, 1912)

For scienfitic thought to achieve it's destiny, according to Durkheim, of helping people to explain and classify their world, ultimately to replace religion, it must comply to some degree with public opinion, including religion, or risk challenges to it's own authority. While the history of science includes several well known examples of researchers who flew in the face of convention, Noble shows examples of the phenomenon that Durkheim identified. He shows that a fair amount of scientific development, particularly technological development, took place within the social and religious contexts of their times.

According to Noble, almost every important 17th century English scientist, from Robert Boyle to Issac Newton, had millenarian beliefs and believed that gaining knowledge was a means of recovering that which was lost in the fall. For example, in Francis Bacon's view, the advancement of knowledge was necessary for transcendance, that only through science and technology could mankind be restored to "it's perfect original condition". Mathematician and inventor Charles Babbage is quoted as saying that "by the exertion of the highest faculties with which we have been blessed, we may make a nearer approach to the knowledge and will of our creator" (Noble, 1999, p. 72).

Considering the current strength of both religion and technology, some have argued that Durkheim was wrong about scientific thought eventually replacing religious thought, and that perhaps technological development played a major role in the turn of events that helped maintain religious thinking. Some social scientists today concur and argue that history has not supported Durkheim's thesis, the evidence is that religion remains strong today despite significant advances in modern technology, but this view overlooks the distinction between technology and science, it is possible that technology has advanced without society becoming more scientific.

Even though technology has come to prominence in the west, scientific literacy remains weak and scientific thought has not yet gained to prominence in determining popular worldviews. Noble´s work provides us with an interpretation more favorable to Durkheim's analysis. Since religious thought is woven throughout the supposedly scientific pursuit of technology, science has not necessarily truly come to prominence in western society and has therefore had no opportunity to overcome religion. Until scientific thought becomes widespread, Durkheim's theory remains untested.

In Magic, Science and Religion, Bronislaw Malinowski argues that all societies have magic, religion, and science, and that, contrary to much enlightenment thought, religious ritual does not substitute scientific thought. Instead religion and magic play a role in areas where science is not helpful and cannot provide answers. For Malinowski, science and religion coexist, and the absence of formal scientific institutions does not mean that science does not exist. In this model, the role of technology and it's relationship to religion is complicated.

Malinowski describes the agricultural technology of the Melanesian and Papuo-Melanesian tribes of eastern New Guinea as a combination of magic and science. Rather than thinking of their agricultural production as the result of their science and their religion as a separate social activity, the people Malinowski studied viewed magic and science as indispensible elements of their most important technology: agriculture.

> If you were to suggest to a native that he should make his garden mainly by magic and scamp his work, he would simply smile on your simplicity. He knows

> as well as you do that there are natural conditions and causes, and by his observations he knows also that he is able to control these natual forces by mental and physical effort [...] Thus there is a clear-cut division: there is first the well known set of conditions, the natural course of growth, as well as ordinary pests and dangers to be warded off by fencing and weeding. On the other hand there is the domain of the unaccountable and adverse influcences, as well as the great unearned increment of fortunate coincidence. The first conditions are coped with by knowledge and work, the second by magic." (Malinowski, 1955, p. 28-29)

According to Noble's view, western society is not very different in this respect from the tribes Malinowski studied. Western societies develop complex technologies, like nuclear weapons and new reproductive technologies, and then rely on spirituality to answer questions raised by their use. Religion is called upon to address the etical questions that science cannot answer. Genetic engineering, DNA research, and artificial intelligence are developed with careful consideration toward spiritual consequences on the one hand, especially those concerning tampering with God's work, and on the other hand the development of these technologies reveals a hope that they will bring immortality or perfection.

If technology is the result of the marriage of scientific and religious thought for the Trobrianders that Malinowski studied and for modern western societies as well, is it possible for science to exist without religion? Is technology possible without religion? Noble would argue that it is, that we can apply the scientific enterprise in all stages of technological development, including decisions about which technologies to use and how, and that only through this end will technologies truly meet human needs.

For Malinowski, science and religion must always exist in concert. When science leaves questions unanswered, religion provides answers, a view in which technology will always have a role to play in society, especially in the development and implementation of technology. This view raises questions about the endeavor to apply technological solutions to problems like poverty: what kind of thinking guides these endeavors? Are they guided by scientific reasoning, religious thinking, or both?

In The Structure and Functions of primitive Society, A. R. Radcliffe-Brown discusses the relationship between beliefs and rituals. He argues that the widely held theory that rituals are developed in support of existing beliefs is backwards. In Radcliffe-Brown's view, people begin with a set of practices without accompanying beliefs and, over time, a set of religious beliefs develops to explain the customs and transform them into religious ritual. According to this view, the religion of technology could be viewed as a set of religious meanings surrounding pre-existing technological enterprises, as though technologies were brought into religion.

Noble’s religion of technology is consistent with Radcliffe-Brown’s thinking about religion and technology. The religious meanings for technology outlined in Noble's book are almost always in reference to technologies already existant or under development. Rarely does technologically oriented religious discourse predict or prescribe future technologies, and when it does the details are quantitative (faster computers, more powerful bombs) rather than qualitative. The religion of technology is not directing the technological enterprise; it enters after technology has been adopted in society, helping to justify and glorify the continued use of technology.

Adapting Radcliffe-Brown’s thinking to the religion of technology, rather than playing a role in the development of technology or even implementation, religious thought enters later at the stage where society evaluates the impact of a new technology. As Radcliffe-Brown described, the religious meaning, in this case of technology use, is developed after the ritual, in this case technology use, has begun.

With ideologies rooted in hopes that technology will help man transcend his earthly existence, technologists have not been well prepared to plan and develop technologies that hold the most promise for humankind, or evaluate technology's costs and benefits for society. Today, with the simultaneous flourishing of both scientific technology and religion, from nuclear weapons to space travel, the discourse between technologists continue to be justified and motivated by millenarian ideas. Genetic research and artificial intelligence are developed with religious undertones, in an effort to bring us closer to god. In fact, for Noble, the recent growth in enthusiasm over technology and technological advance on one hand and the resurgence of fundamentalist religion, which he compares to religious revival, on the other, are two manifestations of the same phenomenon, the growth of the religion of technology.

The connection between religion and technology has allowed technology to develop in some cases without careful criticism. In many cases, the technological enterprise is undertaken without a basis in human needs and instead support religious needs for deliverance or belief. Faith in technology For this reason, Noble argues, technological pursuits continue even in areas where technological developments fail to meet their primary promise.

To what extent is the religion of technology a factor in the implementation of educational technologies? As I will describe in the future chapters, educational technology is often designed and implemented with the goal of improving equality in education while the technology uses that are result are often unequal themselves. As technology continues to be developed for schools, installed at public expense, and accepted by the general public without evidence that it's achieving it's primary goals, the idea that thinking about technology is based in faith gains credibility. Thinking about technology developments without assuming they are based in scientific thought helps make sense of the way technology is used to solve human problems.

Cultural Transmission and Legitimation

Many social scientists have discussed the role of education in passing cultural traits to the next generation and legitimating existing social structures. According to Spindler (1974), education functions not only to prepare people for occupations but as a form of cultural transmission with two major functions, recruitment and maintenance. An individual isn't only recruited into his or her cultural system as a whole but also into specific roles, statuses, and classes within the cultural system.

> The educational system is also organized so that the structure of the cultural system will be maintained. This is done by inculcating the specific values, attitudes, and beliefs that make this structure credible and the skills and competencies that make it work. People must believe in their system. If there is a caste or class structure they must believe that such a structure is good, or if not good, at least inevitable. (Spindler, 1974)

The use of computers in particular represents an effort to enhance Brazil's participation in the information economy. The current generation of Brazilian students is being recruited to participate in a new Brazilian society that does not yet exist. Spindler claims that schools in modernizing societies are characterized by discontinuity between life inside and outside school. These discontinuities can contribute to intergenerational conflict and a situation where what is taught in school is not related to the realities of student's daily lives. Because the curricular content is comes from elsewhere, these schools have a tendency to teach in a highly rigid and ritualized fashion, for example by reading aloud from textbooks.

If education serves to recruit the new generation into the existing or future cultural system, some economists have talked about its role in reinforcing the economic system. Bowles (1975) has discussed the increase in formal schooling in the United States and its historical connections with the rise of industrial capitalism. Rates of formal schooling in the U.S. increased first in the regions with the most factories. Bowles argues that in addition to the value of schools in preparing children for participation in an economy where few could expect to carry on the trade of their fathers, schools provided factories with a workforce that was prepared for factory life, graduates of formal schooling responded to authority, followed routines, and respected punctuality. For Bowles, one of the most significant contributions of schools to industrial capitalism is the legitimacy that it offers to the hierarchy of the economic system.

Kerkhoff (2001) describes the dimensions of national educational systems that influence the relationship between social stratification and education. He compares the education systems of Great Britain, Germany, the United States and France with attention to how each system influences the transition from school to labor force. Beginning with a model where he calls schools "sorting machines", he argues that stratification, standardization and vocational specificity impact the tremendous variation internationally in how the sorting machines work

Kerkhoff's use of the the idea of educational stratification refers to different curricula and schools for different students such as in the German system. He is primarily interested in systems that award different credentials not systems where everyone works toward the same diploma through a variety of coursework options, such as the United States or France. In Brazil, there is little variation in secondary credentials, there is only one kind of secondary diploma.

By standardization, Kerkhoff is interested in the degree to which the education system meets the same quality standards nationwide. This is influenced by budget, teacher training, exit exams, etc. Standardization levels are higher in countries with more central goverment control. France is most standardized, Britain and Germany are mostly state controlled, and the US with its decentralized control and funding to the municipal level is not very standardized. Higher levels of standardization are conducive to social mobility because local economies have a reduced impact on school quality. Despite Brazil's high level of centralization in curricular decisions, funding is channeled through state and munucipal authorities with substantial variation between municipalities and even between neighborhoods. Public schools are operated separately on the municipal, state, and federal level with vastly differing budgets and oversight.

Some countries offer secondary education options with a great deal of vocational specificity. This is obviously tied to how schools function as sorting systems. Germany's high specificity may account for the smooth school to work transition compared to other countries, but it may negatively impact social mobility. In contrast to Germany, British students can seek out vocational education after entering the workforce with less specific credentials.

In Brazil, vocational specificity formally begins with higher education for most students. There are some vocational secondary schools called escolas técnicas in the Brazilian public system but many of them have become institutions for the elite with competitive entrance exams and their graduates often are very competitive in the vestibular college entrance exams. In practice, though they teach specific technical skills, the escolas técnicas serve a college preparatory function for most students.

Despite the fact that primary and secondary schools are not formally divided into college preparatory and vocational tracks in Brazil, there is some consideration to the development of job skills early on, especially in communities where college attendance rates are low. With the introduction of computers, the focus on job skills tends to increase as teachers recognize the opportunity to teach stills with a direct value in the current job market. As early as the first years of primary schooling, teachers consider the work force value of specific marketable skills such as word processing.

Computers in classrooms are often coupled with a job preparation approach to schooling aimed at teaching specific skills, rather than more general literacies. This phenomenon is more pronounced in schools serving low-income areas because students attend school with the expectation that they will enter the job market immediately afterward. The teaching of speciic job skills, according to Kerkhoff's model, will influence the way schools function as sorting systems.

In analyzing the case of cultural transmission in Brazilian primary and secondary education, both Spindler's concepts of recruitment and maintenance and the role of school in reproducing society and Kerkhoff's model concerning the relationship between schools and the economic system and help explain, in part, the limitations of schooling in bringing about changes to social inequality.

Technology and the Promise of Greater Equity

Innovations in IT have brought with them a sense of widespread optimism concerning the value of IT for improving education. Much of the optimism predicts that IT will diminish inequalities by improving distribution of educational resources or improving the overall efficiency and quality of educational programs. Discussions concerning the Digital Divide bring together both of these arguments together with a claim that IT is both empowering for users and a prerequisite for full participation in society.

In this section I discuss the public discourse concerning the power of educational technology in bringing about improvements to educational equity, along with a discussion of similar optimism within schools. I compare the basis for teacher optimism with messages found in the press and research literature. The principal arguments of optimistic authors who advocate technology use as a means for improving educational equity are consistent between popular press and research literature, and center around two basic lines of reasoning. The first is that technology improves efficiency, which allows for greater service to the poor. The second is that technology reduces the impact of some existing inequalities that impact education.

In his discussion of the recruitment and maintenance functions of schools, Spindler (1974) expands on the idea of recruitment and describes a somewhat contradictory role of schools in modernizing cultures where schools are future oriented and intentionally change the cultural system. In these cases, he claims that "rather than maintaining the existing cultural order, schools in these contexts are designed to destroy it." The recruitment function draws students into a system that doesn't yet exist. Spindler's description applies to schools in low-income communities in Brazil, where the government aims to offer the new generation of students more educational opportunity than their parent's generation in hopes of bringing about economic and social changes.

The introduction of computers in low-income areas fits with Spindler's notion about modernizing societies. While the specifics of the changes vary between users of educational technology, the notion that the use of technology can help lead students toward a future that was otherwise impossible is nearly universal. Many students and teachers believe that computer experience will bring students job opportunities, which in communities with high unemployment and underemployment rates means significant social and economic change. With the help of computers, schools are recruiting students into a new society where lower unemployment promises to bring about better living conditions for many. While the schools serve this function with or without computers, the addition of the new technology as evidence of progress and change and serve as a daily reminder that the schools promise change.

Among the computer using teachers who spoke with me and presented at the *Mostras de Informática*, information technology is widely regarded as at least a partial solution to the problem of inequality. Some teachers took a rather conservative stance in support of technology use for improving equality stating that since wealthy children had access to computers at home, schools needed to provide opportunities for lower income students who would otherwise have no access and be barred from the advantages that computers offer. Others felt that the presence or absence of computers in schools was a major determiner of opportunity for children or necessary for schooling. One teacher claimed that "nós não podemos fazer educação sem este recurso" and went on to say that the unequal distribution of computers in schools was a principal factor in the “perverse” distribution of educational resources. Many teachers used words like “magic” to describe the revolutionary effects they thought technology had on educational equity.

In one example, the city of Juiz de Fora used computers as part of an educational program designed to bring about social change, to recruit students into a new less violent city. The municipal education department *secretaria de educação* won a federal grant to develop after school programs in communities with high rates of violence. The after school programs could offer students structured activities in the late afternoon and were supposed to help students build a sense of pride and belonging for their community. One of the programs, implemented at several schools sites was a year-long training for future computer lab peer instructors or *monitores*. Once the program is over, it is hoped that graduates will be able to supervise the computer labs allowing students and community members access to the computer labs when school is not in session. It is interesting that computers played such a central role in a program whose goal was to bring about social change and reduce urban violence, through computer use, program staff hoped that students would improve self-esteem and respect for their communities leading to less community violence.

Much of this discourse concerning technology as a catalyst for change is analyzed within the literature on the digital divide. In my fieldwork, teachers have shown familiarity with the idea that their use of computers is meant to impact social inequality but equity does not form the basis of teacher’s day-to-day decisions about technology use. When asked about their choices in using technology, teachers rarely mention goals related to equality of opportunity.

The Value of Educational Computing

Tapscott (1998) claims that “IT has the power to give everyone a voice and an option." Samad (2001) echoes this sentiment describing the introduction of the personal computer as "Ushering mankind from modernism to the post industrial era and cyber era". Though few would claim that more IT will always lead to greater equity, these vague notions about it's revolutionary impact offer little guidance for educators and policy makers hoping to make use of IT in ways that can improve equity. Though few studies have focused exclusively on equity, decades of research on educational computing has identified some characteristics of computer use that is most likely to be sucessful in schools.

Lonergan (2000) thinks that, in addition to their economic impact, computers and the Internet have become important for participation in political and social life. Sayers (1995) suggests preparing students for life in a globalized world using worldwide communication networks that allow teachers and students all over the world to communicate. Educational researchers have identified several additional kinds of computer use that have the potential to improve skills, scores, and critical thinking skills (Attewell, 2001).

Computers are good at showing intangible things visually. For example, a simulation can explain how data is represented graphically by allowing manipulations to data and changing the appearance of a corresponding graph, helping students understand the relationship between data and graph (Archer, 1998). Many studies have shown the value of using computers as tools in projects that require active student engagement, in programming instruction for building basic reasoning skills. Computers can be tools for self-paced learning, individualizing instruction to each student's level. Computers are often credited with bringing about motivational benefits with sustained improvements found with software that provides motivation intrinsic to the content (Malone and Lepper, 1987).

In the United States, IT has been successful in many experimental pilot programs in schools. But in large scale implementations, educational technology use has been more difficult to evaluate and has on occasion been connected with drops in student performance. IT use has not been connected with greater educational equity across the board but programs aimed at increasing access to technology in low income communities continue to grow along with programs aimed at addressing other digital inequalities ranging from teacher technology training to speedy Internet access.

The digital divide alone does not fully explain the limits of technology improving educational equity. Increases in technology resources are sometimes inversely associated with educational outcomes. Wenglinsky (1998) and Archer (1998) have shown that increased technology use in schools is sometimes correlated with lower achievement indicators. One explanation for this apparent contradiction is differences in the way technology is used. The kinds of school technology use best supported by educational research are more common in higher income areas. Thus wealthier students have greater access to the advantages of educational technology. Some of these differences in types of use have been incorporated into discussions concerning the digital divide (Attewell, 2001).

Technology and Efficiency

There is a line of thinking that with more technology, education can become more efficient and that through greater efficiency more opportunities will open up for disadvantaged students. Improvements to efficiency are potentially helpful, to the extent that inequality in education reflects actual resource shortages. For example distance education programs aimed to efficiently increase certification rates among teachers in rural areas have a good chance of improving equality of access to qualified teachers in those areas. But when technology is not used in ways that address existing shortages, there is no guarantee that the benefits of the new technology would be shared equally by all students.

During both the 1998-2002 and current presidential administrations, there was an understanding on the part of federal level policymakers that more technology investment would not automatically lead to greater efficiency. There are many risks of waste when implementing new technology. In one interveiw, a former Ministry of Educaction (MEC) official, informed me that the Programa Nacional de Informática na Educação (ProInfo) recognized a risk of waste in IT and developed initial strategies to avoid it.

ProInfo did not promote the use of educational software because of a widespread understanding that many educational materials on computers were not worth their price. Instead, ProInfo dedicted much of it's efforts to distributing hardware without dedicated educational applications and facilitating training programs aimed at helping teachers make better use of open ended computer applications. While ProInfo's mere existence indicates a sense of optimism within MEC about the potential impact of IT, their level of caution shows an understanding that whatever benefits are to be realized are not the automatic consequence of more technology.

On the school levels, I have seen a similar reluctance to put scarce funds into educational technologies. One middle school director told me that parents raised money to buy the school a computer for administrative use. They would like to have computers for educational use as well, but the director believes that the level of investment required before yielding results is much higher. Rather than hope to squeeze computers into her small budget, she will wait to be selected for future statewide technology purchase programs. For this director, the immediate benefits of computers for administering a school were much more apparent than the benefits offered by an educational computer. She recognized a potential for improving efficiency in situations with more generous budgets but believes she can get more out of her extremely limited funds with investments in other area.

Technology and Existing Inequalities

In addition to the hope that IT will improve the overall efficiency of educational institutions, there is optimism that new technologies will ameliorate the impact of existing social inequalities. For example, it has been argued that the Internet compensates for inequities in available library materials for children, and that problems with teacher preparation will have less impact with the the support of cutting edge educational technologies. Pilot programs demonstrate the value of putting students in contact with outside experts in environments where professional and intellectual mentors are rare.

Generally, when technology is used to supplement available written resources such as books, there is little dispute that it is helpful in bringing a very large return on a relatively small investment. But in most public schools, the cost of printing is prohibitive and screen time is limited to the point that mass produced books continue to be the most cost effective reading material. Still, it is possible that the Internet could allow independent research projects in schools that have no research libraries and this kind of use has a potential to have a positive impact in low income communities.

Another widely reported use of technology that aims to address existing inequality is the use of science simulations in schools without laboratories. Simulation software was the highlight of several technology sessions of science education conferences I attended. Speakers introduced their use of simulations explaining that funding and space for science labs and hands-on science are disappearing from the schools where they work and that they've tried to address this problem through the use of computer simulations. Ironically several presenters admitted that they lost their science labs when the school needed the space for a computer lab.

The phenomenon of replacing hands-on science laboratories with computerized simulations is both widespread and controversial. Sherry Turkle argues that the rationale behind the manipulating on-screen variables instead of tangible objects is usually financial rather than educational and that simulations are probably more appropriate for things that cannot be readily demonstrated in more hands-on ways.

> The question of simulation is posed from preschool through the college years. Why should four-year-olds manipulate virtual magnets to pick up virtual pins? Why should seven-year-olds add virtual ballast to virtual ships? Why should fifteen-year-olds pour virtual chemicals into virtual beakers? Why should eighteen-year-olds do virtual experiments in virtual physics laboratories? The answer to these questions is often: because the simulations are less expensive; because there are not enough science teachers. But these answers beg a large

> question: Are we using computer technology not because it teaches best but because we have lost the political will to fund education adequately? (Turkle, 1997)

For example, when students used Microsoft Paint to explore color mixing in a computer class I observed, They saw that when they superimposed blue images over yellow images, the overlapping area appeared green. Students with this experience could ask themselves (or their teachers) why the mixture of yellow and blue make green but unlike children who play with mixing paints, or translucent colored materials, they are not confronted with a natural phenomenon. Microsoft Paint in this sense functions as a simulation of a real world phenomenon but the reason that yellow and blue make green in the software is that it is programmed this way. The effects of color mixing don't tell students anything about the world outside the computer, they must recognize that the color mixing functions of the software are modeled after something in the real world before they can draw conclusions about color in general.

Turkle goes on to report on the controversy over educational use of simulations in cases where hands-on activities are possible. For the kinds of uses common in primary and secondary education such as basic sciences, the major disadvantage of simulations is that students learn how things work inside the computer but they don't necessarily understand the relationship between the set of rules in the computer and the natural phenomena after which they are modeled. The distinction between the simulation and the real world is similar to the difference between telling and showing. Giving children opportunities to experiment with mixing real paint shows children what happens when different colors are mixed. With the simulation, the child is told the same information but they may or may not believe it.

Making the leap from silumation to generalization about the real world is not automatic. Children don't usually understand the basic set of assumptions under which the simulations operate. Turkle describes one student using a simulation without any understanding of how it's rules compare to those of the world after which is was modeled as "like someone who can pronounce the words in a book but doesn't know what they mean." She argues that users of simulations must go further than simple working within the model, they must think critically of the models they are using. Since much of the pedagogical value of computer lab work is related to the opportunity for students to test ideas against nature, simulations without this type of reflection on their relationship to the real world offer only a small fraction of the benefits of hands on laboratories.

Teachers recognize the importance of laboratory work, often referring to simulations as giving students a change to "por mão na massa" but simulations don't truly offer such an opportunity because within the simulated computer program students are only learning about the rules of the simulation itself, whether or not they extend their understanding to phenomena in the real world depends on an additional step beyond what the simulation can offer.

Traditional hands-on laboratories help students understand that science comes from nature, rather than books whereas simulations introduce a new authority to be trusted, the computer. Unlike material read from a book or viewed on screen, hands-on experience allows students to test ideas directly against nature. While simulations may offer some of the interactive advantages of hands-on laboratories, students who use them must accept the first hand experience of others as authority much like when reading about science from a book. Computer simulations used in settings where science labs are unavailable cannot be expected to fully bridge the gap between students who have access to hands-on science activities and those who do not.

One common strategy for using technology to address existing inequalities is by overcoming or compensating for inequalities of teacher training. There are two common strategies for this, the first is the idea that multimedia classroom tools can take over a large portion of instruction limiting the impact of an unqualified teachers, the second is the idea IT materials can be used to train teachers who don't have easy access to universities. These two approaches can lead to widely differing results. While the idea of using classroom based IT, to overcome the limitations of an unqualified teacher seems sound, the success of any kind of technology use is based heavily on the quality of the teacher. The teacher plays an important role in selecting appropriate material for students and helping them interpret material. At this point, substituting computers for teachers is not a viable strategy.

The second approach to addressing shortages of qualified teachers with technology, however, shows a lot of promise. MEC is investing heavily in this area by providing portals for teachers, online tools for distance learning, and support for Universities seeking to offer semi-distance versions of their teacher education programs. MEC has used video technology and television for teacher education for years and with a substantial body of video material developed over the years, MEC is well poised to develop low cost, high quality computer-based materials for teachers. This kind of technology use in programs aimed at addressing local teacher shortages could live up to some of the expectations that technology improves educational equity.

The Lesson of the Digital Divide

Optimism in terms of the value of technology must always be tempered by an understanding of the limitations of technology. Simulations can be useful in visually displaying abstract ideas but they should not be viewed as substitutes for hands-on experience, multimedia educational software may be useful but cannot be expected to substitute qualified teachers, and the Internet may be a valuable source of information but with current technology it cannot efficiently replace printed books. While schools with low budgets are presented the opportunity to use computers as a means of saving money or overcoming existing shortages, their wealthier counterparts use technology differently, to complement existing programs.

The digital divide was originally conceived of as a divide between "haves" and "have-nots" (US Department of Commerce, 1995); as an issue of access alone. Discussions concerning the digital divide usually maintain a high level of optimism claiming that the new inequalities introduced by new technologies can be overcome. But as public and private agencies have rushed to develop technology access programs, especially in U.S. schools, more recent research has shown that realizing the benefits of IT in education requires more than just a computer with access to the Internet. Within discussions about education and technology, the term digital divide now comprehends more than just access to include levels of teacher technology training, locally relevant content, information literacy, and the ways new technologies are applied. Those who accept this broader definition of the digital divide argue that the outcomes of digital equity policies in education will depend as much on the social context of new technologies as on access to technology itself. Many have shown that differences between the ways information technology is used in classrooms mean that low-income students tend to be exposed to different types of computer use than their high-income counterparts. Despite several decades of research on educational computing that has indicated the characteristics of the most successful technology programs, use that is consistent with these standards is rarely implemented in low-income areas (Selwyn et al., 2001), (Attewell, 2001), (Natriello, 2001).

Much of the digital divide research in education compares access to information technology in schools serving low-income communities with what is available in high-income communities. Much is known about access to technology and technology infrastructure in schools. On an international scale greater access to technology is available within wealthier countries, however, in the United States a high level of public investment to address the digital divide has made technology funding available to schools that continue to struggle to provide the basics. As we see increasing funding and subsidies for technology in low-income areas, we may expect similar patterns in other parts of the world.

Some U.S. schools in low-income areas offer as much or more access to technology than the national average. Despite Attewell's finding that wealthier American schools have more technology and technology of better quality, there is no divide in terms of student access counted in terms of hours of computer use per student. Lonergan (2000) concluded that all schools were equally likely to have Internet access, albeit not equally likely to have high-speed access. According to Archer (1998), the access divide had disappeared among American school aged children by 1998, with income level having no correlation to the likelihood of spending time at computers in school. Likewise, black and Hispanic students in the U.S. are more likely to use computers at school than their white counterparts.

In spite of evidence that access is well distributed, the 2000 Digital Empowerment Act prioritized low-income schools across the U.S. for massive technology assistance funds and subsidies. The rationale behind these programs is the promise that technology will improve equity by providing opportunities to overcome the limitations of budget shortages. It was hoped that the Internet can compensate for problems like lack of funds for libraries and limited teacher training opportunities. But the expectation that more school access for poor and minority students, should be accompanied by improved equity levels has not been met.

Despite all this action and funding, the literature on the Digital Divide in education is still in its infancy. While the U.S. Federal government has produced reports corresponding to each of their funding programs (Rifkin, 2000), Agalianos has shown a shortage of social science literature on the topic and the impressive body of educational literature is often overlooked in practice. Considering the enormous public and private investment in bridging the digital divide through school access, a number of important questions remain unanswered about the value and limitations of technology in schools, especially with respect to the impact of technology on equality of educational opportunity.

The difficulty for schools therefore comes from the importance of not overlooking the low-technology necessities in the midst of a climate of high-technology enthusiasm. This has become especially challenging in light of discussions concerning the digital divide in which the promise to improve conditions for low-income students with access to technology is embraced and coupled with the danger that students lacking computer skills will be unemployable in the information economy. While the digital divide discourse in academic and policy circles has expanded to include more than a simple question of access, students access is one of the easiest technology benchmarks to measure and schools still experience pressure to provide more technology access with little regard to questions of use.

In Juiz de Fora, MG, the *secretaría de educação* decided to use limited funds for IT to build full computer labs in a small number of schools rather than installing a couple of computers in each school. Eventually the hope was to include labs in all schools but the distribution would be by sets of 10 computers complete with desks, a printer, and chairs. While this may not be the most equal way to distribute computers in the schools, the strategy had its merits in light of the fact that schools with classes of 30-40 students were unlikely to find an educational use for a pair of computers.

The decision to install labs took the experiences of schools with a small number of computers into consideration. If computers are not located in classrooms, where they can be used by a small number of students during regular class sessions, it is very difficult for teachers with large class sizes to make use of small numbers of computer and they often end up not being used or being devoted to administrative rather than educational use. In one public school in Petropolis, RJ a lab of 10 donated computers was installed and used regularly. Over time several computers broke and resources for fixing them were not available. By the second year after the donation, only seven computers were working. For teachers, it became difficult to use the computers under these circumstances and the lab was locked for the remainder of the year.

The decision in Juiz de Fora to distribute complete computer labs unequally but in a manner more conducive to their use came under heavy criticism from the press making headlines in the local newspaper, Panorama. They reported that schools were contributing to the digital divide by selecting a small portion of the student population for access to computers. They publicized the large number of local students with no access to computers at all and apparently made no effort to ask for an explanation from the municipal education department. A more equitable form of distribution would have almost certainly have been more wasteful, guaranteeing that computers were rarely used. But such a distribution would have been politically easier for the mayor's office.

While there is little doubt that technology can lessen the impact of some forms of inequality in education, those forms of inequality that are embedded in the social context of schools cannot be resolved entirely through technical improvements alone. In these cases, technology can just as easily play a role in exacerbating existing inequalities are ameliorating them. An unrealistic view of technology as an automatic solution to social inequality risks a sort of tunnel vision where more traditional solutions and new risks are overlooked.

3. Technology and Public Schooling in Brazil

This Chapter provides an overview of Brazilian pre-college education, educational technology policy, and some summary statistics on Brazilian education, including best estimates on expenditures for hardware, software, training, and support and comparisons of how those ratios compare internationally (Sorj and Remold, 2005). The section on public schooling in Brazil gives a brief overview of Brazilian public education at the primary and secondary level and is followed by a section discussing technology use in Brazilian public schools. The section on technology use and religious thought offers a discussion of the contradiction between the scientific origins of technology and it’s often unsystematic application to human problems. Finally, I have included a section on the interaction between public and private interests with respect to educational technology adoption in public schools.

This chapter also includes a discussion of widely publicized plans for future expansion of educational technology in Brazil, such as massive school Internet access proposed by the executive branch and discussions about adopting a student laptop program. I discuss the discourse concerning equity of opportunity as it shapes public debate on education. I discuss Brazil's high level of investment in public education at the secondary and college level and it’s comparatively low levels of investment at the basic education levels, compared to countries with similar economies. I also discuss Brazil’s very high enrollment ratios in the early grades, the enormous problem with grade repetition, and the policy decisions which make it unlikely that this situation will improve in the near future.

Brazil's first constitution in 1874 declared the right to free primary level education, but the challenge for free universal education continues today. Recent efforts to improve access to basic education have been very effective, and census data indicate that 94% of children aged 7 to 14 attended school in 2000. Secondary enrollments have nearly doubled in the past 10 years. This represents a major expansion in recent Brazilian history, since only about 75% of Brazilians over the age of 50 have ever attended school. Furthermore, today Brazil is able to maintain enrollment rates at or above 90% for 9 consecutive years, showing that the majority of Brazilian children have opportunities to stay in school.

Brazil has come a long way in expanding its education system, but now faces problems of quality, particularly with high failure and repetition rates and high levels of functional illiteracy among people who have had formal education. On average, a Brazilian student spends over 2.8 years repeating grades, and only 80% make it to the fourth grade. Behind Gabon and Rwanda, Brazil has the third highest rate of repetition in the world, and costs of repeating years of instruction is more than enough to offer schooling for all Brazilians aged 7 to 17 or dramatically increase offerings for higher education (UNESCO Institute for Statistics, 2004).

According to Brazil's most recent school census, the problem of students falling behind is so severe that over half of upper primary school students (years 5 through 8) are 15 years or older. In primary schools, one in four students repeats each year with repetition accounting for 20% of education costs (Bruneforth et al., 2004). Though several states and municipalities have put in place programs designed to encourage teachers to fail fewer students, they are widely criticized in the popular media and lack support. High failure rates are an accepted part of education in Brazil, even in the lower elementary grades.

Brazil's legal minimum school year is 800 hours. Students start schools at age 7, and are expected to learn basic literacy skills within the first school year. Those who cannot meet basic literacy levels at the end of the first year must repeat. But it is not clear that 800 hours of instruction is sufficient for teaching basic literacy to a Portuguese speaker without prior instruction such as preschool or kindergarten, especially given a curriculum that devotes a fair amount of time to things other than basic literacy. Many Brazilian students don't have access to preschool and enter classrooms for the first time at age 7. Thus one major contribution to high failure rates may be the incongruence between how long it takes to achieve certain key proficiencies and the amount of instructional time many students actually get, especially in basic literacy.

Many schools choose to address high failure rates by ending the school year two to three weeks early for students who are passing so they can focus on intense review for those who are failing. This further reduces the amount of time available for introducing material. The large number of national, state and local holidays, combined with the common practice to *emendar* holidays that are close to weekends to allow for long weekends, cuts further into the instructional hours, giving students have very little time for developing basic literacy skills.

The fact that reduced instructional time has it's costs in terms of educational attainment is clear but what is less obvious is the degree to which reduced instructional time has a higher cost for lower income students. Middle class children may supplement their short school day with programs in a wide range of areas such as sports, languages, or information technology studies. Meanwhile, for low income students the school day may be the only opportunity for structured activity. There may be other academic advantages for wealthier students during time spent outside of school as they are more likely to spend their time with adults with high education levels.

Fischer et al. have reviewed studies in the United States indicating that much of the unequal educational outcomes reported from different social groups can be attributed to differences that emerge during summer vacations when schools are not in session. They argue that schools are very successful in overcoming the disadvantaged backgrounds of some students but “schools cannot sustain their effectiveness in improving the skills of the disadvantaged because schools are in session only nine months of the year, whereas family disadvantages operate during winder, spring, summer, and fall” (Fischer et al., 1996). One could speculate about the impact of half day schooling on equality. If U.S. schools are limited in their capacity to overcome disadvantages by a nine month calendar, what is the impact of a four to five hour day in Brazil?

Since many of Brazil’s more priveledged students have access to computers during after school time, inequalities outside school end up having an impact on school activities themselves. While private schools may be able to assign Internet research projects or Word processing assigments to their students without further training, many public school teachers, especially those who work in areas where incomes are low, believe they need to begin by developing mousing and keyboarding skills and other computer basics. This kind of school activity is the direct consequence of the different ways that non-school time is spent. It leads teachers of low-income students to use precious hours of school time, especially in the earliest years of schooling, on activities that do not contribute directly to basic literacy skills.

Elementary school teachers claim that it is impossible to pass a first year student who cannot read and write. But with so little time, it’s no wonder that 1 out of 4 first-year students fail, and only 70% of the 15-year-olds have finished primary school. Students who begin school with no prior reading experience have a difficult time succeeding, and those who fail are often forced to repeat the entire process again at exactly the same hurried pace.

Table1: Gross Enrollment Ratios.

Level	Gross Enrollment Ratio	Comments
Primary	155%	The highest in the world
Secondary	108%	Highest in the developing world, substantial gender inequality 108% male, 144% female
Tertiary	17%	Low by international standards

SOURCE: UNESCO Institute for Statistics

In 2001, one in four students was enrolled in the same grade as the previous year. The term Gross Enrollment Ratio refers to the number of pupils enrolled in the given level of education, regardless of age as a percentage of the population in the relevant official age group. In the case of Brazil, this figure points to the inefficiency that results from the high repeating rate. In 1999, for every 100 seven-year-olds in Brazil, there were 129 children in the first grade. This indicates that at least one third of primary school students are above primary school age. Brazil's primary school gross enrollment ratio is the highest worldwide, indicating that the problems of repeating begin at the very early levels. This problem, leads to tremendous waste as students who should be studying in higher levels repeat years of schooling (Schwartzman, 2004).

High elementary education failure rates led to changes in the regluations concerning retention in some areas, providing controversial incentives for teachers who pass students and limiting the cases students can be held back. Implementation of these efforts to reduce retention rates has suffered from several key problems. The responsibility for change lies with the teachers who have limited control over the problems that lead to failure and little support in learning to change those aspects that are within their control. There is also very little teacher support for these changes which are widely regarded as social promotion programs. The problem of failure rates is poorly understood by the public and vastly oversimplified in the press.

Public education in Brazil has been successful in bringing about dramatic increases in the number of people with the most basic level of literacy, but there is evidence that some of these people never reach high enough levels of literacy to evaluate information or read long texts. Many students who do make it to secondary school have low literacy levels. Brazil is a participating country in the recent Programme for International Student Assessment (PISA) international survey, assessing how well 15-year-old students nearing the end of compulsory education are prepared for citizenship. For Brazil, the test was limited to 15-year-olds enrolled in school above grade 4, representing only 69% of all 15-year-olds. Brazilian participants in PISA were among the lowest performers of 43 countries on combined reading, scientific literacy, and mathematics tests. Despite the large number of Brazilians who claim basic literacy, when clear levels of literacy are defined, nearly 40% of Brazilians are unable to find information in short texts (Lobo, 2004).

These PISA findings cannot be entirely attributed to the fact that Brazil has less money per pupil for education that the majority of participating countries. PISA researchers acknowledged that countries that spend more on education tended to have better test results, but they concluded that achievement levels for students from low-scoring countries like Brazil “lags considerably behind what the spending per student would predict” (UNESCO Institute for Statistics, 2004). Brazil’s scores on the evaluation were low, even if compared to other countries with similar per capita income levels. And these results don’t even take into account the fact that over 30% of the population was excluded from the test because they have not reached grade 4 or have left school entirely.

According to the PISA data cited above, these students need to work on more advanced literacy skills, such as evaluating the quality of written sources and writing expository arguments. In all of my classroom observations and visits to demonstrations of work with computers, I never saw any activities that asked students to work on these kinds of advanced literacy skills. Like the elementary curriculum, the secondary curriculum is rushed covering a great deal of material in a small amount of time. Students take over 10 subjects concurrently. Rather than getting a chance to reinforce literacy skills, secondary students are frequently tested with fact-recall exams on subjects ranging from religion to physics.

The secondary curriculum is ambitious and few would argue that students should not learn Physics, Chemistry, and Sociology in secondary school, but it could be argued that these subjects are not truly accessible to students who lack the ability to form or evaluate logical arguments or evaluate written material. With such a late start in developing basic literacy skills, the secondary curriculum in Brazil jumps the gun, skipping directly from basic literacy to a large amount of subject specific content that relies heavily on advanced literacy skills.

The ambitious secondary curriculum is not simple case of oversight or excessive optimism on the part of curriculum planners. It reflects a model of learning where schools aim to transmit as much information as possible to students, while basic literacy and reasoning skills are all but ignored. Throughout secondary schooling, students are asked to memorize and repeat vast amounts of information. This approach goes against a strong constructivist movement that appears to dominate within Brazilian education, but still has a clear influence on curriculum goals for the secondary level. Students describe their role in ways that are consistent with this model, hoping to "absorb" as much material as possible before exams. Secondary school is largely regarded a place for collecting facts.

Availability of qualified teachers is a problem in Brazil as well. According to the 2000 census, over 40% of the population is less than 20 years old, and 31% of the population is in school. Couple this with a large school-aged population and increasing rates of school attendance, and shortages of qualified teachers become a predictable problem. Thanks in part to expansions in teacher education offerings at higher education institutions, and recent legislation, over 90% of secondary school teachers now have undergraduate degrees. However, according to the 2000 Censo Demográfico de Educação, at the lower and upper primary school levels, only 36% and 77% of teachers, respectively, hold college degrees (IBGE, 2003). This may in part be a reflection of a set of policies that prioritizes quality at the higher levels of public education and quantity at the lower levels. Primary teaching salaries are much lower than secondary teacher salaries offering considerably more return on investment to teachers who pursue secondary teaching credentials.

Students attend school in either the morning, afternoon, or evening, with each shift lasting under 5 hours. Most primary school teachers work at least two shifts in different schools while many secondary school teachers teaching individual subjects give classes in several schools across all shifts, often with substantial travel time and expense. With multiple shifts, school resources are not available to students outside of class time, and teachers lack time for class preparation and correcting student work. Many students and parents believe that the first shift has better instruction, because teachers arrive at later shifts exhausted. This is corroborated by failure rates reported in the 2000 Censo Demográfico de Educação that are more than one third higher for night shift students as compared to the morning shift (IBGE, 2003).

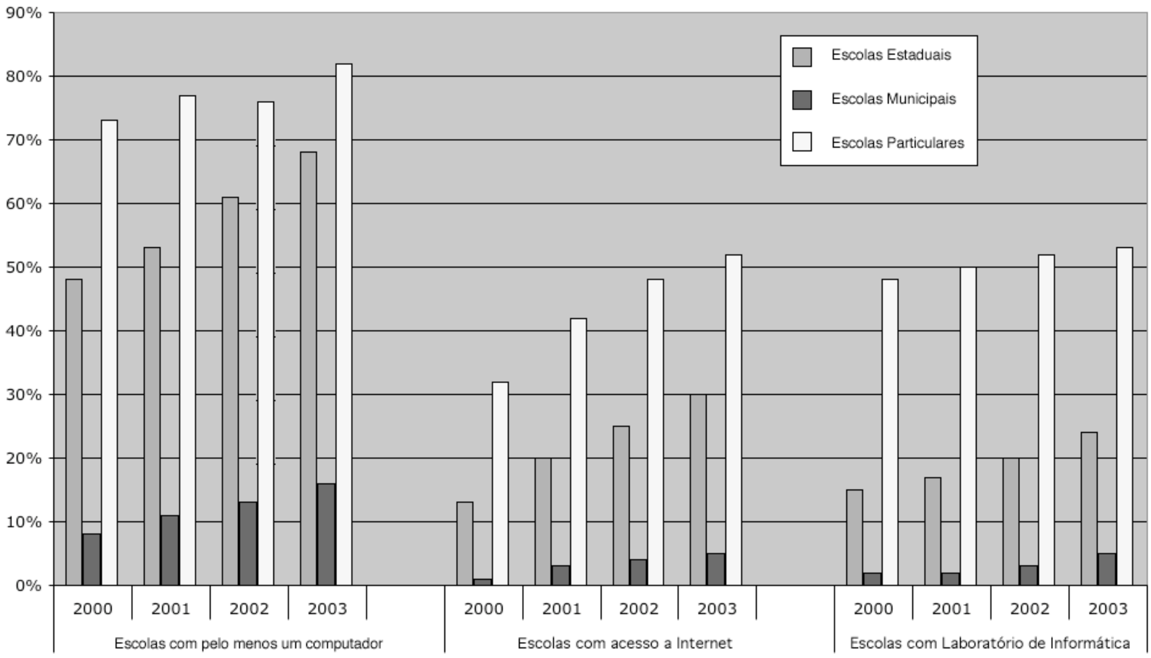
Despite all of the problems in the quality of education, Brazilian students show a high level of interest and commitment to learning. Brazil's 13-year school life expectancy is quite remarkable, considering the average 2.9 years that students must repeat. Apparently, students recognize the opportunities that come with public education, and persevere despite the failures and difficulties. In one PISA questionnaire, focused on reading, Brazilian students showed among the highest levels of interest in reading. This despite the fact that their combined literacy scores were the lowest (Kirsch et al., 2001) of all participating countries, and that very few Brazilian schools offer libraries or take-home books. Given opportunities to succeed, Brazil's students may be willing to put in substantial effort toward academic success.

Information and Communication Technology in Brazilian Schools

While the number of schools with computers and the number of children with access to computers at school remain small, Information and Communication Technology (ICT) plays an important role in plans for improvement in Brazilian education and figures prominently in public discussions on educational policy. In the past, the Federal Government has announced plans to wire all schools with broadband Internet connections, but funds allocated for these purposes as part of a program to universalize telecommunications access (FUST) have not been made available (Sorj, 2003). But interest in large-scale technology programs remains high. Recently, the government has agreed to consider a proposal from MIT's Nicholas Negroponte and Seymour Papert and to provide laptop computers to Brazilian public school students (Lana, 2005).

Despite the widespread media coverage concerning technology use in schools, this area does not appear to be a priority in either of the last two presidential administrations. Under FHC, educational technology was subsumed within the distance education offices at the Ministry of Education. In Lula's government, the secretary of technology and education focuses on technology education, the teaching of specific technology skills, rather than educational technology, the use of technology to support curriculum-wide goals, and the two are often confused. In some cases, key decisions concerning educational technology have been left in the hands of the Ministry of Communications (Pires, 2001). For at least 10 years, decisions concerning educational technology at the national level have not been policy priorities and have been addressed by people whose primary focus was something else.

Figure 1: Percentages of Brazilian primary and lower secondary schools with access to computers, the Internet, and computer laboratories. 2000 – 2003.



schools with at least 1 computer   schools with Internet access   schools with computer labs

Source: EDUDATABRASIL - Sistema de Estatísticas Educacionais, INEP - Instituto Nacional de Estudos e Pesquisas Educacionais Anìsio Teixeira (INEP, 2004)

Figure 1 shows the percentages of Brazilian primary and lower secondary schools with access to ITC resources. The state schools serve about 40% of the school population, the municipal schools are responsible for about 50%, and approximately 10% of students attend private schools. Note that computers listed here are not necessarily dedicated to direct educational uses. The category for schools with at least one computer includes computers used exclusively by office staff. Schools are increasing their investment in information technology at all three levels, but even in private schools, where computers are more likely to be available and where rates of increase are dropping, only half of schools offer computer laboratories for student use. Not surprisingly, the schools most likely to have IT resources available are the private schools serving a higher income population, while the schools least likely are the municipal schools, which tend to serve lower income students.

As with much of the world, the decision that Brazilian schools should have computers for educational use pre-dated many important discussions about how the computers would be used. For over 10 years, the federal government has promoted and funded classroom computers with limited guidelines for their use, under the expectations that expert teachers would guide their peers in appropriate computer use. This method of bottom-up management stands in contrast to MEC's administration of other technology programs, which are often centrally organized on a national or statewide level, software for classroom use is not managed centrally, nor are there centrally organized plans for using computers in the classroom. With technology use, teachers and schools are offered a large degree of liberty in making decisions locally.

Rather than providing specific instructions to local educators, MEC's programs are aimed more at supporting technology use. Many computer uses don't support the overall educational goals of schools. As I discuss in chapters 3 and 4, many teachers struggle to find technology uses that help meet their educational goals with the technology and support available to them. Under current conditions, computers require that teachers experiment with alternative approaches to teaching and without easy models to follow, are difficult for teachers to work with. This problem has been primarily addressed by putting teachers in contact with one another providing opportunities to share success stories resulting in informal networks of computer using educators.

Public and Private Interest

Educational technology is a multi-billion dollar business. When schools install computer technology, someone needs to provide the software, the setup, the Internet access, and the training. The growing industry that provides hardware, software, and technology services to schools, is increasingly interested in policies related to technology use. In this section I discuss the interests of private industry and the necessity for public service managers to negotiate on behalf of the public education system. I do not argue in favor or against contracting for private goods or services, but I describe the characteristics of public/private partnerships that are most effective at defending the public interest and the problems that can arise when the public administrators fails to negotiate effectively on behalf of the public education system.

Corporate and governmental sectors have been quick to recognize the new market that school technology offers. They also have been surprisingly attentive to concerns about the digital divide, considering how slowly they have responded to other types of inequality (Natriello, 2001). The technology industry, especially major hardware and software manufacturers, have invested in policy research on educational technology and the digital divide, especially research urging the immediate adoption of wider scale technology purchases in schools. In the United States, filtering companies offering products that block access to pornographic and violent internet content went directly to congress where they sucessfully lobbied to make the use of filtering software mandatory in public schools and libraries using federal funds for Internet access.

Private Interests

The educational technology industry is a major stakeholder in educational technology policies. Companies support research on the effectiveness of educational technology, send representatives to educational and policy conferences, and contribute to research concerning the impact of the digital divide and the resulting research brings press attention to these areas. Industry benefits from its influence on policy decisions when it promotes educational technologies that are most profitable regardless of the educational value of these products. While their interests do not come into direct conflict with the public educational interests, they are also not aligned and their different perspectives and interests are often ignored.

According to Selwyn et al. (2001), the role of the private sector in technology initiatives should not be underestimated. "The sustainability of technology-based education programs ultimately depends on business' ability to make them profitable rather than soft concerns such as education." The interests of private industry are not always consistent with the public interest. For example, educational technology that offers the most promise of profitability such software designed to be used once by each student, may be widely promoted by the educational software industry while schools would perhaps find a better cost/benefit ratio using open ended software tools with less limited uses.

Castells et al. (1999) have discussed the increasing role of the private sector in public education. According to McLaren (1999) as schools become increasingly financed by corporations, education reform is influenced increasingly be the capitalist economy. For McLaren, new technologies serve principally to improve the efficiency with which capital is transferred from productive employment. Sayers (1995) was among the first to link educational technology with the increasing role of the private sector in education. In addition to the the appeal of the large school market in selling educational software products and services, Sayers gives examples of educational technologies that are driven by marketing toward the captive school audience describing the large industry that provides free digital educational content for schools with advertising built-in. A number of free software products and school oriented web pages are developed with marketing goals in mind. When children are exposed to familiar branded cartoon characters in school, the brands get an advantage in the marketplace.

Products adopted in schools also have a competitive advantage in developing prominence in their category. Learning to use a MS-Windows PC in school, for example, increases the chances that students would seek out similar products when they buy computers in the future. Having new members of the workforce emerge from public schooling proficient in Microsoft Excel increases the chances that a company would choose this product over its competitors as well. When schools already have a small number of a particular type of computers, there is an advantage to buying more of the same in the future to ease compatibility and maintenance.

As Apple computer demonstrated, getting a product to schools can be an easy way of ensuring product loyalty. Apple donated Macintosh computers to schools in the seventies and gained a loyal customer base of an entire generation of school children and teachers. IBM and Borroughs (now Unysis) followed a similar strategy in Brazil, donating mainframes to Brazilian universities and in hopes of gaining an advantage in the Brazilian mainframe market. Jeremy Rifkin has argued that developing a loyal user base is of tremendous value in today's economy where established brand names can more valuable in the marketplace than tangible products (Rifkin, 2000).

The use of school time for transmitting commercial material is another compromise to educational quality. Much of the widely debated commercial material that gets to classrooms does so by way of new technologies, including a number of educational software titles that feature well-known animated characters. Schools in low-income areas in the U.S. suffer from public pressure to meet standards and demonstrate technology use. These schools often resort to pre-packaged digital educational programs that come with wiring and hardware (Sayers, 1995). These complete programs are tempting for schools with insufficient budgets for up-front technology purchases. Schools can pay for software, hardware, wiring, and support on a monthly basis. But the increased flexibility in payment methods comes with loss of flexibility in content. Schools using complete digital education packages cannot select the right technology application for a particular need, and they maintain very little control over the amount of commercial material that enters their classrooms via computer screens.

In Brazil, I have observed commercial materials in the classrooms most frequently in the form of classroom assignments that require students to visit commercial Internet sites or in the form of small downloaded games for use during classroom time. Though local secretarias de educação sometimes produce collections of internet links, students show much greater interest in sites designed primarily for commercial interest and given a choice almost always select them. These sites are also often the first to appear when students perform searches. They also tend to have a more polished graphical interface and tend to use more audio and video than non-commercial educational sites.

In contrast to student attitudes toward commercial material, some teachers have a sense of pride with respect to the use of free materials that are not pirated in the classroom. Teachers who use open source free office suites will always make a point to mention it when summarizing their technology use. Another area of pride is the use of programs developed in research settings. USP has made a Portuguese translation of Logo for classroom use in Brazil, and all teachers who I have seen using this equipment are proud of their selection of software with origins in educational research.

Technology use in schools also serves as a more indirect form of marketing; as children develop computer skills early in life they simultaneously develop loyalty to the brands they are most familiar with. The hardware and software used in schools has a competitive advantage, being closer to becoming an industry standard. As the educational technology industry grows, industry will develop greater expertise in how to get the most out of their participation in the school market, there is, therefore, an increasing demand that school administrators are competent in selecting the right products, negotiating fair prices, and limiting the use of public schools as a site for marketing.

In addition to sales and marketing, there are other benefits to industry of increasing technology use in schools, such as the promise of a technologically competent work force and of support in infrastructure development. For example, in areas where there is little market for Broadband Internet access, Internet Service Providers (ISPs) can build the infrastructure to wire schools with the support of the local public schools. Once installed, the ISP can use that new infrastructure to offer service to nearby communities with very little additional investment.

Companies can even turn donations around to their own financial gain, for example by widely publicizing donations of training materials or software at almost no cost to reproduce. When public agents contract for technology and technology services, they must weigh all of the benefits for vendors in considering reasonable costs. Schools should not accept the sole burden for large infrastructure investments from service providers or allow vendors to include direct marketing with equipment and services while paying full price. They must develop the competence to evaluate these costs and set standards for evaluating technology contracts.

Whenever IT is used in public education, schools must contract out for hardware, software, and support. Technology may be used to handle tasks that schools once managed themselves, such as correcting tests, demonstrating concepts, or evaluating student performance. When technology produced in the private sector is used to perform these tasks, a kind of outsourcing takes place, the introduction of technology into public education always includes a form of privatization[1], in the broad sense of the word, which includes both selling of public companies and terceirização.

Defending the Public Interests

According to Sclar (2000), the success of the relationship between the public buyers and private sellers depends on the ability of the public system to set clear goals, make decisions about their needs, and prepare for evaluation of contracts before involving the industry in the process. The public sector's ability to promote public interest is based in large part on the degree of specificity and planning that goes into contracting for goods and services, including planning for how the contract will be evaluated and accurately comparing costs to alternatives. The more that public school representatives know about exactly what they hope

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1. In his preface to Eliott Sclar's book, Richard C. Leone explains how the term "privatization" is used differently in different countries. "In other nations, privatization often refers to the sale of government-operated "businesses" […] here [in the United States] the term "privatization" ordinarily refers to the expansion of the already widespread practice of providing public services and goods by contracting with private entities.". In this discussion of how Sclar's work applies to the Brazilian case, I will use the term amply, referring to both sales of public entities and processes known in Brazil as *tercerização*.

to achieve with technology products, the better prepared they are in negotiating with the private sector.

In the case of educational technology, it is difficult for representatives of the public system to be specific in outlining goals and standards for evaluation as they negotiate with the private sector. At this point in time, many educational technologies are still in experimental stages, there are high hopes concerning the power of technology to transform schools but the details are ambiguous concerning implementation. Unfortunately, the negotiation further complicated by the fact that industry representatives are involved in almost all aspects of planning for technology in public education and it is nearly impossible to distinguish the planning stage of the process from the sales stage. The fact that research on educational computing research is often overlooked in decisions regarding the use of public money for educational technology is not surprising under these conditions.

Sclar also discusses the importance of separating private sector contracts from politics and even restricting the political involvement of companies that provide public goods and services. He talks about the potential effects of corruption on public contracts and calls for the same standards of conduct that exist within the private sector where buyers are usually prohibited from holding a financial interest of receiving gifts from the companies they negotiate with. Sclar argues that the same standards in public procurement would go a long way toward protecting the public interest from the threat of corruption. In the Brazilian case, where corruption has been difficult to control, these concerns must be considered as well.

One of the great obstacles to thorough planning and clear methods of evaluation, in the use of educational technology is that in an area with a great deal of rapid change and innovation a certain amount of flexibility is necessary to allow for the introduction of new technologies. These factors make it difficult for public agencies to contract out for goods and services in the manner outlined by Sclar. This problem is frequently addressed through the use of small-scale pilot programs, testing new technology uses before they are adopted on a large-scale basis. In practice, however, pilot programs can often be successful without being easily duplicated. In many cases the experimental conditions of a pilot program, the enthusiasm of participants, and levels of support are not easily maintained when program goes large scale.

Although pilot programs may continue to be the best approach for work with cutting edge technology uses, it is still important that the public system be represented by buyers who are competent to define clear goals for educational technology, evaluate technology contracts according to educational goals, compare their costs to the alternatives, and set clear means for evaluation of products and services provided by the private sector. Competence in representing the public interest in these areas is not straightforward; it requires participation and expertise of people from various roles, from classroom teachers to central accountants.Sales

A number of policy initiatives aimed at increasing student access to computers or reducing the digital divide provide technology access, services, and technology training programs for teachers. In the United States, schools are often awarded public money specifically for technology use while the higher level of centralization in Brazil often means that instead of distributing technology funds, state or municipal government distribute the computers directly to schools or provide low-interest loans to teachers (Kehrle, 2004). In either case programs that subsidize or provide technology in schools using public money must negotiate their relationships with vendors carefully to ensure the greatest possible education advantages at the lowest possible cost.

Problems can arise when public representative buy computers without first establishing clear educational goals and plans for technology use. The most obvious symptom of this problem is underuse of computers resulting from either a) computers being passed down to schools from higher levels of administration without local interest in using them or b) computer purchases not accompanied by the necessary software, training, time, maintenance or other requisite for effective use.

In chapter 4, I discuss several cases of computers that were never used or very rarely used. This problem was widespread in my research, and if especially alarming considering that teachers and school directors were only interested in allowing me to visit if they were using computers or on the days when they were most likely to be used. Further evidence that sales rather than educational goals are driving the spread of technology in schools comes from the delay in their use. Many of the public schools I visited reported a long period of time between the date that computers had been installed in schools and their first use. It seemed that rather than purchases being driven by educational needs and goals, technology was often delivered to schools where staff would then begin to consider how they might be used. This problem points specifically to failure to detail specific technology goals, plans, and evaluation methods before investing in technology programs a top down process.

The expansion of educational technology in public schools requires an intensified relationship between the technology industry and public schools. The responsibility falls to public officials to go through the difficult process of ensuring that the public interested is defended as technology contracts are negotiated and evaluated. This process is made even more challenging because of the innovative and constantly changing nature of educational technology and because of a long standing policy decision that technology planning should be decentralized.

4. Unequal Starting Conditions

Many of the differences between the technology experiences in schools in higher and lower income areas relate to differences in the backgrounds of students and the conditions at the school even before computers are installed (note, you'll have trouble with the word background, I would translate it as the experiences they bring to school with them but keep the English "background" if you can in italics or something). Literacy levels vary between students in high and low-income communities, limiting the kinds of computer use that are possible and encouraging some teachers to focus on developing basic skills while others have greater freedom to consider enrichment activities. Teachers with reasonable student to teacher ratios can plan their technology lessons around their curriculum goals while those with large classes are more likely to either not use computers, or send subgroups of their class to specialists (translation note: I mean informatica teachers) in computer labs without participation of the classroom teacher. The qualification levels of teachers themselves, along with their support in pursuing professional development opportunities plays a role in their ability to use computers effectively as well (Mergendoller, 2000).

One middle school teacher said that she thought computers did a great job of making education leaders look good and building public confidence in schools, but that she felt that the lack of follow-through, especially in the form of computer lab staffing and infrastructure, made it impossible for schools to make effective use of computers. She thought that the resources necessary for effective use of computers such as training or time to make use of the equipment were rarely provided together with the equipment itself and claimed that the powerful technology was therefore doomed to go unused.

These conditions were somewhat better in private schools, although rarely ideal and often much worse in schools in the lowest income areas, where pre-existing conditions made computer use almost impossible. All of these existing factors that contribute to unequal educational outcomes can impact the effectiveness of computer use in acheiving educational goals.

Class Size

In many of the schools I visited there were between thirty-five and forty students per class. Many teachers I spoke with and visited indicated that the consequences of this extend beyond the necessity for students to share computers with partners or work in small groups. Teachers in both regular classrooms and computer labs must be creative with classroom management. Controlling noise levels, working with uncooperative students, and dealing with normal day to day teaching challenges is increasingly difficult when classes are large. Teachers are therefore particularly focused on student motivation, cooperation, and responsiveness and interested in choosing activities that make classroom management easier. Many teachers I observed and spoke with were concerned about the potential for difficulty managing classes working on the kinds of open ended tasks that are more common in computer labs. In these kinds of activities, individuals or small groups might need teacher attention and teachers with many students can struggle to meet everyone’s needs. Highly structured work offered classroom management advantages as did assigning familiar tasks requiring little instructions.

The literature on the impact of class size is somewhat contradictory. While many researchers have connected smaller class sizes with improvements in educational outcomes, some research has indicated that under specific conditions, large class sizes (up to forty-five students) have no negative impact (Carnoy, 1999). Carnoy desribes how these studies have been used by international funding agencies and government to support the cost cutting measure of high teacher to student ratios. But Carnoy identifies a severe limitation to these findings, the conditions under which large class sizes have no negative impact are extremely limited, large numbers of students seem to cause no harm when teachers rely exclusively on lecture recitation format classes. With other approaches to teaching, however, including approaches stronly suported by educational research, low student to teacher ratios are more important.

Teachers were concerned about the logistics of large classes in computer labs. They were concerned about how they would handle entire classes of students in the small computer labs with limited computer and these concerns weighed heavily on their day to day planning. In many public schools computers were installed in rooms that were not large enough to fit an entire class. In these cases, either the lab went unused or the school arranged for a computer teacher to pull groups of students out of classes. Thus the space restrictions led to real problems with integrating computer time with the rest of the school day and getting the most possible use out of the computers. One teacher I spoke to explained that her school computer lab was almost never used because the room couldn't accomodate enough chairs to fit an entire class. The room has only 30 chairs but the classes have up to 40 students. She said that she tried to use the computer lab, but that it was impossible to work under those conditions.

Even when physical space was sufficient for the entire class, teachers often found themselves overwhelmed when large groups of students were all working on computer assignments at once. At one of the *mostras de informática*, annual events where teachers share their work with information technology, a teacher dedicated the majority of her presentation to a set of management techniques she had developed for taking large numbers of students to the computer labs. She split her class in half allowing one to two students per computer and placed the other half of the students at a round table in the computer lab working on related activities. She developed a set of strategies for working with questions that arose, dealing with students waiting to have their questions answered, and planning for the possibility of some students completing an assignment while others are still in the middle. For this teacher, her classroom management innovations made it possible for her to use the computer lab despite a class size that made the lab initially seem quite difficult to use.

Some teachers reported underuse of their school's computer labs and claimed it was at least partially due to large classe sizes. Several suggested that a computer teacher was the best solution to this problem, allowing classes to be split into two smaller groups. Most of the public schools that reported routine and frequent use of the computer labs followed a scheme like this; half of the class visits the computer lab, the other half either visits with another specialist teachers, such as the librarian, or stays behind in the regular classroom. This meant that computer lab time was generally broken into relatively small blocks of less than 30 minutes each, with very few visits per pupil per year. This solution to the problem of class size contributed to the difficulty teachers face in integrating computer time into their curriculum, in most cases the classroom teacher was unable to accompany students on their trips to the computer lab. Teachers who were interested in finding ways to integrate computer use with regular classroom work would have to rely on planning meetings with the computer teacher outside of the usual class time.

One teacher explained that large classes at her school made computer use almost impossible. The computer lab at her school was much to small to fit a class of the average size (about 40 students), the room only had 30 chairs. From her point of view, the chaos she would have to endure to use the computer lab made it not worthwhile. She questioned the value of installing the lab with so little follow-through that it was never truly usable and reported that most of her colleagues had given up on using the computers under those conditions.

The difficulty in using computer labs with large groups was exacerbated in schools with small spaces for computers but it was a concern even in schools with spacious labs. This raises questions about why large classes become more difficult to manage in the computer labs as opposed to during regular classroom time. Observing students working in the computer lab, it's clear that their overall energy and enthusiasm levels increase when they're taken to visit the computer labs, even as they line up to leave their classrooms, primary school students would be so thrilled about using the computers that they were filled with nervous energy. Once they've reached the labs, this nervous energy transformed into a strong sense of urgency every time they needed the teacher's help. When error messages appeared on the screens children waited for their teachers' attention in a state of almost desperate impatience. Teachers who might normally be able to work with a class of forty students could find themselves easily overwhelmed with only twenty in a computer lab.

The computers themselves offered the greatest challenge in most cases, as teachers gave instructions, there would almost always be at least one computer with a dialog box complaining about needed updates, changes to connected hardware, or something similar. These problems were usually simple and teachers resolved them with a simple mouseclick but most of the children asked for help after each and every dialog box appeared. Instructions that would have been straightforward with low-technology materials, such as instructions to read a text, became much more complicated using computers forcing teachers to dash around from terminal to terminal helping students. Older students in the higher grades were able to read dialog boxes and make some decisions themselves but even in these cases it was clear that the computers made the high student to teacher ratios more difficult to work with.

Large classes also present classroom management challenges for teachers. Teachers are always looking for ways to get students to motivated and in improving their cooperation levels. They seek activities and approaches that promise improvements to student motivation. For teachers working with an overwhelming number of students, the ongoing challenge of overseeing such a large group of children can sometimes be just as important as their educational goals. While computers seem to make some aspects of classroom management more difficult, teachers who struggle with uncooperative students may find the computer labs improve some aspects of classroom management. Many report that students who are difficult to work with in the regular classrooms are cooperative in the computers labs.

Student enthusiasm did not appear to depend on how the computers were used or on levels of challenge afforded by a particular technology use. Students appeared to be equally satisfied to write their names on the screen using a word processor as they would be to work on challenging or content rich assignments. With more difficult assignments, they were more likely to be forced to wait (often impatiently) for the teacher to *tirar duvidas* but otherwise the level of challenge had little impact on classroom management. Thus, the teacher's focus on classroom management does not appear to draw attention to educational goals.

Between the classroom management changes that computers bring about and the improvements to student motivation and cooperation, computer use appears to interact with the issues raised by large classes. Many schools, both public and private addressed the difficulty of large classses and computers by decreasing class size in the computer labs. Other schools lacked the resources for such an increase.

Literacy

Student backgrounds influence the choices that teachers have when assigning work with computers. Students with more advanced literacy levels, those with access to books at home and at school, generally are able to make much better use of computer resources than students with limited literacy. Factors influenced by socioeconomic status, such as access to preschool education, peer literacy levels, parent education, and access to reading materials have an impact on literacy levels which in turn can effect the capacity of technology to be useful in the classroom.

In classrooms where the majority of students share basic literacy skills teachers can make use of a broad range of possibilities that computers offer. They can use the Internet as an information source and begin working with students on evaluating the quality and relevance of Internet information sources. They can also work with word processors and other writing tools to further develop their written communication and editing skills. In classrooms where students lack basic literacy, computers must be used in completely different ways, often with much more restricted interaction and less versatile software. These limited choices and student's limited independence draws teachers toward using video games with limited educational value or teaching students to use the computers themselves.

Postman (1993) compares the introduction of Internet technology with the invention of the machine made book, which brought increases in access to information, causing a greater demand for literacy. Postman argues that with the introduction of information technology, the definition of literacy itself has expanded to include new proficiencies often referred to as information literacy or digital literacy. As with the basic literacy skills that printing press demanded, these new proficiencies are increasingly important in daily life, increasing the demands on education and the expectations for new generations. Basic literacy levels that may have been satisfactory in the past are no longer sufficient in an age where advanced skills like evaluating the quality of written text is increasingly important.

According to Gilster (1997) "digital literacy is the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers" (p.33). The greatest and most important challenge to literacy, he claims, is the ability to evaluate the quality of available material. New technologies allow almost anyone to produce material with the professional looking layout, fonts, graphics and graphic design that were once restricted only to reputable sources. No longer can appearance be a guide, with new IT tools, readers must have more advanced content evaluation skills. Carvin (2000) echoes these concerns and defines 6 stages of literacy, claiming that full participation in digital life is not possible without at least the ability to evaluate content.

The ability to evaluate the quality and trustworthiness of information sources can be especially important and difficult with limited financial resources. Schools lacking generous budgets for research material are more likely to use on-line resources that are available at no charge but include commercial content. Commercial messages are often woven within the content and distinguishing between reliable and misleading content is difficult for students. With less exposure to non-commercial material, students gain little practice in regognizing the characteristics of commercial material or in distinguishing commercial from non-commercial content.

In my observations, reading and writing assignments using computers vary tremendously between schools and private schools expect more sophisticated literacy skills of students of the same grade levels indicating that students from wealthier backgrounds do indeed have better literacy skills and higher levels of challenge at school. Students in private schools are expected to write more and with greater independence while public schools students are often assigned very short writing assignments with little editing and perfecting. Students in these environments used word processors with great attention to formatting and text appearance and little attention to content. They are often allowed to copy pieces of text from original sources and this activity is often called writing.

Teachers often claimed that word processing was an improvement over paper and pencil writing assignments where it is very difficult to get students to write at all. In one case, several teachers showed the results of a student project in which groups of 4 to 5 students collaborated to produce a single paragraph. Teachers were very pleased with the outcome claiming that they struggle to get students to write with paper and pencil at all. The teachers reported that their students had *vergonha* to write and that the computers helped them overcome it.

Reading levels appeared to vary tremendously between students of different socioeconomic backgrounds. I observed student student participants in an optional after school program. The students self-segregated themselves into two large groups, one group was priarily black, consisting of students wearing mostly *chinelas* and T-shirts, with simple pencil cases and inexpensive notebooks. The other group was predominantly white, students had new or nearly new closed shoes, wore formal clothes, carried more expensive school supplies, day planners, some even carried celular phones and there was one briefcase. The groups were assigned to read from a newspaper for later large group discussion about journalism.

The first group selected the section containing gossip, soap opera news, and entertainment updates while the second group work with front page headlines. Listening to members of the two groups as they read aloud to their peers, it was clear that literacy levels, and basic vocabulary varied widely between the two groups. Students in the first group struggled to read aloud sounding out each word individually and needing help from the instructor with basic vocabulary. Those who read headlines silently in search of interesting stories moved their lips while they read and focused on their reading material for a maximum of 15 seconds at a time with constnt interruptions to their reading. Meanwhile, children in the other group were either reading aloud to neighbors at a normal speaking pace or reading silently.

Writing skills also seemed to be low in schools serving poor neighborhoods. In one public school serving a very low income neighborhood, seventh serie students were asked to use Microsoft Word to write tourism brochures for the Middle East. In this geography class, students visited the computer labs to produce brochures after they had completed study of each continent. Since they lacked Internet access the teacher provided each pair of students with several pages of printed text on the Middle east that she had copied from various Internet sources. Those pages had been the substitute for a textbook throughout their entire study of the region. The teacher also copied a folder of related images on each of the computer lab hard drives. Pairs of students searched for blocks of text on their printed pages and retyped them into their Word documents with substantial use of text formatting features and little attention to content.

While students worked on their brochures, the teacher walked around the classroom primarily helping students use the features of Word to select text colors, centralize text, and perform other formatting tasks. Students never asked questions about the content and the teacher never brought them back to thinking about content related questions such as what is appropriate for a tourist brochure or what their selected excerpts mean. Though the teacher had instructed students to write their own material using the printed text as reference, all the the students actually copied short blocks of text from the original material onto the screen, none of the students wrote original material. Much of the literacy lesson embedded in the activity, such as thinking about audience or organizing content was lost. Since students were only copying text, not writing their own text, they also didn't get any actual writing practice.

On pair of students had inserted a photo of an oil drop into their tourist brochure with text explaining that the region is strategically important because of it's oil reserves. When the teacher approached, I expected her to ask them what the text meant (since strategic importance is generally not a desirable feature in a vacation spot) but instead she helped them resize and centralize their oil drop image and moved on to another group. Thus it appears that the assignment wasn't even an opportunity to work on reading comprehension skills since students managed to copy and manipulate blocks of text without even understanding them. In this case, the only skills that were emphasized were Word processing skills.

The fact that these students weren't required to write in their own words or demonstrate even minimal literacy skills is especially alarming because they were in their last weeks of the seventh *serie*. These students had, at best, four more years of basic education (not including repeat years). For those who would not continue on to higher education, formal education was more than half over and they were still unable to understand short blocks of texts or write in their own words.

Students in nraby community school serving a more mixed income neighborhood used computers to learn about local elections with a great deal more opportunity to work on literacy skills. These students interviewed candidates for local office, conducted polls, and used Microsoft Excel to evaluate the results of polls. They wrote up comparative descriptions of each candidates platform and prepared a Powerpoint presentation using this information. The stated goals of this activity were to develop a sense of responsibility as citizens and to learn the importance of voting but many other basic literacy skills were practiced simultaneously. The opportunity to compare competing messages helps student develop skills in evaluating information sources and the written assignment and Powerpoint presentation was an opportunity to work on writing skills. These students were in the fifth *serie*, two grades below the geography students mentioned above.

The types of school activities that help students build the critical thinking skills identified by both Gilster and Carvin (above) are often included in enrichment curricula, the work students often do after completing the basic requirements in a particular area. Assignments like the tourism brochure, when well implemented, are filled with opportunities for developing literacy skills when the chosen emphasis is literacy. Rather than being a direct component of literacy instruction, students practice their literacy skills through work in other subjects and thereby develop the ability to understand and evaluate written material and communicate through writing.

Students who attend schools that struggle to meet basic skills standards are rarely exposed to instruction designed to build critical thinking skills and may instead spend their classroom time on the mechanics of literacy and their computer time on computer literacy. This means that the same groups that have traditionally suffered from educational inequities, those with lower scores on standardized tests, will start their work with information technology at a disadvantage. Their lower literacy levels make them less prepared for evaluating the quality of material they encounter on the Internet, and they will therefore be less prepared to make good use of it.

Qualified Teachers

Access to more than just a computer and the Internet is needed to make effective use of technology in education, but some programs attempt to compensate for inequalities in some areas with the use of computers. Qualified teachers have been shown to be the most important predictor of the success of classroom technology use (Archer, 1998) and teacher training in technology use impacts their ability to make effective use of technology (Wenglinsky, 1998). But, despite this, technology is often suggested as a solution for shortages in qualified teachers with the expectation that educational software can compensate for gaps in teacher training. Technology use has shown it's greatest successes when teacher preparation levels have been high. Considering this, I will discuss my observations in the area of teacher preparation and technology use, looking for evidence that computers are being partnered with teachers rather than used as a substitute for quality teachers.

Qualified teachers are an important part of any successful educational program. But when public schools are strapped for resources, there is a temptation to try to use technology to compensate for shortages in teaching staff using structured technology programs that take some of the planning, teaching, and feedback responsibility away from the teachers. Using computers without the active involvement of the teacher, including the understanding of the pedagogic aims, is contraindicated by research on educational computing which show that the best use of computers is with adults present and helping students with analysis of their learning experiences (Attewell 2001). Computers can be used to illustrate a concept, but teachers remain important for demonstrating the importance of concepts and helping students to fit what they are learning in with what they already know.

The role of the teacher is more than simply having an adult present while computers do the teaching. Qualified teachers select technologies that fit with what students are working on in class and have specific plans for how technology can be used and integrated with the material. These teachers help students draw conclusions from material and connect their learning experiences. Educational technology does not resolve the problems that arise from inequality of access to qualified teachers. Rather than compensating for shortages, research indicates that technology puts greater demands on teachers.

The UNESCO Institute for Statistics estimates that in 2001 87% of Brazilian teachers were trained with the required degrees needed for teaching at their level but training levels vary substantially between rural and urban areas with rural children being much less likely to have teachers meeting the minimum qualification levels. Even teachers who have completed the degree requirements for their teaching level may have little experience with teaching approaches other than the lecture recitation format and may be ill prepared for the challenges of working with computers.

Teacher education programs rely heavily on practice teaching in the field allowing traditional teaching methods to be easily passed from one generation to the next. Alternatives approaches are also difficult to explore and often less effective in schools with very large class sizes. So even teachers who are highly competent in their classrooms may suddenly find themselves in unfamiliar territory when they begin to work with computers. They have little experience working with students on independent projects, supporting groups of students working together, and helping to encourage students to reflect on their work.

In my observations teachers were very conscious of the fact that the class dynamic is different in the computer labs and placed new demands on them. Many teachers observed that the computer lab was a place for open-ended assignments and that this was different from the majority of school time. Some thrived in this new environment, one teacher reported that the open-ended assignments he uses in the computer lab seem to help his weakest students reach the levels of their peers, he said “so sala de aula não da mais conta”. But other teachers were uncomfortable with the computer labs, not just because of the technology itself but also because of the changes the computers bring to the learning environment.

Computers and New Demands on Teachers

One teacher who used computer downloads of visual art and music to compensate for the absence of art education material in her school said "O laboratorio de informática ainda não esta sendo usado da maneira que deveria ser. O profissional tem mais medo do que as crianças." This fear is only partially related to lack of familiarity with the technology itself, it is also a reflection of the fact that teachers aren’t used to open ended assignments, having students work in pairs, or completing projects independently. Their prior training and experience does not prepare them well for the changes that computers have brought.

Regardless of their competence as lecturers, the computer labs demand new competencies that were once relatively unimportant in their schools. As discussed by Carnoy (1999), despite the limitations and failures of exclusive use of *cuspe e giz* methods their results are not compromised further by high student to teacher ratios which can be problematic with other forms of instruction. Thus the average Brazilian teacher using *cuspe e giz* and working with large classes could be regarded as a teacher who is well adapted to the school environment despite the limited and ineffective repoitoire of teaching approaches. Though these teaching methods may not be innovative nor the most effective under ideal circumstances, they may also be a good choice under the actual conditions of the public schools. What is needed may be support and instruction in alternative teaching methods coupled with the reduced class sizes needed to make the methods effective. As long as classes remain large, there is little value in encouraging teachers to change their approaches.

The computer lab environments often weren't conducive to the kinds of activities that are usually assigned in computer labs such as small group work or for concentrating on individual projects. Overall noise levels were extremely high, both because of permitted voice levels inside the classroom and because of environmental factors like small computer labs and other classes moving about in the hallways. Teachers dealt with the challenges to extended concentration and focus by giving short sets of instructions followed by student's completing short tasks. For example teachers would ask students to type their names on the screens and then instructed all students to wait several minutes, until the last pair of students had finished typing their names. In one case, it took fifteen minutes for a class of 17 students to make and name a folder on their computer desktop. Under these conditions, teachers compensated for noise levels and difficult to control circumstances by micromanaging students, creating extremely stuctured activities in even as students worked on open ended assignments.

Students were rarely given extended instructions allowing them to begin working. On the rare occasion that teachers spoke in more than short bursts of one of two sentences, they would eventually have to repeat themselves to pairs of students who hadn't been paying attention. The necessity for assignments that involve following instructions that are short and specific rather than open ended puts important limits on how computers are used. The alternative, however, would mean a dramatic change to school rules and expectations for student behavior. It is not possible to expect students to focus for long periods of time or control their noise levels in the computer lab (where they are already more agitated by the thrill of the computer) if day to day classroom activities have a different set of rules.

Assigning students work in groups or pairs demands that teachers have a set of skills on managing and making the most of collaborative work. In the classrooms I observed, the groups of students that formed for work at the computers were almost always pairs with a few exceptions. Usually a small number of students would work individually and sometimes a group of three would form spontaneously (usually when one student abandoned his or her partner to join a nearby group). Some students took turns, completing the activities individually and never communicating with their partners during the activity while other groups worked together. It wasn't unusual for one student to complete the assignment alone while his or her partner looked on.

I never saw teachers select partners for students, nor did teachers intervene when significant imbalances developed between the level of participation of one partner over the other. Generally the pairs were seen more as two students sharing one computer and the opportunities to capitalise on the educational value of peer interaction were nearly ignored. Teachers did not demonstrate any knowledge or experience in how to make group interactions most valuable, how to group students into productive pairs, or how to ensure that each student participates equally in an assignment. Teachers may never have needed these competencies before the technology was introduced and their lack of familiarity with peer interaction teaching techniques may be a reflection of the differences between computer lab assignments and the rest of the school day.

In the computer labs, when students were given open ended and multiple stage projects, teachers spent an enormous amount of very limited computer lab time explaining the assignment and answering questions before students got started. Usually students had very limited time to work on the activity and the assignments were designed to be completed in these very short blocks of time. Students who finished early would usually be allowed to play video games until the period ended. The amount of time that went in to waiting to start and waiting after finishing often exceeded the amount of time spent on the activity itself.

Teachers who I observed occasionally had video games installed for students who had completed their work but none had developed or selected an educational backup activity for students who finished early and those who were waiting for an answer to a question. Nor did any public school teachers maximise their explanation time by developing ongoing projects or assignments that could be completed over the course of various class periods.

Teachers also didn't appear to be experienced in guiding students through independent assignments or encouraging reflection about their work, both important elements of teacher followup to independent assignments. When groups of students completed assignments or stages, they would check in with teachers for instructions on what do do next. Usually teachers gave new sets of instructions without asking questions about the completed assignment. Feedback was usually very limited and followup questions were extremely rare. Teachers put themselves in more of a monitoring role than a teaching role when students worked on independent assignments, rarely discussing educational content.

The skills needed to help guide small groups of students to make sense of their work and help them reflect what they've learned are, like the other skills related to open-ended assignments and group activities, rarely needed in the context of the large classes these teachers have worked in and been trained for. It's not surprising that they have difficulty adapting to the new demands of the computer labs, recognizing and taking advantage of the learning opportunities that arise from their interactions with small groups of students.

Technology Training

Many teachers who have the required credentials did not get any technology training while they were in college and have little to no experience using computers. ProInfo tries to address this problem by offering training opportunities for some teachers and creating networks of technology using teachers who can support their peers at the school sites. The ProInfo program does not reach all public schools since municipal schools aren't served by the program but since many teachers work in more than one setting, training provided through PriInfo does sometimes reach the municipal schools. The programs ProInfo offers vary by state and region. In the region that I visited, ProInfo's training was broad, not limited strictly to technology. Teachers got support in how to work with technology in the broad sense including ideas for how to work with groups of students and with students completing more open ended tasks.

ProInfo's training does have it's limitations, especially the fact that is relies heavily on teachers attendig trainings during unpaid time. Since teachers are only paid for their classroom hours and a small number of meetings and events outside of school, any program that asks for substantial out of class preparation time will be attractive only to a small number of teachers. The second is that there are no clear evaluation criteria for teachers to work with when selecting technology. Teachers have opportunities to share ideas and compare experiences through ProInfo sponsored events but they aren't given any sets of guidelines through which they can make their decisions.

Many of ProInfo's official evaluation criteria, for example those for selecting educational software are the result of conferences with teachers themselves. ProInfo's trainings therefore offer a wonderful grassroots networking opportunity for teachers interested in sharing ideas but it does very little in terms of bringing in information from outside the teacher's experience, exactly what is needed when new technologies are introduced and local knowledge is limited. Teachers are not offered training in the results of research literature on educational technology use or the experiences of collaborative learning researchers. They must reinvent the wheel locally without an infrastructure for bringing in outside ideas.

Class size, literacy levels, and teacher qualifications are three main elements of starting conditions that can influence the effectiveness of technology use in schools but they are not the only examples. Additional factors like parent involvement and prior experience with computers could play a role as well. All of these factors come together to provide further advantages to students from favored socioeconomic backgrounds to get the most out of IT use even before the computers are installed in the schools.

5. Inequalities Of Access

Schools differ in the quality of infrastructure available to support technology use. Schools in low-income areas struggle to keep their computer labs accessible to students and must arrange for staffing, support, and equipment security. Many schools must get by with donated or very low cost equipment that operates slowly or cannot run recent software and many operate computer labs without Internet connections or networks. Schools with more limited budgets are more likely to use low-cost or no-cost technology products whose revenue comes from commercial content, such as free educational software with embedded marketing directly to children.

While it is possible for an experienced teacher who is comfortable with technology to find very productive educational used for of obsolete machines without the help of techical support staff or commercial software, these limitations can be obstacles to effective computer use for the average teacher. In many cases lack of access to current equipment, software, and support contributes to situations in which computers aren't used at all, in other cases, they are underused and students have access to them sporatically.

According to Revenaugh (2000), technology has become an expensive, time-consuming, imperative for some schools. Reallocating scarce resources to technology may mean cutting elsewhere in the budget, a choice that is especially wasteful when the funds are not available for the staff training and operating costs of appropriate computer use. Funding that is earmarked for technology investments often leaves schools with little flexibility in establishing priorities, as they are forced to spend the money on hardware or software, even if basic materials are in short supply or if the existing budget does not allow for IT maintenance, infrastructure, or support.

If computers are used in ways that do not show clear results, if technology resources are managed inefficiently, or if technology is rarely used, IT can easily wind up having greater costs than benefits in these situations. Cuban (Cuban, 2001) described problems of underuse in California schools where funding for technology was generous. He reports that even in Silicon Valley schools, students have very little access to computers on a daily basis.

Cuban's most general observation explaining underuse, that schools are institutions that change very slowly, may hold true in the Brazilian case. One public school director explained to me that her school's computer lab would not be used until the following school year, teachers made all of their plans for the year during meetings at the start of the school year and since the computers weren't working then, they would not be used that year. Underuse was a problem in the schools I visited as well and there were some logistical obstacles to computer use that contributed to this problem like a high risk of theft, fitting large classes into small spaces, preparing to use computers from home without access to the computers themselves, and dealing with spotty maintenance and support. The obstacles to computer use were more pronounced in lower income areas and have the effect of bringing about inequalities of access for students, even in cases where hardware, software, and connectivity are all in place.

When students did have access to computer labs, differences in the amount of support available to teachers impacted the likelihood that computers would be used to meet curriculum goals. Teachers with adequate support, access to the labs for preparation, and adequate facilities had better success in their efforts toward curriculum integration. Not surprisingly these advantages were more common in private school settings where technology staffing worked in concert with teachers. Without such staffing, those who attempted curriculum integration invested substantial amounts of unpaid time preparing. Teachers who used the labs also had a lot of variation in the kinds of software materials available for their use. Private schools were more likely to stock CD Rom libraries while public school teachers often downloaded free material from the internet.

All of these differences, in the amount of access to computers students have, the quality of the hardware, the availability and speed of internet connectivity, and the software available influence the way computers are used and ultimately impact the effectiveness of technology use and the return on technology investment. The public system, with it's necessary bureaucracies is sometimes slower to respond to change than private schools so that even when ideal levels of support and infrastructure are possible it should be expected to lag behind in responding to the demands of effective computer use. That plus the limited budgets for hardware, software, and support in some schools leads to levels of student access that vary tremendously, even between schools equipped with computer labs.

Computer Lab Access

We've already shown that private and state schools are more likely to be equipped with computer labs than municipal schools, but the question of access from a student point of view is more complex due to the number of labs that go unused or underused. In my field research and interviews, one of the top reasons for computer labs to go unused or underused were teacher complaints about logistical problems in preparing for and carrying out computer assignments. Once students did have access to labs, the kinds of activities available to them were limited by the degree of access their teachers had so software, connectivity tools, and support. Even relatively minor cost items like printer ink influenced the choices teachers made when preparing to use computer labs.

The number of schools with computers that were entirely unused was astounding. As I searched for opportunities to observe computer use, I was often given contact information for people whose schools had computers and in many cases I learned that the computers were rarely or never used. In at least two cases, entire labs had been stolen.One school reported that their computer labs were robbed in the middle of the school year leaving the entire school with only two working computers in the midst of a busy school year with technology projects going on. The only alternative to abandoning the project was to delegate the work to students who have computers at home.

One of the municipal schools I visited most frequently, probably the school with the most regular use of computer labs, had an attempted burglary during a weekend. The school is locked with a high wall, bars on the windows of both the office and the computer lab, and an alarm that is connected directly to the police station. The computer lab is locked during both the morning and night shifts and the door is padlocked when the computer lab teacher uses the bathroom or takes a coffee break. Because there is only staff available to be responsible for the computers during the afternoon, the lab is not used during the morning or afternoon shifts. In the name of security, the school had restricted access to only about a third of it's students and still they were vulnerable to theft.

On the night of the burglary, the police arrived to find that thieves had entered the office and stolen the office computer and they were in the process of breaking through the locks on the computer lab when the police arrived. The consequence was that one of the lab computers had to be moved to the office, reducing the number in the lab to nine. During the short periods when one additional computer was waiting for maintenance, large classes became difficult to handle in the computer lab as many students had to work in groups of three rather than pairs.

One large school that combined elementary/middle/adult education levels had only one computer set up for use. It was located in the teacher's lounge, away from students, and it was used primarily for typing tests. The school had been awarded a computer lab of 11 computers which were stored away for a remodeling project. After the remodel it was discovered that components had been stolen from inside the CPUs. After the theft, all the computers were placed in a closet. The director told me that, since she had no money for constructing a secure location for the machines, they would stay in a closet, at least until all police investigations concluded.

The same school has been very successful at making use of some older technologies for educational purposes. The school librarian maintains an extensive library of videos taped from TV Escola, and helps teachers select videos to go with the classroom work they are doing. The school has been able to set up an impressive video viewing room. A log of movies shown indicates that the video collection is well organized, tied to curriculum topics, and used quite often. The contrast between the video and computer technologies in the same schools raised questions. Why was one so effective while the other failed? Why do teachers choosing to use video materials have such a large collection of prepared material while those who choose to use computers must prepare everything from scratch?

Other schools were as concerned about theft and these concerns effected student access. One teacher told me that some directors were reluctant to request computer labs from the city because they didn’t want the risk of such valuable equipment in their schools. Since labs were always locked and alarmed, teachers needed to request access from their directors. One teacher reported that he was not allowed to use the locked lab in his school (that was never used) and he believed he was denied access because his use of the labs would make the rest of the teachers look bad.

In the public schools that I visited and that reported at the events I attended, there were two different schemes for using the computer, either classroom teachers took their classes to computer labs or a dedicated computer lab teacher collected students from their regular classrooms. Dedicated teachers were most common at the primary level and in many of these cases classes were split in half leaving the other half to go to another specialized class or to stay behind in the classroom. In both of these cases, students visited the labs sporatically.

For regular classroom teachers visiting the lab, the preparation time involved meant that regular use was a major time investment. In schools with computer lab teachers, these teachers aren't responsible for a group of students of their own and were always available for emergency duties or other work. One computer lab teacher spent over 25% of the work day monitoring the school lunch and often substituted for other teachers in case of illness or other absences. We had to postpone one of my visits a full week because she was substituting all five days.

Private schools tended to have a different system for computer lab staffing. Usually a technically trained specialist, often with little education background, would staff the lab and perform basic maintenance on the computers. Teachers could bring students to the computer labs but they weren't required to prepare in advance by downloading or installing necessary material on the computers, the computer lab staff would take care of the technical end of the preparations. This system seemed to be more effective in encouraging that computers got regular use. In one private school, each student used the lab for six hours per month while the most use I ever encountered in a public school was less than an average of one hour per month per student[2]

Teachers who used computers struggled to integrate computer lab time with the curriculum and often viewed their computer time as taking from their available class time rather than contributing to their goals which made technology use unappealing to some teachers. The most successful were teachers in private schools with technology resource people for preparing the logistical end of things seems to have freed up teachers for focusing on the pedagogical issues. In public schools, some teachers made efforts toward curriculum integration, while others used the labs to teach technology skills.

2. Some individual public school students did use the computers for more than one hour per month but there were no cases of entire schools where the average student had more than an hour of computer time.

I will discuss curriculum integration in more detail in Chapter 6 but for the purposes of this section it is important to note that the resources of a technically capable support person in the computer lab was an effective incentive for teachers to actually use the labs, even if the person was not a teacher and offered no direct instructional support. These staff members might install required software on computers in time for a class visit to the computer lab. By removing much of the logistical problems associated with computer use, these schools free the teachers' energy to focus on making better use of their computers.

Overall, levels of computer lab access varied even between schools equipped with computer labs. Concerns about theft were among the major obstacles to computer lab use but there were additional logistical difficulties seemed to have more of an effect as a disincentive for computer use in some environments than in others. Overall, the existance of computers in schools was no guarantee that students would have access at all and certainly not a good indicator that students would use the computers on a regular basis.

Hardware, Software, and Connectivity

Different schools had tremendous variation in hardware, software, and connectivity available in computer labs. Some schools used donated computers with substantial variation between machines in a single lab while others were awarded complete computer labs resulting from a single purchase. In addition to the operating system itself which was usually Windows 95 or 98, there was a great deal of variation in available software. Some schools had specialized educational software installed, used educational CD roms or multimedia authoring projects while teachers in other locations could choose between word processing, spreadsheets and drawing. Some schools offered networked computers with high speed Internet connections while others had no Internet access at all. All of these factors influenced the ways computers were used.

The greatest obvious variation in the capabilities of computers related the the operating systems they could run. Many older computers were still running Windows 95 while the majority of machines were newer and ran Windows 98. Startup time and installed programs usually varied between schools, not only depending on the capability of the computer but on the amount of maintenance conducted on it. Almost every lab had a single computer in the front of the room used by the lab teacher to prepare for activities and Word process, these computers were usually the fastest ones to boot up, probably because they got small amounts on minor maintenance, on a regular basis. When large classes visited the labs, the teacher computer was used by students.

Since computing tasks were never very demanding there were very few problems with older computers running, as long as they were capable of running the desired software. In some cases, older machines couldn't run desired software, usually not because of a strict hardware limitation but because upgrades would be needed to web browsers or media player. In my experience, I never saw an example of a case where the actual limitations of slow processors or limited memory were obstacles to computer use but the maintenance challenges of keeping software up to date on older computers often did pose problems.

Older computers usually had old mice and keyboards attached to them. It was unusual to see individual components upgraded to any system. The older monitors tended to flicker or have somewhat fuzzy images, many of them were bad enough to cause eye strain under long term use but since students use the computers for less than 40 minutes at a time, the monitors were probably adequate and safe in most schools.

There was one school where these issues were problematic, possibly because children used the computer lab for longer time periods (one hour). At this school one student complained of eye pain while several others rubbed their eyes. The chairs either didn't go high enough or students didn't know how to operate them. As a result students tilted their heads back to look up at the screens. As the hour progressed student posture was visibly worsening and many children were gradually moving closer and closer to the screen, possibly to compensate for eye strain. Certainly the conditions weren't ergonomic although the twice monthly visits to the lab were infrequent enough to offset the potential problems.

The greatest frustration from the older machines and even some of the more recent purchases seemed to come from low quality or broken input devices and peripherals attached to them. On several occasions I watched very young students working at computers on activities specifically designed to help them develop mousing skills such as on screen paper dolls or coloring activities. While the value of such an activity is questionable under almost any circumstances, these cases were especially so because several of the mice were clearly defective. Many of the old mice failed to sense movement in one direction or another. Students showed clear frustration, most computer users know the frustration of working with a defective mouse at some point but to do so with activities specifically designed to test mousing coordination must require a great deal of patience for a young child.

In one school, children were asked to make a folder, name it, and open it. The lesson was intended to introduce some basic *informática* (computer use) concepts, familiarize students with the mouse and keyboard, and pave the way for future assignments where students would save work to their folders. The mice were old and the buttons had gotten sticky. Students were trying to double click on the mouse buttons but the response was so slow that several of the computers interpreted the commands as two single clicks. Microsoft Windows has a control panel allowing adjustments for slowed mice like these but these computers appeared to have been left at the default setting. This left students with the exasperation of repeately trying to double click on a folder (in this case to open it) and being unsuccessful. After nearly fifteen minutes of trying to open her newly created folder, one girl finally complained "ai, que dor de cabeça!" (oh what a headache!).

Another problem with labs stocked with older machines is that they tended not to be connected to each other or to connect to newer external devices. This ended up influencing software options. One teacher I spoke to selected all of the software she used based primarily on the criteria that she must be able to download it from the internet at home and then fit it on a floppy drive. This restriction was because she didn't have access to a CD burner and her lab computers lacked internet connections or an internal network. To install software for her students to use, she copied the material from floppy disks and repeated the process for each computer in the lab. Sometimes she would conduct research for her students and copy internet content to floppy disks so that students could have access to Internet content from the school lab. She couldn't use external removable drives with larger capacity or other media because the computers lacked modern ports.

Printer ink was a tremendous expense for schools and there was some evidence that costs weren't very well planned for printing. Almost all schools I visited had ink jet printers in the computer labs, these printers have the advantage of producing color output and have the lowest purchase price of all the printing options available. Unfortunately they also have the highest cost per page. While the initial cost of a laser printer would certainly be higher, the difference would probably be paid for in the first year of use. The choice of ink jet printers is probably not the best option for schools and in many cases meant that student work was almost never printed. Teachers would usually print one or two of the best examples of student work for their own records and for display but few students got to see their work in print. One teacher told me that at the end of the year she would splurge on ink and allow each student to print up his or her completed project, a Christmas card.

In addition to the software restrictions brought about by hardware limitations, there were no funds available for educational software in the public schools I visited. This is partly the result of a ProInfo decision to support the use of standard office software that has many flexible uses in education. As a result of this decision, ProInfo has prioritized hardware purchases over software and focused on training teachers to use software not specifically designed for education in the education market.

In keeping with a widespread federal initiative, MEC has promoted the use of *software livre* (open source software) the ministry itself has even required it's staff to switch to open source (Cristaldo, 2004). These changes may eventually increase the number of open source offering available for school use but since not all open source software is free, it does not necessarily eliminate the need for budgeting and planning software options for schools.

The lack of commercial software and the increasing expectation that multimedia replace traditional classroom resources is coupled with a new responsibility for teachers, that they author the educational material they use in their classrooms. Though teachers have always produced some amount of classroom material, use of written material copied from books or video recorded from *TV Escola,* the Federal government's education network, is not frowned upon. With computers for some reason teachers are expected to create a great deal of their own material. Many teachers who have computer labs in their schools but don't use them cited the burden of longer preparation time as a major factor in their decisions not to use the computer labs.

One research group from the Universidade Federal do Mato Grosso do Sul commented at a conference rountable about technology uses in schools that one of the principal obstacles for teachers wishing to use technology was "falta de preparo para transpor o conteúdo para o computador" (lack of preparation for teachers to transfer content to the computers). One is left wondering why a teacher would be expected to transfer content to computers when they were never expected to copy textbooks to their chaulkboards or create their own video material when using older technologies. An overall lack of support for teachers wishing to used prepared educational materials on computers may be contributing to the low levels of technology use by classroom teachers.

One form of reasoning behind this expectation is that each teachers must develop classroom materials that match their own approaches to teaching and that many teachers prefer to make their own worksheets and multimedia allows them to do much more. But in practice, multimedia materials developed by teachers are extremely limited. Teachers have a relatively small amount of time to invest in creating multimedia materials, they are not programmers, and they do not have specialized training in every topic that they teach. Asking them to develop their own educational software is a poor use of their time.

Private schools usually reported having software libraries available for teachers to use but when private school teachers presented their work at ProInfo events, the showcased computer uses usually involved simple programming, multimedia authoring, or most common of all, Internet research. The public schools I visited either lacked Internet connections entirely or shared a single dialup connection, billed per pulse, for the entire lab. During my last days of field research, high speed Internet connections were being installed in many of the municipal schools with the hopes that municipal schools would be 100% wired. By then most schools were in the phase of intense review for failing students and the computer labs had been shut down for the year.

The difficulty with using office applications in the classroom is that even in this area, the selection available is dismally low. For example, almost every public school I visited had at least some use of Microsoft Paint for carrying out student art projects on the computer. Microsoft Paint is the free drawing program that comes with the Windows operating system. It is meant for users who don't plan on doing a lot of drawing or painting to have a basic tool for their occasional graphics needs. Students had a hard time working in Paint and even toward the end of the school year they found it limited and complained about missing features. Many students also expressed surprise at how the program responded to their input indicating that they were having a hard time learning to use it. Paint lacks both the functionality of more sophisticated alternatives and the easy of use of programs designed specifically for children, the only advantage to Paint is that it comes with the Windows operating system. After the large investment in a computer lab, it is disappointing that even in schools where computers are used extensively for creating digital artwork, teachers were not offered a more appropriate product. Microsoft Paint was among the most used software in all of the classes I observed.

The lack of adequate software limited what students could do with the computers. Many classes worked with Microsoft Word and though there are specialized tools that may have been more appropriate such as multimedia tools designed for on-screen work (rather than printing) or for children, students didn't seem to be hampered from carrying out assignments in Word the way they were with Paint though. Powerpoint was also a popular tool and like Word, schools used it in ways quite different from it's original design, for multimedia authoring rather than preparing presentations. But again, with Powerpoint students seemed to grasp how to use it and to find it adequate to their needs.

Aside from Microsoft Office programs, Paint, and some similar open source products, the most common kind of software use were free games found on the Internet. Teachers in several schools use free downloaded games from the *Portal da Turma da Mônica* provided on the Globo television network home page. Within this selection, teachers seemed to prefer a small subset of the games, the most common being the paper dolls game called *Guarda Roupa da Mônica* (figure 2), a coloring game called *Vamos Pintar* and a memory game, *Jogo da Memória*.

One interesting common link among the game selections is that they are electronic versions of classic games that have almost no material cost when carried out on paper. What advantage is there to simulated memory cards or coloring books on a screen over the substantially less expensive paper equivalents?

Studies comparing educational activities with different media have not found any differences between different media once other variables other than delivery method have been controlled for. If you are going to do exactly the same activity either with paper and pencil or a multimedia computer, there is no significant advantage to either media. Any advantage of a multimedia computer comes not from the media itself, but from its attributes, the things you can do with it that are not possible, or more difficult with other media (Salomon and Clark, 1977). Thus it is difficult to imagine activities like virtual paper dolls as an efficient use of resources, especially when these kinds of use, that couldn't just as easily be done with paper and pencil, make up the bulk of computer time.

Teachers usually responded to questions about the value of using computers to mimic paper and pencil activities claiming either that student motivation was improved with computer use or that the games helped develop basic computer skills such as mousing. But in defense of their decisions it should be noted that coloring with paper and pencil, and memory games using paper cards, though much cheaper, is not an option for many teachers, there are simply no funds available in many classrooms for art supplies or learning games. Working under these material constraints with the limitation of free software, small file size, and limited preparation time, the Mônica games and similar free downloads become an appealing option for teachers allowing them to download virtual versions of material that is otherwise unavailable.

One teacher, who had developed a rather elaborate set of on screen art projects for students to work on, was conscious of her decision to use the computers to accomplish goals that could just as easily be accomplished using more traditional materials. She had previously taught preschool for years and had decided that creative art projects were important for young children. She told me that on many occasions she had bought materials on her own to offer creative projects to her students because art supplies were not provided by the school. Today, as a computer teacher, she is able to do similar work with students without worrying about materials because all of the work is done in the computers. The only material cost is printer ink for the rare project that is printed. In her school, almost all computer use was for on screen artwork.

Since most teachers have limited access to the Internet themselves it would be unrealistic to expect them to invest large amounts of time to seeking out alternatives, especially when their options are restricted to free software and small programs. This may, in part, explain why the various free games that mimic cheap but unavailable paper and pencil activities have found their way into so many classrooms. Teachers seeking alternatives on the Internet must use their own time and often must access the Internet from other locations.

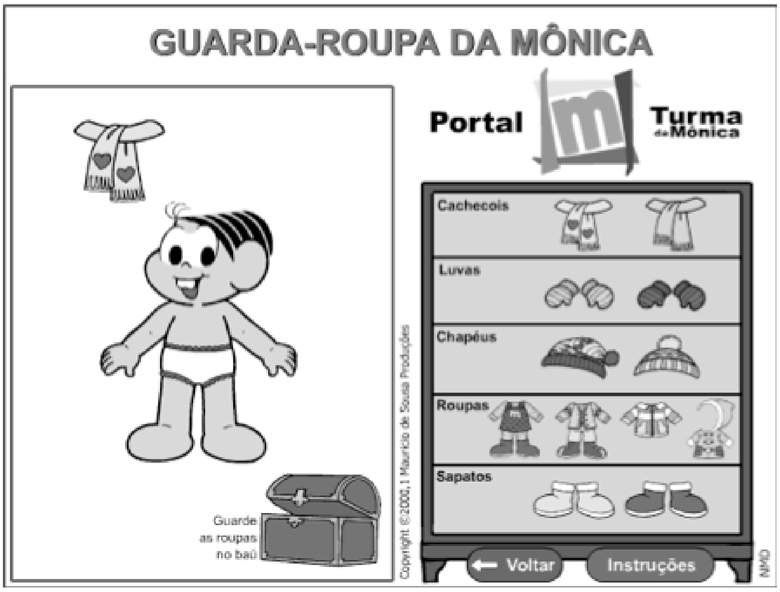


Figure 2: Guarda-Roupa da Mônica. One of the free games available on the Mônica portal. This game was one of the most popular. Children select clothes in the closet and drag them into place.

Many of the schools I visited had no Internet access or precarious access. It wasn't unusual to find laboratories with a single modem installed at one computer. The entire laboratory was connected to the Internet by the single 56kb modem. Teachers in these situations would report having tried to use the connection during class time with students directly accessing the Internet themselves but they found that the speed was impossible to work with. Some would then use the modems to prepare for class, downloading material off the Internet before class and copying it to each computer. Others would choose not to do their class preparation in the laboratory at all, they would access the Internet from another location entirely and bring material to the lab on floppy disks.

Commercial Material

When teachers are given choices between free options in selecting educational software, many of the most easily available options are commercially produced content provided for free with embedded advertising. The Mônica games, for example, are provided for free but each page of the web site includes a link to an online store selling more video games and other children's products. The offline versions lack direct product links but does further advance the brand by giving children additional exposure in school. The use of school time for transmitting commercial material is another compromise to educational quality. The material isn't developed with careful attention to educational content and in some cases, the commercial messages themselves can distracting from educational goals. Much of the commercial material that gets to classrooms does so by way of new technologies, including educational software like the Mônica games and online web content provided by large companies and designed for classroom use. In the U.S., schools without budgets for educational software use are more likely to use pre-packaged digital educational programs like the Channel One network (Sayers 1995), a closed circuit television network which forces more than 8 million U.S. students to watch 12 minutes of commercial television in school every morning. In exchange, Channel One provides schools with video equipment in all classrooms. The daily advertising revenue for Channel One in the United States is $630,000.

In Brazil, the stakes are substantially lower in the field of advertising based school materials, schools are not offered free hardware, only free software and downloads with commercial content both of which are fairly popular for classroom use. Several companies use web sites designed for children as a means of marketing their products and teachers often use content from those web sites, especially contests their students can enter, in the classroom. Nestlé is one example, offering online games and frequent essay and drawing contests designed for school use.

The Grupo Belgo, the steelmaking (*siderujico)* company that is one of the worst polluters in the states of Minas Gerias uses their web site to announce annual essay and drawing contests through it's associated non-governmental organization Fundação Belgo. The contests have environmental themes and schools often participate as part of their environmental education programs. Belgo supports teachers using web based teacher content and classroom materials in their environmental education programs. For Grupo Belgo there are tax advantages for supporting it's foundation but the foundation's work is part of the company's public relations efforts to improve public opinion concerning Belgo's contribution to the environment.

The opportunity to shape the content of environmental education in public schools is potential very valuable for Belgo as a part of their public relations efforts. This is especially true in the communities where Belgo has caused the greatest damage and depends on favorable public policies. Shaping the way the community thinks about science is a common public relations strategy (Rampton and Stauber, 2001). Schools are a very practical place to begin such efforts. School-based Belgo programs teach children to think about environmental issues through a focus on non-controversial themes like planting trees distracting attention from difficult questions about industrial pollution and regulation. Students using Belgo materials study basic environmental lessons but it is doubtful that it is in the company's interest to help them develop independent critical thinking about environmental issues.

The opportunities for marketing and public relations through the use of children's content on web sites have been recognized by other companies as well, the Internet is one of the easiest way to get their message to schools. In the height of the public debate over transgenic agriculture, industry representatives created computer materials for use in schools that taught about the safety of transgenic agriculture. For schools to dedicate any amount of their limited time to such commercial messages is problematic, not only because the content runs against their efforts to help develop a generation of citizens capable of thinking for themselves but also because the have a limited amount of time for teaching critical content like basic literacy.

If the public system is willing to invest in hardware and internet connectivity for schools, one would hope they would top off that investment with the materials and staffing needed to help teachers make productive use of the computers and to ensure that students actually have access to the equipment. This may include the staff needed to keep computer labs running during the entire school day, hardware maintenance, internet connections, and support for teachers interested in using the computers in the form of software of instructions for technology uses that require little teacher planning. ProInfo and the Municipal technology programs I observed seemed to be operating in a phase of finding out what works but one would hope that as the obstacles to computer use become increasingly apparent, teachers won't be inventing the wheel at individual school sites anymore.

Ideally public schools will someday have their computer labs running during all three shifts of the entire school day rather than during the limited to the hours of an individual resource teacher. These labs would use software can be selected on the basis of it's pedagogical value rather than its ability to fit on a standard floppy disk, and hopefully, rather than turing to Nestlé for online content for classroom use, teachers will someday be able to turn to MEC supported content designed to meet educational rather than commercial goals. Considering that many public school technology purchases are made with the promise of improving digital inclusion, the failure to follow through with hardware purchases by ensuring that the benefits of technology reach students is problematic. Without software, support staff, Internet connections, and working peripherals, there are real questions about whether hardware purchases are an effective use of limited school funds.

6. Institutional Bias

This chapter discusses how institution bias results in differences between educational programs and teacher expectations in low and high income communities, how these differences influence computer use, student learning, and how they contribute to unequal educational outcomes. In addition to the set of inequalities connected to the different quality of resources available in low and high income schools, institutional bias contributes to unequal outcomes in the use of educational technology. Schools serving low-income students operate with different sets of expectations, which results in different kinds of computer use and different outcomes.

Students from more privileged backgrounds are more likely to have opportunities for developing independent thinking skills, working on tasks that require multiple mental steps, experiencing academic challenged in school. They are less likely to spend school time focusing on basic skill building than low income students. Their education prepares them for full participation in society, while schools serving low-income students are more likely to focus on workforce preparation and building specific skills without consideration to independent thought and critical thinking.

Expectations about what students need to learn and and what they can learn influence the choices that schools make about what technology to use and how to use it. Schools develop different sets of goals based on these expectations leading to differences in educational programs and outcomes. Attewell (2001) has described these differences as "social differences in the ways computers are used." In addition to the inequalities in the quality of technology programs, he argues that unequal educational objectives and expectations contribute to different kinds of computer use.

The widespread differences between the expectations and educational goals in high- and low-income areas are not new, and technology is only one of many areas of educational efforts that are affected. According to Attewell, technology can both affect and reflect surrounding social conditions, and it is not surprising that technology has failed to revolutionize education. Educational technology is implemented within a social context and existing power relationships shape its use. He argues that the power of technology to bring about social change is limited by these power relationships.

The mechanism through which power relationships are reproduced in schools is the set of different goals and expectations held for students of different socioeconomic groups. In the case of technology programs this usually translates to more challenged uses for higher income students and uses aimed at the acquisition of specific job skills for lower income students. While it is widely considered unacceptable to deny low-income students access to computers, the need to fight for equality of educational goals is less apparent. In fact many would argue that goals should not be uniform. For example, some administrators and teachers believe that job preparation is be more important in economically depressed communities than in communities where students have a good chance at a college education.

In the United States, the differences between educational programs for low and high income students is often not explicit. Schools serving low-income communities often struggle to meet standards on basic skills tests. Their administrators experience pressure for improvements on standardized tests, pressure that influences many curriculum decisions, including decisions concerning the use of educational technology. With goals set on the next standardized tests, creative and stimulating activities that allow students to develop independent thinking skills are a luxury that the schedule and budget do not permit. Unfortunately many of the applications of educational technology shown to be most effective fall into this category, and are passed over for remedial skill drilling programs that are not supported by educational research.

Administrators in low-income schools are constantly forced to measure up against job preparedness indicators and standardized tests. Much of this trend is supported by family expectations. Low-income families are more likely to value obedience and good grades while higher-income parents want their children to develop intellectual curiosity. This is probably due to what Pareto referred to as sentiments of social ranking (Lopreato & Hazelrigg, 1972). According to Pareto, people who hold low status positions in society have sentiments of inferiority, subordination, reverence and fear. These sentiments make it much more likely that low-income parents will have expectations that their children should aim for low status as well. Thus, schools in high-income areas are more likely to experience parental pressure to challenge and engage students. Therefore, their use of educational technology, like the rest of their academic programs, is more likely to challenge and engage.

Underlying these differences are assumptions about the purpose of school itself (Postman, 1992). He argues that administrators in middle-class schools consider educating the whole child, designing education programs for the sake of knowledge and understanding and for developing citizenry. They answer to parents and community leaders who demand this kind of education and expect their education system to open doors by preparing students for active leadership roles. Their goal is to prepare students for all aspects of their future lives, including teaching students to think and learn independently. There is an expectation that middle-class students will continue beyond high school, so the importance of developing greater independence as thinkers is valued.

In the Brazilian case, the distinction is less clear cut. Unlike American SAT's and college entrance essay requirements which demand logical reasoning skills, reading comprehension, and mathematical reasoning, the *vestibular* college entrance exams tend to focus much more heavily on specific factual knowledge. While *vestibular* content varies from one university to another, secondary teachers in most communities know that their best strategy for getting their students into college is drilling facts and formulas.

Since private schools compete on the basis on college entrance statistics, these schools must focus on whatever areas tend to be emphasized in local *vestibular* exams. Thus private schools in Brazil often don't have the luxury of focusing on comprehension or critical thinking. While their public school counterparts may be focused on basic skills, private school students do a lot of memorizing. It is rare for students in either setting to complete independent research projects or develop expository writing pieces. The kinds of school assignments that have been associated with higher order thinking skills, rare in both environments.

American students in low-income areas are more likely to use computers for simple task-completion type assignments, contrary to the importance given to active learner participation in the educational computing literature. They are more likely to spend time learning specific technical skills that, unlike learning through exploration, cannot be carried over to other technologies. Their educational materials are more likely to feature motivational tools that are not connected to the content, doing little to increase their long-term interest in the material they study. Low-income schools are more likely to use computers as remedial tools, providing no new material. When educational objectives focus on specific technical skills and simple task completion, there is a reduction in the quality and outcomes of technology use (Selwyn et al., 2001). Programs to broaden access to technology education must take into consideration how they will be used. Natriello (2001) makes a similar case that information technology does not fundamentally change the social processes that determine the impact of educational efforts.

According to (Diamond et al., 2004), concentrations of low-income or African American students in American schools "is deeply coupled with a leveling of teachers' expectations of students and a reduction in their sense of responsibility for student learning".

While this bias manifests itself on an institutional level, it is reflected in the words of teachers as they describe their expectations of students. While it is difficult to draw direct comparisons to different treatments of racial groups in the United States and Brazil, my observations showed similar patterns in Brazil at least with respect to low-income students. Teachers in low-income areas believed that they were fighting an uphill battle in addressing the needs of their student population, and were generally satisfied with lesser achievements than the teachers in higher-income areas. In one primary classroom, a teacher pointed out examples of students she viewed as particularly needy. Many of these students were repeating the first grade and one had repeated at least twice. From the teachers point of view, this is unavoidable given the distractions from schooling they must endure. She described her primary goals with many of these students as trying to make things easier on them.

The teachers I observed showed particular concern for children whose level of poverty means that consistent adult supervision outside of the classroom is difficult. they rarely described home conditions, nutrition, or other consequences of the children's poverty but they were very concerned about time spent without adults. One teacher pointed out students whose parents worked multiple jobs and could name for each child the older siblings and cousins who looked after them during the day and night. The teachers describe taking extra measures to try to make the school day as easy as possible for these children, even if this means avoiding extra challenges.

The goals of school staff in low-income communities are different from those who work in private schools serving wealthier students. Teachers serving low-income students tend to offer lesser challenges to their students due in part to greater concern about the phsychological well-being of their students, whose lives include a great deal of insecurity and uncertainty. Teachers know that motivation to succeed and the sense that one is capable is critical in families where previous generations have not attended school, and many teachers are therefore wary of challenges that may lead to failure and discouragement.

Though even the wealthier schools I visited did not focus on preparing students to think for themselves, they did aim to offer skills with more broad application, with a great emhasis on reading, writing, and independent research. While their lower income counterparts did very little reading and writing and had most information provided for them in pre-processed forms like book summaries, private school children and children were often given simple independent research projects. In the few cases where I saw open-ended projects, where students explored the use of computers as tools in solving simple projects, they were private schools. Overall, higher-income students were given more opportunities to be active participants in their work with computers and were given greater challenges.

Active Engagement

> "For every inner city implementation of an integrated learning system focusing on basic skills, there was a countervailing deployment across town of multimedia PCs for student publishing and presentations" (Rifkin, 2000)

For several decades, researchers have reported different levels of student engagement across socioeconomic groups. Higher income students are more likely to use computers in ways that are engaging while lower income students are more likely to work with computers in less interactive ways (Ascher, 1984) (Sayers, 1995) (Castells, 2000). Social scientists have attempted to discuss this problem in terms of social differences in the way schools work in low and high income areas and differences in what students bring to schools (Attewell, 2001) (Natriello, 2001).

Some have argued that levels of student engagement have changed over time as well claiming that changing attitudes toward the goals of schooling, social pressures concerning student control, and changing conditions of public school management have contributed to the replacement of many active learner technologies developed in the seventies and eighties with the animated multimedia products that are more common today. Agalianos (1996) uses the examples of Britain and the United States while Roberston (Robertson, 1998) shows similar patterns in the Scottish case. Since computers reached higher income

Research on educational computing is relatively clear in the conclusion that students benefit more from technology use when they are engaged in their work, as opposed to experiencing the lesson as passive recipients of information. Even though a small number of less engaging types of technology use, such as drill and practice programs, can offer results when used in moderation, for most kinds of technology use student engagement is key to effectiveness.

Open-ended projects in which computers are used as tools can be a very effective way to make use of technology resources. This kind of computer use, under good conditions, with qualified teachers and proper support, has been shown to bring about positive learning outcomes. These kinds of technology use can help students developing proficiencies in writing, logical reasoning, problem solving, and organizing ideas. These kinds of computer uses, such as programming, working with databases and spreadsheets, word processing, and multimedia authoring, have been in use for decades but in some cases, especially in low-income areas, they are gradually being replaces with newer technologies that offer students less control and fewer opportunities to be engaged in their work.

> [T]he information "haves" will retain or strengthen their ability to shape technological innovations to their own advantage, and the "have-nots," when not completely excluded from access to technology, will be more often manipulated by computers and computer networking than in control of these powerful technologies. (Sayers, 1995)

Robertson (1998) connects the idea of student control with interactivity. When computers respond to student actions in a logical and systematic way, they are interactive. “Computers [...] have the potential to apply complex sets of rules to our actions and to respond in a manner which may illuminate our understanding of a topic – *interactivity*. Because the machine response need not be mediated through another human being, but goes directly to the learner, this *may* result in greater *learner control*." Learner control, in turn, is for Robertson "the necessary prerequisite for meaningful and fruitful engagement".

Technologies that engage students are connected to higher order thinking skills. Some of the most successful educational technology uses were early computer science applications, notably the Logo programming language, designed to provide students with and environment that allowed them to explore abstract ideas with immediate feedback and control. The goal of these programs was to help students build critical thinking and problem solving skills through open exploration. In the United States, even though the use of passive learner educational technology is on the rise, schools in high-income areas are more likely to deploy these kinds of technologies that engage students.

In Brazil, new versions of Logo itself are increasingly popular, as part of the science or math curricula in some private schools. These schools use Lego Logo, where Logo programming techniques can be used for controlling small robotic devices. Efforts to bring similar open ended uses of programming tools and robotics are underway in some public schools as well with the support and participation of the American group that originally developed Logo. Unfortunately there were no examples in the states where I conducted my research.

Robertson (1998) highlights the recent history of technology use in South-West Scotland and finds that Logo, databases, and other student controlled technologies were popular in the eighties and were driven by a theory that learning abstract ideas like linguistic and mathematical concepts could be based on sucessful hands on experimental approaches involving an environment in which students test and get feedback. By the mid-nineties, these uses of educational technology had been replaced by CD-Roms containing a great deal of information but offering very little student control. The new material, with more appealing graphics and sound offered more appeal to teachers just as public education in Scotland was undergoing a process of de-centralization offering individual teachers greater technology choices.

Agalianos (1996) discusses the pendulum swing of attitudes toward Logo (at first strongly favorable and then strongly negative) among educators and policy makers in both Britain and the United States and places these changing attitudes in social context. Logo was introduced in the United States, during a time characterized by a new emphasis on student centered approaches to education while “a quest for an alternative paradigm in education which was already underway” (p.9) but shortly afterward, a renewed emphasis subdividing the curriculum, school accountability, and curriculum basics swept education reform movements in both the U.S. and Britain.

In Britain, Logo was adopted with the hope of revolutionizing educational practice, much like the rationale of its developers. But as with widespread adoption in U.S. schools in the eighties was Logo programming became a new area of curriculum content, as though knowing how to program in Logo was part of basic computer literacy. Agalianos ties this transition to the shift in political climate that characterized American and British education reforms of the eighties.

In both the U.S. and Britain, the back to basics movements in education and the consequent increasingly compartamentalized curriculum made student centered tools with uses that cut across many curriculum areas undesirable to school leaders. As school accountability movements increasingly meant that schools were forced to administer routine tests, the focus shifted from how well students could carry out higher order thinking to how many facts students knew in a particular subject area. Using Logo as originally intended by it’s authors, across the curriculum was gradually replaces with computer classes in computer labs offering Logo programming instruction. In an environment where student engagement was not valued, Logo was at first adapted to fit with the existing models of teaching and learning and finally replaced with other programming languages and software.

Why does student engagement matter when comparing different forms of learning? Claudia Strauss (1984) addresses this question by making a distinction between well-defined and ill-defined learning tasks, based not only on how open ended the task is, but also on how much the given information and operations are pre-defined. Strauss describes tasks that involve higher levels of student engagement in the absence of clearly defined tools and procedures. With ill-defined learning activities, students must develop their own strategies for solving problems. While ill-defined activities may not always be the most efficient way of meeting the initial goal, it is more effective in developing skills and knowledge that can be transferred to different contexts.

Strauss demonstrates her theory on the advantage of ill-defined activities by drawing cross cultural examples, comparing elementary math education in the United States and Japan and weaving instruction in two different Maya communities. In both cases similar material is taught with widely varying degrees of structure to the activities.

> [T]he findings of anthropological fieldwork and psychological experimentation lead to the same conclusion. Well-defined procedures are more efficient than ill-defined procedures at imparting a particular skill or piece of information. On the other hand, ill-defined procedures, much more than well-defined procedures, promote originality and ability to apply one's skill or knowledge in a wide variety of contexts. (Strauss, 1984, p.208-209)

The the cognitive skills that Strauss associates with well-defined and ill-defined tasks are the same cognitive processe that are considered to be higher order and lower order skills on the basis of Bloom’s taxonomy (Anderson et al., 2001).

Unfortunately technology uses that engage students and encourage them to use technology as a tool for their own work are relatively rare in schools. These activities are not usually available to teachers in pre-packaged format, and require more teacher preparation time. They are difficult to implement in environments where students have been conditioned to seek the single correct answer to every question or where there is an intense focus on objective measurements of student performance. Students who are accustomed to more structured work will often resist these kinds of assignments, asking for increasing direction, ultimately reducing the scope of the assignment to following increasingly specific steps. By doing so, they miss out on the learning experience that comes with developing strategies to complete a problem or project. Students ask for more structure when little is provided for them.

One teacher in a school located in a low-income area was very proud to have given students an open ended assignment where they were to design computer artwork and text similar to a billboard on the theme of child labor. Before the assignment, the class read a book about child labor and there were discussions on the topic prior to the activity. Many of the children in the class work selling gum or popsicles and make contributions to their family income, so many of the students in the class had a very different perspective on child labor from that of their teacher.

Opening a discussion on the topic of child labor provided an opportunity for students to contribute their own ideas and begin a dialog. But surprisingly, despite the wide range of personal experience among the children in the class, the content of almost all of the student artwork was nearly identical to what the teacher had to say about child labor and to the remarks in the book students had read. It seemed as though despite the teacher's best efforts to get students to express their own ideas, student habits of mimicking teachers were too ingrained, when they were given something open-ended, they reduced the scope of the project.

One form of technology use said to promote active student engagement is the use of multimedia authoring tools for communicating ideas. While this kind of use is widely promoted in education circles, it is more likely to be the teacher than the student who actually does the multimedia authoring. Many teachers are encouraged to create multimedia materials to replace paper and pencil quizzes. They make multimedia, multiple-choice questionnaires using clip art and text. In this sense, homemade educational software replaces both drill and practice material and books. Instead of reading from printed material, students read on-screen content developed by their teachers. They devote enormous amounts of time to the development and graphic design of these materials, and claim that these are different from the dry paper based quizzes students took before, especially in terms of added benefits to motivation and self-esteem.

Much of the discussion around technology education is part of a broader issue concerning the balance between concrete practical skills and generalizeable literacies. The balance between students who know how to give the right response and those who can think for themselves. The theoretical line of most Brazilian schools of education prepares teachers for work with students that can be applied to more generalized situations, teaching as a guide through discoveries helping students test their own ideas and develop understanding, and becoming independent learners, teachers are trained to think. Teachers, familiar with this thinking use these concepts when they explain their objectives, they talk about students assimilating their learning with their own reality and constructing knowledge. But often classroom practice and evaluation methods reflect an underlying belief in a stimulus-response learning model, effective in the teaching of concrete skills. The educational theories that teachers espouse don't always correspond in transparent ways with their teaching practices.

One of the difficulties for *licenciatura* (teacher education) programs aiming to prepare students to use computers effectively is related to the disconnect between theory and practice in teacher training. The certification process for secondary teachers involves coursework in the department of the teacher's content area plus some additional coursework in education theory. Chemistry teachers, for example, enroll in programs based in the chemistry department but those who choose *licenciatura* rather than *bacherelado* (bachelor's degree) must take some coursework in their university's school of education

When constructivist learning theories began to influence education policy about twenty years ago, the programs were modified with instruction in teaching methods coming from content area departments. The idea was that only a chemist could understand the most common misconceptions (or spontaneous concepts) in chemistry, biologist understood common misconceptions in biology, and so on. The result of these policies is that in many disciplines, *licenciatura* students across the country learn teaching methods in their home departments and study learning theories in the schools of education. The study of theory and practice in education is not integrated. This makes the process of bringing theory to practice especially complicated for new teachers.

In one teacher presentation on a teacher's use of multimedia-authoring software in the classroom. She explained that the use of multimedia-authoring software makes it possible for the student to "participe em construir conhecimento, porque têm controle sobre a experiência." ("participate in constructing knowledge because they have control over their own experience"). These remarks indicate that the teacher has been exposed to constructivist educational theories and believes that active student engagement ("participe", "controle") is an important component to learning. She also has been exposed to the reasoning that multimedia-authoring software can be used in activities supported by this lines of educational theory. But instead of allowing students to use the multimedia-authoring software, this teacher, like many who used authoring programs, is making her own multimedia lessons that students simply watch.

Several *licenciatura* programs teach students to use multimedia-authoring software and develop their own educational material in hopes of encouraging teachers to develop this kind of material on the job. Understanding the importance of active engagement in learning with computers, a professor from one such *licenciatura* program commented that their students "*puseram mão na massa*" ("put their hands in the batter" i.e. working hands-on) working directly with authoring software in order to develop their own multimedia materials. When these students go on to work as teachers in schools, their university professors regard their production of multimedia demonstrations and questionnaires as evidence that they've become effective at using classroom technology.

While multimedia authoring may be an opportunity for learning through practice for the teachers as they become more comfortable with simple programming, the students themselves are far from true hands-on experience since their interaction with the computers is limited to simple multiple choice, matching, or answer box assignments mixed with short blocks of text. While multimedia authoring uses for computers are widely regarded as a means for improving student engagement, this advantage is limited to cases where students themselves do the authoring. Teachers who do have this experience, however, are probably much better prepared to someday offer similar opportunities to their students in the future.

In a small number of cases, we see students working on multimedia projects on their own in groups. In most cases, this is accomplished when each student of pair of students creates some multimedia artwork and the teacher later puts the material together in a PowerPoint presentation. After seeing over 50 Powerpoint presentations of student work, I have seen only one in which students logically mapped out the order in which they presented information creating a logical sequence for the presentation. Most cases of using Powerpoint for multimedia authoring really boil bown to displaying student drawings or writing in sequential slides (one for each student) and adding a musical background. So despite the fact that almost every teacher reports some use of Powerpoint, multimedia authoring is still a virtually unexplored area.

There was remarkable consistency in the use of computers for creative purposes. Almost every teacher who spoke at the *Mostras de Informática* or allowed me to visit her classroom was using computers for free writing or drawing in Microsoft Paint at some point, and I was told that there was almost no writing or drawing outside of the computer labs. Some teachers reported that the computers helped with writing either by improving motivation or by reducing inhibition, and several teachers were pleased to offer students tools for creating visual arts after years of working without art supplies of any kind.

Classroom work aimed at engaging students often means giving them an opportunity to address a problem creatively, to think of and test their own solutions to a problem. On many cases, student engagement depends on giving students opportunities to address problems with more than one satisfactory outcome. Many teachers who I spoke with and others who gave presentations at the annual *Mostra de Informática* events had developed relatively open-ended activities for students to work on where considerable variation was expected between one student's work and another. In most cases, assignments that didn't involve pre-packaged educational software were somewhat open-ended, requiring some level of active involvement of the students. But there was considerable variation in student engagement levels.

Focus on Product vs. Process

One factor that limits ways computer are used is the emphasis on the products of student work over the learning process that is very common in schools. When it is time for teachers to evaluate student work, Brazilian teachers must consider the importance of having objective measures of student work. When a task can be completed in more than one way satisfactorily, the means of reaching the end is important for evaluating the learning, the teacher in this situation is left with a substantial grey area when it is time to grade and rank students. The work of the teachers themselves is also evaluated based on student work. Teachers report that parents come to the school interested in finding out what their children have been working on, and they are not satisfied unless they see examples of their own children's work. Without examples of each student's work to show case, on teacher feared that parents would loose interest in school and decide it wasn't worthwhile.

When describing what they are doing with computers, teachers tend to show student projects and products rather than describe the classroom processes. Many teachers save examples of students work for use as demonstrations of what they do in the classroom. This focus on products of classroom work is reinforced by students who enjoy showing off examples of their own work as well. Teachers claim that they are more motivated when they believe their work will lead to finished products such as posters, stickers, and artwork. Teachers like to plan activities that give students something to show for their work, because students are more motivated when they are creating something tangible. Unlike the small chalkboards of the past, the computer allows for easy saving and printing of student work.

Unfortunately this emphasis on products clouds the dialog between teachers over classroom processes. When teachers come together to discuss work and compare classroom practices, they end up comparing student work, rather than discussing the much more important characteristics of effective classroom practice. When I attended events aimed at bringing teachers together to share teaching strategies, the events resembled school fairs. Teachers often brought students to show off their own work rather than giving presentations about the goals and methods of the project. Unfortunately student work not always the best measure of learning, and often a focus at producing the best finished product possible can lead teachers to give up learning opportunities along the way.

One example of the emphasis on students as producers of tangible work is the amount of resources that go into printing student projects. Printing on the inexpensive ink-jet printers available in many public schools can be quite expensive, since ink-jet printers need frequent cartridge replacement. Most teachers select a small number of exemplars of each assignment, which they save as a record of each activity. But teachers report that having their work printed, even when they can't take it home, is important for students. One public elementary school teacher working in a low-income neighborhood had students make greeting cards in Microsoft Paint for each major holiday, but as a special year-end treat to students, she promised that the Christmas cards would be printed. She explained to me that the cost was substantial, and her largest material expense for the year, but that it was important to both students and parents. She explained that showing examples of student work was her only way of demonstrating to parents that the time and effort spent at school was worth it. When parents come to visit her classroom, they are very interested in printed examples of work done on the computer.

The Jeitinho

In one private school, students used Logo programming and simple robotics to produce a small model city made up of motorized miniatures. But a brief conversation with some of the participating students selected to represent their school at a technology event revealed a great deal of attention to finished product, while the kinds of learning opportunities for which Logo was developed were often passed by. The students were in their second to last year of *ensino médio* with plans to take vestibular for entry into a Federal university the following tear.

The students I spoke with were interested in studying engineering. They explained that they had developed their small model city as a programming exercise to develop skills in that area. In the model, traffic lights change colors and cars run on tracks on roads with painted lanes. The city has been painstakingly assembled with careful attention to painting and drawing small details. One of the most elaborate areas of the city had a small car circling on a track painted to look like a road. There was a traffic signal dangling above a crosswalk in one area of the track. When the light turns red, the car stops at the light, and after the light turns green again it starts again. The car circles 3 times with the green light before the light turns red again and the car stops.

I asked the student how it was programmed, does the movement of the car depends on the traffic light? He told me it doesn't, the whole thing was timed so the movement of the car coincided with the traffic signal. The car is programmed to circle the tracks 3 times continuously and then stop for a few seconds. They figured out exactly how how long the car takes to circle the track and timed it so it would stop in the same place each time. The light is set to the same number of seconds, so it turns red during the time that the car is stopped. So, the traffic light and the car actually function nearly independently, and each time the students turn the model city on and off they must place the car at the starting point again and resynchronize the car and the lights.

While this is certainly one way of achieving the goal of assembling an impressive looking model city, it is not really the simulation it appears to be, nor is it a very rich way of exploring Logo and robotics. The programming is not generalizable to other similar cases, and even though students were able to set things up so that it worked nicely at the event, any slight changes like the speed of the car, the incline of the surface, or the length of the track would require reprogramming of the entire thing. This kind of programming is a *jeitinho*, an acceptable workaround to a problem but in the case of a school assignment it bypasses many of the kinds of learning opportunities that Logo was designed to uncover.

I asked the student if it would have been possible to program the car to stop at the light without the trick of timing, to program things so they worked as they appear to work. He said yes and explained that the car could be programmed to stop when the light is red and go when the light is green. But then he stopped himself and thought for a moment and corrected himself, his initial strategy wouldn't work, because the car would stop no matter where it is, even if it wasn't going through the intersection.

After a moment's thought, the student then began thinking out loud out loud explaining different solutions to the problem and then recognizing reasons why each solution was inadequate. He concluded that it could be done but that it would be more complicated.

The kind of complication involved in resolving the traffic signal programming problem in a generalizable way was exactly the kind of thinking the model city project and Logi were designed to encourage. I wondered why these students had been allowed to create the appearance of having simulated complex interactions, while what they had produced more closely resembled a movie set. It seemed that if the learning environment had been less focused on product over process, students could have worked out some of those complex problems in the time they spent painting crosswalks and installing expensive model trees.

Group Products

Another problem that can result from too much emphasis on product outcomes is that it is that when students are given group assignments it is more difficult for all students to be involved in a project participating in ways that challenge their weaknesses. For example, when groups of students are assigned shared tasks for a project, it is important that teachers stay focused on classroom processes to make sure that students are doing more than capitalizing on their strengths. The shy students must be encouraged to take on leadership, while the weak writers must write, while the least organized gets some practice in planning. Without teacher supervision and intervention, most students will tend to work on whichever component of a project they feel most comfortable with, so that instead of learning from one another, teams of students wind up compromising one another’s learning. With attention focused on the products of classroom work, teachers have a disincentive to effectively carrying out their role creating balance between strengths and weaknesses. Their interests are best served when each student works on their areas of greatest strength, the best artist does the drawing and the best writer does the writing.

One class made a news report in which two boys dressed in suits and ties and sat at a table in the role of news anchor reading reports produced by others members of the class. Whatever learning opportunities came from the experience of creating such a news report or editing the resulting video, they were limited to a small number of children with the clearest presentation skills, the rest of the class stood on the sidelines with low levels of participation. Opening up the floor and giving students chances to take turns in front of the camera may have been a better educational choice but it would have resulted in a much less impressive looking video production.

Drill and Practice and Remedial Work

Of all educational computer uses, so called drill and practice software, which is usually comprised of basic skill practice, has the best record of success when it use is studied under controlled conditions (Archer, 1998). But in large scale studies, drill and practice software use is correlated to an overall drop in performance indicators (Attewell, 2001), (Archer, 1998). It is possible to use drill and practice software with good results, but in many cases it is misused and wasteful of school time and resources. In fact, in one study, the use of computers for learning basic mathematics was shown to be negatively correlated with student achievement in mathematics (Wenglinsky, 1998). Some possible explanations of this are reduced levels of teacher participation and the fact that these programs are often used to hold students at remedial levels. Also, not all drill and practice software are alike. Quality and organization of content, as well as the capacity to individualize the level of work, is critical to success. Drill and practice cannot be used as a stand alone teaching system, and is not necessarily effective in all subjects across the curriculum. The conditions under which these programs are used influences their success as much as the choice of programs themselves.

Problems with the implementation of drill and practice software begin with the reasons for their selection. In the U.S. many schools in low-income areas respond to low-performing cohorts of students by focusing on basic skills often eliminating the kinds of work that engages and challenges higher order thinking skills. In the United States the use of drill and practice software that focuses on basic skill building and memorization is much more common in low-income areas while wealthy districts tend to focus on computer uses that foster higher order thinking skills (Attewell, 2001). Archer (1998) believes that higher order thinking skills (domínio cognitivo complexo), developed through work involving multiple mental steps such as simulations, and problem solving exercises. Sayers (1995) claims that in the United States, these disparities extend beyond just income level and that female and minority students there are more likely to encounter drill and practice work at school than their white, male counterparts who are likely to be assigned complex problem solving work.

Drill and practice software is very attractive for the educational software industry to develop. Generally, these products are developed to drill very specific content meaning that when students move on to new material in their studies, they will need new software. For the software industry, this means that different products, for example one that drills addition facts and another that drills multiplication facts can be be developed easily. Only the content must be changed, the programming for the overall framework can be re-used. Companies can sell different content packages of drill and practice software as entirely different products. In Brazil, the danger that significant money could could be lost to software packages like these with very short term use, contributed to MEC's decision not to fund software through it's ProInfo program.

Two capabilities of drill and practice software, the potential to provide students with immediate feedback and possibility of individualized instruction, have been regarded as major advantages of this type of educational computing since the 1960s (Suppes reference, incomplete). But even today, few products include sophisticated movement mechanisms for advancing students through material at an individualized pace or provide students with meaninful immediate feedback. Programming drill and practice software to predict possible errors, anticipate underlying misconceptions, and provide supplementary explanations is labor intensive and hidden components like feedback messages and individualized pacing are difficult for purchasers to evaluate and not in high demand in the marketplace (Remold, 1999). While some programs with these features are developed in research settings, they have not been adopted by for profict software developers.

One common problems with the implementation of drill and practice software is related to their use for remedial work rather than their intended use as drills. It is not unusual for school administrators to respond to low scores with widespread remedial work. Only a small number of school reformers have recognized that lowering expectations only makes performance problems worse and repetition and remedial work continue to be the norm. Although the many drill and practice programs are not designed with remedial work in mind, they can be adapted to this kind of use easily. Since drill and practice software does not teach anything, it only improves fluency in existing skills, Archer claims that it can waste valuable school time when overused. Thus despite the evidence that favors drill and practice software use in schools, these programs are used to further ineffective school policies connected to low student expectations and therefore are correlated to lower performance scores in practice.

Unfortunately, forcing low-achieving students and schools into a continuous loop of remedial work in basic skills is not the solution. Only a small number of school reformers have recognized that lowered expectations worsen performance problems. Repetition and remedial work continue to be the norm (Finnman et al., 1996) in the U.S.. While it may not be designed for remedial work, drill and practice software is usually designed in a way that favors this kind of misuse and can be applied to this kind of practice easily. Thus, drill and practice programs are tempting for administrators who must respond to outside pressures to improve school statistics (Natriello, 2001). With the help of new technology students can be forced to repeat the same material more than ever before. Thus despite evidence that drill and practice software is effective under controlled conditions, in the context of already problematic school management policies these programs are used to further ineffective school policies and therefore are correlated to lower performance scores in practice. In Brazil, where a standards-based system determines promotion to the next levels, when schools gain greater access to technology, there is a risk of succumbing to the same pressure to reduce recidivism.

In the Brazilian case students don’t currently risk wasting much time with excessive repetition of remedial material on computers because it is very unusual for students to use computers for more than a few hours each month. The risk is further reduced by the almost complete lack of investment in educational software. But as the government makes plans to support more educational technology, a problem like the one identified in the United States could emerge.

One of the reasons why Brazil is at particular risk of falling into the trap of misuse of drill and practice software is that so many Brazilian students are already doing remedial work at school. The widespread practice of holding students back to repeat grade levels reveals an underlying logic that if a student fails to learn something the first time, the best course of action is to teach it again in exactly the same way. Abuse of drill and practice software could be seen as the computerized version of widespread grade repetition and could easily fit in with the current way of looking at failures. Nevertheless, at the time of this research, drill and practice work was rare.

The kinds of drill and practice programs I encountered in classrooms and presentations have comprised a very small minority of classroom computer time overall. About half of the drill and practice work has involved basic skill software drilling Portuguese, Math, or Typing, often in formats resembling games. The remainder have been simplified drill assignments or on screen quizzes produced by the teachers themselves in order to get students to do the practice with greater enthusiasm. These cases were ususually simple on-screen versions of worksheets in which students filled in blanks or selected one of many choices on screen. Teachers who used basic skills drills often were unsatisfied with their use of computers and looking for alternatives. Their discussion of the value of computers as tools indicate that they would prefer to use computers differently but are limited by preparation time, lack of Internet connections, and their own learning curves.

One teacher explained that even though most of her computer use this year was on a typing drill game, she plans to do more next year. She said that her plans to use technology in more robust ways this year were held up by the time investment involved in other kinds of computer use and the difficulty of using computers differently given heterogeneity of her classroom. Typing and mousing practice is an especially tempting form of drill work in low-income areas because the software is readily available and many teachers believe that a certain level of computer literacy and typing skill is needed in order to be successful with further educational uses of computers. Since low-income students don't have computers at home, typing programs are thought to bring them to a level playing field with their higher-income peers. Like so many other technology uses, teachers who use typing and mousing drills often note that typing and mousing skills are wonderful confidence boosters for students seeking early success with computers.

Challenge and Positive Outlook

Many teachers I spoke to were concerned about self-esteem problems among students from low-income communities. Teachers were concerned that a negative sense of self and community put these students at high risk of holding low expectations for themselves in-school. Several teachers claimed that they beleived their students needed positive experiences in school to ameliorate the hardships they face outside of school. On a national basis, MEC has introduced *temas transversais* (transversal themes) teaching citizenship themes such as respect for community, multiculturalism, respect for the environment and others. These themes have been emphasized in low-income communities as a means of building self-esteem, a positive attitude about school, and a strong sense of belonging to a community, all this while improving relationships between schools and communities.

Student motivation and satisfaction with school is a concern to teachers who know that students may be among the first generation in their family to attend school and recognize the importance of family commitment to schooling. For teachers, computer use can contribute to securing families' commitments to school and relationships to the teachers, students enjoy and feel proud about using computers, and their families often view computers as an important step toward a good job. Unfortunately, these efforts to help students build a positive sense of self worth, interest in, and committment to school often meant providing students with activities in which students were guaranteed to succeed, often with very little challenge.

Teachers who use computers are generally pleased with how the technology use improves student self-esteem, interest in school, and motivation. Some claim that parents are proud when they see evidence that their child has been working with computers. Others claim that school attendance improves on the days when the computer laboratory is scheduled, and many teachers told me that that students demonstrate pride in knowing how to use computers. Some teachers believe that self-esteem benefits alone justify their computer activities as a good use of time, and almost all teachers are able to use computer projects as a reward for hard work in other areas.

During one presentation, a teacher from a municipal primary school addressed these issues directly. Her goal in choosing to work with computers was to increase student self-esteem, and she said that her students felt proud simply for knowing how to properly hold a mouse. Another teacher from a state school reported that her students had similar responses. She said it was difficult for her to describe how happy students were just to be able to type their own names on the screen, or just to get chance to work with Microsoft Paint. Obviously there were opportunities for teachers to make use of these situations in ways that provided students with challenges and opportunities for success, but many teachers were so focused on self-esteem goals that they were satisfied to stop there. This meant that students were often assigned computer time without specific academic goals or challenges.

One conversation between two students writing their names in blank Microsoft Word documents demonstrates how small accomplishments on computers bring them great pride. This conversation took place as one girl explained to the other what the red underline of the Word processor means, that words the computer doesn't recognize get underlined:

> Girl 1: Por exemplo, o meu nome, o computador não conhece
> (For example, my name, the computer doesn't know it)
> Girl 2: Não? seu nome?
> (no? your name?)

> Girl 1: Não conhece. (places hand across her heart and smiles). Agora vai conhecer.
> (it doesn't know it (placing hand across heart). Now it will.)

During one classroom visit, one teacher explained her perspective to me while her students worked on a writing assignment. Students had a source text that they were allowed to use for their assignments but almost all of her students were copying text from a hard copy document into a blank Microsoft Word document, and instead of explaining the difference between getting ideas from source documents and copying text directly, the teacher accepted their work, as though changing font size and color and centering text was enough to make the work their own. She told me about a few of her students. She pointed out a girl who didn't see their parents for several days at a time because of multiple jobs. She talked about another young child who was responsible for even younger siblings, and one who had to visit aunts and uncles asking for meals on a regular basis.

Unfortunately a large number of the students in this teacher's classroom, especially those singled out as having difficult home lives, were failing and most likely would have to repeat the year. Several students would even be repeating for the second time. In this class, nearly one in three students was expected to fail and repeat the first year of school. Almost all of the failures were due to problems with basic literacy skills.

The teacher explained that the school couldn't simply promote students who weren't ready for the next level. There was no point in watering down the requirements at this level because eventually the lack of preparation would catch up to the students. But this policy of maintaining minimum requirements for success stands in striking contradiction to the standards of achievement in the computer classroom where students are praised for even the most limited achievements, such as properly handling a mouse. Their lesson was an opportunity to work on literacy skills but the teacher had allowed them to use this time to learn text formatting and graphic layout instead.

If basic literacy is so important for grade promotion, why isn't it important in the computer lab? This contradiction, between low standards for day to day work, and high standards for grade promotion were reflected in both the classes I observed and the comments of teachers I visited, especially those who worked in low-income schools. Teachers demonstrated great satisfaction with the most minimal sucesses, such as teenaged students typing their own names. But, at the end of the year, their measures for success were much more rigid and they reported that even obedient compliant students who completed the work assigned to them were often held back.

Teachers were left with a difficult choice between challenging students who may not be emotionally prepared for it and setting minimal goals on a daily basis, making grade promotion difficult. In the absence of an effective social services network, teachers don't have the option of doing their jobs without consideration to student's emotional needs. Without just minimizing the challenge students would experience failure and self-doubt along the way without the support that they need for dealing with these experiences. Teacher's only alternative is providing students with an easy escape, watering down daily challenge, despite the strong probability that this lack of challenge in school would make school ineffective in its primary goal.

Computer labs played an important role in this choice. Teachers found that students felt good about their own computer skills and accomplishments. Despite claims that computers were wonderful tools for supporting existing educational goals, the day to day objectives of computer lab activities I observed were more often developed by teachers themselves and related to improving self-esteem and sense of identity, rather than usual curriculum goals. Sometimes teachers were able to connect the self-esteem benefits of computer use with content, allowing them to make use of the satisfaction that students feel with computer use in ways that helped support curricular goals. One teacher reported that students felt inhibited about writing and were often ashamed of their written work. Using Word processors, her students became less inhibited and were more willing to write and show their written work.

In this case, computer use was geared not only toward content goals but specifically to literacy skills, the kinds of skills that teachers reported most often caused grade repetition. (is this in a high- or low-income school?)

Computers for Motivation

Education professionals in Brazil are strongly influenced by the thinking of the constructivist theories of learning. While the theories may not have influenced day to day classroom practice or the way teachers think about the learning process, certain specific notions permeate educators' discussions about teaching and learning. One such notion, derived from thinking about the active role that students must play in constructivist learning, is the idea that student motivation and interest are important predictors of success. Student motivation is highly valued and regarded as a. Teachers are strongly oriented toward motivation as a goal for student work. But often, like self-esteem, motivation overshadows the other educational goals, instead of complementing them or supporting them. When teachers evaluate the success of their approaches, they often evaluate the success of different activities according to student motivation. In the case of computer use, given student's widespread enthusiasm about working with computers, this means that computer activities are likely to be viewed positively regardless of their success in supporting other educational goals.

Teachers reported that nearly all students were interested in working with computers and that some students who were less motivated in other classes were among the most eager to work on computers. Their claims were substantiated by the energy level among students as they waited lined up in corridors outside computer labs or filed in their lines from the classroom to the lab. Several teachers reported that students tended to show better behavior during computer lab visits or that the promise of computer lab time could be used as an incentive for good behavior during regular class time. One computer lab teacher explained to me that when it came time for all teachers to contribute to individualized reports on students who were having discipline problems, her contributions were usually not consistent with those of the other teachers. The students who cause disruptions during the rest of the school day are well behaved when they worked at the computers.

The motivation benefits of educational computing have been researched thoroughly. Evidence indicates shows that lasting benefits can result from efforts to improve student motivation using tools that are intrinsic to the content. On the other hand there is little lasting benefit to extrinsic motivators such as animated characters, music, and other attention grabbers that are not connected to the curriculum content. Malone and Lepper (1987) have shown that motivational tools applied in educational settings are most effective when they are intrinsically related to educational goals. The challenge of providing motivation without distracting students from the content is not new, but with the help of multimedia it has now taken on new proportions. Educational software designers are constantly inventing new ways of getting the attention of their audience but not all multimedia attractions are connected to the educational content.

The primary limitation of motivational tools that are not directly connected to the content is that they are only effective in helping to reach short-term motivational goals. A teacher may have an easier time convincing students to work with the help of enticing animated characters, music, and video images, but unless the multimedia material is actually related to the curriculum content, the software does little to peak student interest in what they are learning. This means that the benefits of the motivational tools may be sufficient to get students to complete particular tasks independently, but it does nothing to develop real motivation to learn.

When Geography students use the Internet to compare information with other students from other regions, they may develop an interest in the region they are studying or regional differences in general. The motivational advantages of their work at the computer may carry over to their motivation and interest in geography in general. But when students work on programs that use animated characters to draw students' attention to unrelated work, they may develop an interest in the characters but are unlikely to improve their motivation in the subject area. As I observed computer uses designed to improve student motivation, I looked for signs that motivational tools were intrinsic to the content and for evidence that teachers were interested in building motivation in ways with potential to bring lasting benefits using motivators that were connected to educational content goals.

Many teachers chose to work with computers completing activities that were identical in content to a similar offline activity. In these cases teachers usually claimed that the advantage to working on the computer was that students were more motivated. Several teachers used multimedia-authoring software to make questionnaire style worksheets for students to complete on screen. In most cases teachers admitted that identical content could be completed on paper but they prefer to assign students work on the computer screen when possible because they are more motivating for students.

Many teachers reported improved attendance rates on days when the computer lab is scheduled. One teacher reported that you could tell if plans to use the computer lab had been announced from the size of the class on any particular day. During one of my visits to a public school, children approached the computer lab teacher during their snack time pleading with her for computer time later that day. Later in the day, on his was to the computer lab, one first year boy happily remarked “estamos indo brincar” (“we’re going to play”).

It is easier for teachers to get students to do school basics such as reading and writting using computers, even when computers aren’t necessary for a particular task. In one school, the class was assigned a book to read but instead of reading the book on paper, the school staff scanned each page of the book and a Powerpoint presentation. Students were asked to read the book on screen. The teacher claimed that it was difficult to get her students to read printed books and believed that she her students were more motivated to read on screen “foi um motivação junto com a realidade deles, uma novidade" ("it was a motivation consistent with their reality"), she said.

There are probably many reasons why students are so interested in using computers. A survey of student applicants to a free after-school computer training program revealed that many had a clear idea of why they wanted to learn to use computers, they were motivated by the promise of future jobs. When asked why he wanted to participate in the program, several students responded in terms of the job market "hoje em dia é difícil arrumar emprego" (nowadays, it's difficult to find a job"). Other students simply stated that they found computers interesting or challenging, or had curiosity about how computers work. Many gave a mixture of both responses, stating that they liked to work on computers and additionally thought it is important for future employability. Several students said they wanted to participate in the free after school program because their families could not afford to pay for computer classes elsewhere, as though the question of why learn to use computers itself was so obvious that they didn't even address it.

Several teachers believed that the multimedia itself has power over students and is more powerful in catching their attention, that computers changed student attitudes toward school and their level of interest. One teacher who makes multimedia style lecture material instead of talking to her students from the front of the classroom explained that "várias mídias podem despertar a atenção do aluno" ("various kinds of media can awaked the attention of a student"), for her the digital media itself drew the attention of children. She believed that by using multimedia tools, she had drawn student attention to the content she had developed. Another teacher who had transferred his worksheet materials into computer forms believed that with multimedia, students took to the work more easily "eles não percebem que eles estão trabalhando" ("they don't realize they are working") and didn't need to be coaxed into it. One teacher found that students really didn't consider work on the computer to be work at all. He said that when students visited the computer lab, he remembered a student saying "que bom! hoje não teve aula" ("how good! today we didn't have class").

Many teachers said that students were attracted to multimedia as a result of their access to television and video games at home, as though their experience has desensitized them to face to face classroom interactions and printed materials. They argued that with increasing access to multimedia outside of school, schools need to use multimedia to motivate students. These teachers often talk about computers as a motivational tool that helps schools compete for student's attention. One teacher made the following remarks about competing for student attention.

> É muito difícil motivar uma crianca somente com aula tradicional... Nosso Brasil tem que dinamizar e expandir. O que é que nos precisamos? …informática." ("It's very difficult to motivate a child with only traditional teaching. Our Brazil needs to become more dynamic and expand. What do we need? computers.")

These teachers viewed the problem of motivation and attention as a product of the fact that students are exposed to high-technology communications and presentation tools outside of schools. Without computers, schools appear antiquated and old-fashioned to students. For these teachers, their work was in competition with the entertainment industry and many believed that computers helped even the playing field and reduce their disadvantage.

Some teachers understood student motivation as based in social factors. They believed that the computer was something with social value and that students enjoyed working with computers because for them computers are a cutting-edge (*moderno*) representation of progress and even social mobility. Teachers told me that students were proud to attend a school with a computer lab, that students recognize that computer skills are valued in society, and that their access to computers was an investment in their futures. Students confirmed that they saw computers and computer skills as holding social value of computers and computer skills in their thinking that computer skills would improve their job prospects.

Teachers have demonstrated that they are usually satisfied with technology use when students have shown higher levels of motivation. Additionally, they value the increased bargaining power they have with students when they can offer computer time in exchange for good behavior. With only a superficial understanding of the importance of student motivation, teachers tend to positively evaluate any work that gets student attention. As evidenced by the abundant use of computers to duplicate worksheets and books, teachers are sometimes satisfied to with improvements to their short term goals such as increasing time on task while doing little to develop genuine student interest.

7. Unequal Goals: Curriculum Integration vs. Technology Education

The use of educational technology to support existing educational goals often helps students develop technology proficiencies. The reverse is not necessarily the case, technology education, instruction aimed explicitely at teaching computer proficiencies, rarely helps students in other curriculum content areas. Because of an emphasis on job preparedness among educators working in low-income communities, children in these schools are more likely to spend time learning to use computers instead of using computers to learn. The use of technology to teach computer skills is encouraged by the separation of computers into computer labs (Lonergan 2000), especially with separate computer teachers who work independently from regular classroom teachers. In these cases, computer class is easily separated from the rest of the curriculum, much like other specialized classes, such as physical education. This leads to lower levels of curriculum integration and makes it difficult to use computers in support of existing curriculum goals.

Schools can easily wind up unintentionally turning computer labs installed for supporting curriculum goals into *aulas de informática* (computer classes) in part because the separate spaces hinder curriculum integration. As a result, computers become a new content area rather than supporting the existing ones. Postman (1995) claims that this is a waste of school time on the grounds that 35 million people have learned to use computers without the benefit of school, he argues, and students can learn to use computers through normal use and with only a small amount of formal instruction. This case seems consistent with Strauss' notion about the advantages of both incidental learning and learning through ill defined tasks (Strauss 1984).

Instruction directly aimed at teaching children to use technology is often supported by arguments that students will need these skills when they enter the workforce, and that technology skills are an important step toward technology literacy. But when computer time is spent learning to use specific software, students loose out on the most important technology literacy lessons. Students whose experience with technology consists primarily of lessons in software use will not learn how to choose the right technology for solving a problem or how to apply technology to new situations.

Many students learn how to produce spreadsheets in Microsoft Excel but it is rare for them to learn why you would want to do so. Students become skilled technicians but lack the kinds of technology proficiencies needed to apply their technology skills to future problems. These students are unprepared for developing new uses of technology and participating in technological innovation as well. Rather than learning how to manipulate computers and use them to meet their needs, these students memorize commands most of which will be obsolete long before the students enter the workforce.

In one example, a teacher lectured a classroom full of students as they sat in front of their screens looking at their names in print. Beginning with a lecture to students who had never used computers before, the teacher introduced a long list of keywords related to computers like central processing unit and binary code but he gave no real explanations of what these words mean. Students following this kind of computer instruction might be able to point out the optical drive on a computer but they would not necessarily have any understanding of it's function, nor would their studies of *informática* help reinforce their studies in any of the other curriculum areas.

Private schools that I visited had more positive experiences combining computer lab work with the existing curriculum. Private school students were more likely employ computers as tools in problem solving activities and learn how computers can be used to serve their needs. Their use of computer lab staff who work with classroom teachers seems to be more effective in terms of curriculum integration than the use of computer teachers who work independently. Private school students use technology with their regular classroom teachers while technology staff helps ensure that the programs run smoothly. This kind of technology use supports efforts to teach content areas and helps students develop more general technology skills.

As Davis and Moore illustrated in “Principles of Stratification” (1945), technical skills fill a function in society by helping society meet its goals but there are limits to the social status of technicians. Since technicians are never involved in planning or in setting goals, they will never enjoy high status. The unofficial policy of offering technology education for low-income students while private school children use educational technology to support learning across the curriculum is problematic. It prepares the former group as technicians with the ensuing limits to social status. While By preparing low-income students for low-status careers, these uses of technology only serve to carry inequalities from one generation to the next. Even in a functional view, inequality of opportunity like this is problematic because it fails to give talented individuals opportunities to excel.

There are additional questions about providing public school instruction on the use of proprietary products as well. It would be unacceptable if schools started offering instruction in the use of Brastemp appliances, for example, but few people complain when students are taught to use Microsoft Office or Netscape Navigator, both proprietary products whose value increases with each trained user. Companies that manage to get new users trained as part of school time have an advantage against their competitors and many companies recognize this by providing materials for software training at low or no cost to public computer centers and schools. Cisco Systems’ Networking Academies are perhaps the largest example of this, the international network of secondary and tertiary vocational education programs uses Cisco materials to train networking professionals proficiencies on Cisco equipment. The public education system pays for Cisco material and all other operational costs of the schools. As of September 2005, there were 114 Cisco Networking Academies in Brazil.

There is some debate on the subject of whether technology skills should be taught explicitly or if technology skills can be developed through the course of content oriented activities that use computers. In the U.S., technology training is often supported by arguments that students will need technology skills when they enter the workforce. Much of the digital divide literature has focused on the use of computers in education for developing job skills. By 2006, 50% of all US jobs are predicted to be in the information technology sector, and today high tech workers make 78% more money than the general working population. Carvin (2000) needs no further justification for advocating in favor of wiring every American classroom, claiming, "we have already recognized the need for better Internet access." This thinking is echoed by many claims that technology jobs will go to the countries that have highly skilled workers (Selwyn et al. 2001). This point was not lost on the U.S. government during Clinton’s administration, which linked resolving the digital divide to corporate anxiety about a nationwide shortage of skilled technology workers (Tetreault 2000). The prospect of a future generation of high technology jobs is not ignored by government officials in Brazil either, many of whom recognize the potential for economic growth if Brazil could play a bigger role in this growing field.

The fact that computer skills may be required in the workforce of the future is not necessarily sufficient justification for providing technology training in the classroom, especially for students who are not expected to enter the workforce for a decade or more. Learning to use specific software tools does not prepare students with technology skills that are more easily transferred to new environments and settings, for example the skill of choosing which technologies might be helpful in addressing a particular problem or the kinds of general computer skills that allow some users to more easily adjust to new programs than others. Students with highly specific technology training will not have experience deciding when to use technology or learning how to select between available technologies and they will not be prepared to apply their technology skills when new standards emerge. As technologies change, students whose technology skills were developed incidentally, through normal computer use, will be better prepared for updating their skills to match changing demands.

According to my field observations, students in high-income areas appear to be more likely to learn computer skills through use, following less structured trial and error techniques that can later be applied to other tools. They employ computers as tools in problem solving activities and learn when computers can he helpful in addressing specific problems. They learn how computers can be used to serve their needs through the use of open ended tools like web browsers for Internet research. These students use technology to learn other subjects and acquire a level of technological literacy that can be more easily transferred to changing technology. Students with this kind of technology training are more likely to be prepared for participation in a technological society in a wide range of roles and for critical and independent thinking in general.

Technology education, it is argued, can reduce social stratification by equalizing the level of access to technology. When children in low income areas are offer technology education programs, this is widely regarded as a step toward social inclusion, providing low-income students with the access to same technology that wealthier children are using and hopefully giving students and advantage in the job market. But the special status associated with access to computer technologies and basic computer literacy cannot be expected to endure for another decade, especially if the expansion of access to computers through computer labs in schools and communities continues. As computers become more widely available, the special status associated with computer use may change.

Technology education programs may have their place in Brazilian public schooling. There are populations of adults or older students involved in job training programs with intentions on immediately entering the workforce. These kinds of students might benefit from technical skills that can be acquired quickly and applied immediately, even when training is so specific that users will have to retrain when technologies change. But for the majority of primary and secondary students, it is probably more approriate to teach general technology skills through normal use. Right now, despite widespread initiatives to increase access to computers in schools, it is still very unclear if computers are to be used to support learning or if they should be regarded as a new content area of their own. Often teachers who lack direction in how to use computers to support the curriculum decide to start with basic technology skills. This begins the transition from computer labs installed for curriculum support to their common use as a place for computer class.

I have seen technology instruction woven within some general classes on self-expression and art. I have also seen computers used to support instruction in general citizenship themes. But integration of the curriculum with activities in the computer labs are rare. The vast majority of the computer lab use that I've observed has involved using the computers to learn computer skills. Even when student use the computer labs to work on assignments related to the usual curriculum, once they begin to work at computers both students and teachers focus most of their attention on technical skills, like how to copy text or make it appear bold, rather than the curriculum content like the substance of the text being manipulated. In many cases, the instruction in technical skills is so highly structured and specific as to have limited value even for other kinds of computer use. A number of logistical issues make it difficult for teachers to use computer labs in ways that support existing curriculum goals, these challenges will be discussed later in this chapter.

Teaching Citizenship

The Ministry of Education has promoted the inclusion of something called *temas transversais* (transverse themes) in public education (Ministério de Educação e do

Desportivo, 1998). These themes have several goals including a number of goals related to citizenship and full active participation in society. They are part of an overall effort to improve critical thinking about citizenship and individual agency. The main areas include ethics, health, sex education, multiculturalism, and work and consumption. *Temas transversais* are intended to be interlaced with topics from the normal curriculum, for example students might learn about recycling and the environment while studying ecosystems as part of the science curriculum. They are different from the other content goals in that teachers are never expected to hold classes focused on the themes, they are meant to be woven within the usual curriculum.

Through the inclusion of the *temas transversais* in the curriculum, students are hoped to begin to recognize injustice and become aware of their means as individuals for taking action against injustice. In addition to the six national *temas transversais* selected by MEC, local education secretaries can select additional themes relevant to their “local reality”. For example, in one school where a number of low-income children worked after school, a teacher created a unit on child labor. Through the inclusion of the themes, students are to develop a greater sense of autonomy in questioning the way things are and proposing changes. *Temas transversais* are not intended to be simply imposed as a set of values handed down to students from teachers, as this goes against the democratic principles that they were designed to support. They are meant to lead to open discussion in schools.

Part of the objective is that students will become better citizens in a democratic society if they start thinking early about social issues. It is similar to the thinking of pre-elementary educators who work on themes like sharing, consideration, and fairness but rather than focusing on the smaller social sphere of the classroom or the school, students in fifth to eighth years of schooling are asked to think about these same questions, while reflecting on issues in the larger society. Many teachers believe that *temas transversais* are important for giving students a stronger sense of community, improving both their sense of self-worth and their participation in the community. Their hope is that work in these areas will reduce community violence and crime, and improve the relationship between the school and the community, especially student's parents.

Temas transversais and other content related to citizenship are often the focus of *informática* classes. Computer lab teachers often seek discrete content material that students can work through in a fixed period of time and that does not need to fit into a fixed sequence of material. This allows them to have flexible schedules and to work sporadically for short periods of time, without the need for continuity. Working with the temas transversais and similar content aimed at helping students develop into full participants in society allows computer lab teachers to plan their work without constant communication with classroom teachers. Working on health education or helping students build a sense of tolerance of differences or a sense of national identity, fits in well with the computer lab schedule and format.

An important component to work on the *temas transversais* is that students form and express their own ideas, and since teachers use the computers for student artwork and students have been reported to write more on the computers, the labs make a sensible setting for work on self expression. These may be among the reasons why the *temas transversais* and other content aimed at fostering citizenship and developing independent thinking skills find their way into the computer labs so often.

In many cases, even though students may read or write short on-screen texts, the *temas transversais* are not really woven into the existing curriculum. They become a separate subject, a structure around which students can learn to use computers. In my observations, temas transversais found their way to the forefront of informatica teachers' planning and evaluation, often in public school settings and low-income settings. Though the Ministry of Education's explicit instructions are to weave these themes within coursework designed to teach the standard curriculum areas, *temas transversais* often seemed to be woven into the teaching of computer skills instead

Sometimes there were efforts to weave temas transversais into the usual content areas but they often seemed to replace the original content. For example, on several occasions I watched students produce independent projects on environmental themes as part of their science classes. But the messages that the students produced in their final projects usually lacked science content, instead students framed their environmental messages in moral terms. Students learned, for example, that it is bad to litter but they don't really work on the ecology that makes littering harmful.

Teachers often addressed the *temas transversais* or related citizenship content directly, and considered them almost exclusively in evaluating the success of their programs. For example, one computer lab teacher decided dedicated an entire year to the concept of *respect,* a theme that had been added locally as part of a school campaign to improve relationships between the school and the community. She worked on this theme using different creative projects like posters, class newspapers, and artwork for different grade levels. Private school teachers, on the other hand, were different from their public school counterparts in that on the whole they showed little direct interest in temas transversais, other than in developing classroom assignments connected current issues with the curriculum and might help get students' attention and foster debate. For example, environmental education programs in private schools were connected to curriculum content in more cohesive ways than similar public-school programs. Students connected their study of ecosystems with class trips or Internet research on local environmental problems.

One of the problems with the work I saw teachers doing with the *temas transversais* is that really including these concepts in the school program requires a level of reading, writing, and critical thinking skills lacking in many of the schools I visited. The stated goals of supporting students in independent thinking about social issues are difficult in environments where basic literacy and oral communication skills are weak. Students who struggle to express simple ideas orally or in writing aren't really able to discuss some of the ideas in the way MEC expects them to. Teachers use art projects and posters as a next best alternative, in which students express their feelings about the subjects at hand but there is little debate and students do not *expor* ideas.

In many cases, their academic level is one in which the teacher's authority is still unquestioned and students are not accustomed to being asked what they think about anything. Students appear be looking for teachers to tell them the right answer to open-ended questions and seem to be unsure of how to approach assignments where they are asked to give their own ideas. In many cases, students end up recycling the teachers ideas or words instead of thinking about what they have to say about a particular topic. Both communication skills and classroom hierarchy make open discussion almost impossible. This is reflected in student creative work on social issues, where students in the same classrooms come up with various versions of the same idea. It appears that many students are so ill equipped to do their own independent thinking and express their own ideas that they copy ideas from one another when teachers provide open-ended assignments. None of this reflects on the importance of the *temas transversais*, but reflects simply on that working with students on drawing their own conclusions and doing independent thinking is often quite challanging for teachers.

When students cannot be assigned to read or do independent research or writing on the *temas transversais* to weave these concepts into their school days, teachers often seek other means for them to develop and express their own ideas, often in the form of creative projects. It is not uncommon to find groups of students assigned to think about social justice issues and expressing their ideas through computer drawings. One teacher, who was unusually successful in linking her classroom work on Greek mythology with her computer lab work on the theme of problems affecting the local community, had students design cartoon artwork of characters in mythology facing today's problems. Students came up with creative analogies, one replaced the Minotaur from his mythology studies with the Pitt Bull dogs they fear in their neighborhoods, and another drew a poster of an unemployed Hermes, whose services are no longer needed thanks to email. But even in this classroom, where a highly creative teacher was able to link temas transversais with her curriculum and the use of computers, the majority of students were unable to come up with their own ideas about local problems and express them, even in drawings. Thus for every student who developed clever and original commentaries about social problems, there were several copies from students who couldn’t or didn’t come up with an idea of their own.

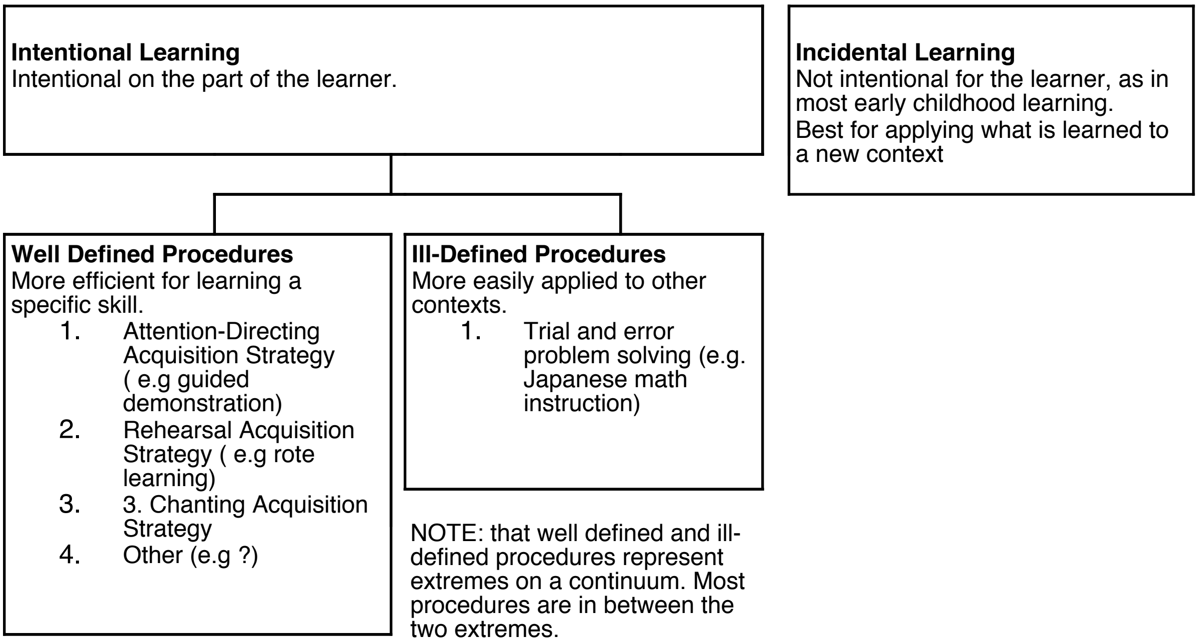
The decision to use the computer labs for teaching citizenship concepts may have been a simple question of timing. The *temas transversais* were first drafted by MEC in 1998 meaning that their proliferation throughout the curriculum was timed with the introduction of the first computers in many schools. Schools were presented with both the national *Temas Transversais* and a policy favorable to developing locally relevant themes at exactly the time when their new computer labs were installed and awaiting curriculum content for their use. The choice is problematic however in that both the *temas transversais* and the computers were introduced with the expectation of being woven within the normal curriculum. Use of computer labs for working on temas transversais has in many cases resulted in neither computer use nor discussions of the temas transversais being integrated with the regular curriculum.

Curriculum Integration and Incidental Learning

Strauss' (1984) taxonomy of different forms of education for cross cultural comparison places, as the highest level of differentiation between educational forms, the distinction between intentional and incidental learning. For Strauss these represent opposite extremes in comparing different forms of education cross culturally. Intentional learning is a situation in which the learner knows his or her intention or objective is to learn a certain thing. Incidental learning is learning that takes place without deliberate choice on the part of the learner. Thus according to Strauss' taxonomy, a group of students learning to use word processing software while working on writing assignments and another group involved in the apparently similar activity of learning word processing through explicit instruction actually represent completely different kinds of learning. Strauss shows that intentional learning results in less flexibility in transferring what is learned to difference activities. Since technology will likely change before today's primary school students enter the workforce, there value of intentional technology education programs are questionable even in cases where work force preparation is the primary goal. This way of categorizing teaching and learning is valuable in a discussion of computer use in schools, especially as it can help us make predictions about what the strengths and weaknesses of different types of computer use might be.

Traditionally social scientists have categorized learning processes into the two major categories of formal and informal education. Research guided by the formal vs. informal distinction compares schooled (formally educated) and unschooled (informally educated) children, but formally educated children always come out ahead. The label "informal education", according to Strauss is limited by cultural bias because there is much formal education throughout the world that does not look like western schooling. Strauss argues that a taxonomy allowing for better cross-cultural comparison will allow social scientists to learn more about teaching and learning. Strauss' taxonomy of learning processes begins with the two major categories of intentional and incidental learning at opposite extremes and categorizes forms of learning "by the cognitive processes they tap". She further distinguishes between well-defined and ill-defined procedure as sub-categories of intentional learning. Figure 3 shows a main outline of forms of teaching and learning according to Strauss' taxonomy.

Figure 3: Overview of Strauss' Taxonomy of Learning Processes in Different Forms of Education



SOURCE: STRAUSS, C. (1984). Beyond "Formal" versus "Informal" Education: Uses of Psychological Theory in Anthropological Research. Ethos, 12(3), 195-22.

The distinction between intentional and incidental learning is determined by the learners, and not by the teacher's point of view. Educational games and social skills building during the school day are therefore usually considered examples of incidental learning even if the activities were designed by adults hoping to acheive specific learning goals. Intentional learning happens when the learner recognizes that he or she is supposed to be learning. With few exceptions, school learning is designed to be intentional learning although incidental learning may take place at the same time as well. Incidental learning happens at all ages, but children must develop skills to learn intentionally with help (i.e. selecting learning strategies), and it takes even more time to develop the ability to formulate independent intentional learning strategies.

Comparing the strengths of the main categories of learning, Strauss argues that incidental and intentional learning are equally effective for recall, assuming that incidental task involves meaningful contact with the material. She also shows that integration (i.e., applying what is learned to a new context) is better in incidental learning because learners compartmentalize content during intentional learning. Well defined procedures are defined by Strauss where given information, stated goals, procedures, and the goal state are specified while ill defined procedures are assignments where students must figure things out on their own. Most intentional learning activities fall somewhere on a continuum between the two.

Strauss argues that well-defined procedures are more efficient for learning a specific skill while ill-defined learning can be more easily applied to other contexts. She cites an example from fieldwork among different groups of Maya weavers with different teaching and learning styles. The weavers trained with less structure tends to make innovative and creative designs while the ones who learn with more structure are only able to repeat the designs of their mothers, grandmothers, etc. Another example shows that Japanese students who learn math through open-ended story problems are more successful at applying their knowledge in new situations than American students who tend to learn math through highly structured assignments.

The differences between well and ill defined learning processes was noticeable in my classroom observations. In one first *serie* class that I observed, the teacher assigned an art activity of coloring an on screen picture of Santa Clause. Students clicked on a color sample and then on an area of the outline drawing of Santa. The selected region then changed color. While working on this well-defined task, discussions between students were limited, students talked about which color belonged in each area of the picture, reminding each other which parts of Santa's costume are red and which parts are white. Other than some specific skills of working with Microsoft Paint and maneuvering a mouse, it was not clear what more general concepts and skills students were working on. There were no clear opportunities for drawing on material learned in the assignment to complete other tasks.

When students completed their Santas, they were allowed to do free drawing in Paint. Through this less structured activity with ill-defined end states a much richer discussion emerged. Students noticed that shapes could be fit inside each other, that when an object was the same color as its background it became invisible, and several pairs explored color mixing, noting that the overlapping area of a blue shape with a yellow shape would appear green. With less structure and more open ended goals, students explored the software and uncovered learning opportunities with more general scope. Lessons learned from this experience may be more easily applied to different context. Less structured activities at the computer with less explicit computer skills goals leads to learning that will be more easily applied to new contexts.

When computer use is integrated with the curriculum as a form of incidental *informatica* learning, students learn computer skills while working on projects related to their curriculum area, exploring the potential of computers through use. The most common example from my fieldwork of the distinction between this approach and an intentional approach to teaching *informativa* is the two commong approaches to teaching word processing. Some teachers decided to instruct students in a word processing program, holding classes on word processing skills using texts that students copied from other sources. This is an example of an intentional learning program. In cases where the only goal is to gain familiarity with a specific software package, this would be an appropriate approach. Teachers aiming to help students develop more general computer literacy might choose to include word processing instruction in a writing assignment helping students develop computer skills though less structured tasks such that they can apply what they've learned to new software as it emerges.

In my observations, teachers often set out to do the latter, incorporate computer work with the curriculum and leave the technical work but struggled to avoid giving all of their attention to the computers. Teachers began computer assignments with research, writing, or drawing tasks in mind and gave initial instructions that tied the computer work with curriculum topics. But as soon as students began working on the computers the content seemed to disappear. Students only asked questions related to the functioning of the computer and those teachers who tried hard a hard time redirecting student attention to the content of the material they were reading or writing. Often students preferred to wait for teacher instruction rather than to try to solve simple problems by trial and error. Teachers never gave students specific instructions allowing them to explore the different options of the word processor rather than wait for instructions at every step so even assignments that appeared to involve ill-defined procedures at the beginning turned out to be highly structured as they were carried out.

Sometimes teachers had difficulty giving students general instructions without well defined procedures because students lacked the background skills and concepts for exploring computers independently. During one computer class, students had difficulty navigating through the Windows Start menu because they had difficulty with the concepts related to the categories and subcategories. Students were given instructions to click on Start, and then Programs, Utilities, and finally Paint to select the MS Paint program but they followed these instructions by rote memorization. Students didn't understand the general concepts of Programs or Utilities, nor the even more basic idea that the route they follow with their cursor on the screen represents categories and sub-categories.

Through repeatedly accessing the Paint program in the Start menu with the help of detailed instructions students may eventually learn how to launch Paint. But these skills will do little to help the children understand how to do other things with the computer or work with file heirarchies for storing and accessing data. Teachers may have preferred that students work more independently, for example by giving them more general instructions about what might be found in the Programs menu and how files are organized, but these concepts were often well beyond student's vocabularies and conprehension levels.

Exploratory use of computers with open ended assignments that are tied to curriculum content areas were uncommon in my field work. Students were almost always given very specific instructions when using computers. During one first meeting of an *informática* class, children who had never used computers before were instructed in turning on the computers and then forced to wait through a vocabulary lesson on English words used in the computer field while they sat in front of the computers. They were no allowed explore the computer while listening to the lecture, they were not even allowed to touch the mouse of keyboard. After the lecture, students were led through step by stap activities covering some basic Windows function.

For young children with rapidly changing technology, offering computer classes aimed at teaching specific computer skills in highly structured ways is probably not a good use of time or resources. Whether the best alternative is to forgo technology education entirely and focus on using technology for supporting the curriculum or focus on incidental technology education programs where students use technology as a tool in their own work, is not clear but either scenario would result in similar programs. For most students, working more independently with technology and gaining experience exploring the computer, would require greater reading and writing skills, students who lack written communication skills aren't fully prepared to interact with operating systems like Windows and Linux that rely heavily on text based information. Technology education would be improved if technology could be used as a tool by students working to solve problems or complete projects. But this kind of education is only possible if students were better prepared to work with computers indepenently.

Challenges to Curriculum Integration

Curriculum integration is difficult for teachers to implement for a number of reasons such as lack of preparation time, separation of computer labs from the classrooms both physically and in terms of scheduling and staffing, and lack of educational materials and connectivity. But probably one of the greatest obstacles to curriculum integration is the fact that despite the nearly widespread thinking that technology is best used as a learning tool supporting existing curriculum goals, most of the examples teachers have as they explore their options with technology use, are of computer classes designed to teach specific computer skills. There is a shortage of role models and example lessons for teachers to gain familiarity with and experiment with uses of computers that are tied with the curriculum.

It is interesting to note the conflict on this issue between policy and practice. Almost all policy papers and applications for funding for classrooms technologies require elaboration of a proposal that includes curriculum integration with technology use. They require that technology be used a tool to reach curricular goals. But as I described earlier, the office (*secretaria)* for media and technology in education at MEC (now the secretary for media and technology in education) focuses almost entirely on technology skill building with very little practical support on a national level for teachers interested in working with computers to support their work. This support is, however, available through the network of ProInfo offices.

The lack of clear goals on a policy level is reflected throughout the hierarchy and can be seen at the classroom level, possibly as a result of the contradictory goals at the planning stages concerning decisions to emphasize technology use for technology skill building or for meeting other curricular goals. Teachers and school staff talk about using technology to support the curriculum and teaching technology skills using the two concepts interchangeably as though they were closely related activities. A clear distinction between the two is not always made by teachers or other school staff. Students will almost always think of the time they spend in the computer lab as aula de *infomática* and clearly see the computers as a school subject.

Almost all of the computer uses I have observed have either involved intentional technology instruction or technology use for research and creative activities. Teachers I spoke to almost always expressed a preference for using computers as tools rather than prodiving direct technology instruction, but they have difficulty with true curriculum integration. One compromise for teachers who had trouble integrating computer lab time with the curriculum was the use of computers for creative work such as computer drawing.

This kind of creative work is not part of the official curriculum but in many cases teachers claim that art and creative work has been missing int he past because of a lack of materials. Thus their use of computers to introduce art education is a way for them to use the technology to support their existing educational goals, if not the formal curriculum. Creative uses of computers were the most common examples of computer use that was not oriented primarily toward teaching specific computer skills.

Computer time is very much separate from the time that teachers spend on other things. Students are generally given very specific projects for completion on the computer and it must be possible to finish the projects within a single period. Teachers rarely know when a particular group of students will return to the lab again and it is therefore difficult for them to plan activities for multiple class periods. Teachers struggle to use the computers in ways that fit in with the schedules expecially since it is difficult for them to plan on what children will be doing in the classrooms the next time they visit the labs. They struggle to come up with assignments that can be completed independently in a single class period and many students end up finishing before the period has ended. Usually students who finish their assigned task are allowed to play video games when they finish. In many cases this means that a large number of students are playing non-educational games for up to half of the class period.

All classes I observed in public schools involved doing activities in the computer lab that were relatively separated from the rest of school activities. I never saw teachers continue activities over more than a single class period and in most cases curriculum links were weakly defined. I did sometimes see teachers refer to content in other classes but the closest any public school teachers came to really following through with classroom work during computer lab time was the use of computers for onscreen reading of a scanned book or the occasional group writing assignment. This is an area that several teachers admitted they would like to improve on. Many teachers had reluctantly accepted computer classes that were not tied to the curriculum because of an inability to implement such programs in their environments with their levels of training.

For teachers to develop computer uses that support existing curriculum goals, computer time must be treated as a part of the normal school day, scheduled consistently, and planned in advance. Teachers they must work with computers on a consistent schedule so that computer assignments can be matched to regular classroom work and regular classroom. Ideally, teachers should accompany their students during comptuer lab visits with support for setting up computers and selecting technology tools. The approach that is common in private schools, in which support staff help teachers work with students in the computer labs seems to be more effective in than separate computer teachers in supporting curriculum integration.

8. Conclusions

In many respects, educational technology is similar to other innovations in education in terms of its relationship with educational equity is. Schools interested in improving equality find that it is easier to improve access to technology itself and much more difficult to bring about changes that reduce the impact of unequal home conditions or unequal teacher practices. In his introductory description of the experiences of programs aimed at improving educational equality in the Americas, Reimers reports that results have been similar with attempts to improve educational equity through low technology means.

> In discusssing existing policies, implementation emerges as a significant topic to explain why impact appears to be so modest. The limited evidence that exists suggests that it is easier to reduce some kinds of inequalities (in access, in educational inputs) than others (in teacher practices, in learning outcomes). This knowledge is valuable for suggesting what can be reasonable expected from interventions, such as the ones recently tried in Latin America, as well as which areas need further research-based knowledge. (Reimers, 2000)

Even though we see great inequality in Brazil between access to technology in private, state, and municipal schools, programs are underway to improve equality of access and they report improvements in this area each year. Low-income children are still much less likely to use computer technology in Brazilian schools than their wealthier counterparts but access levels are increasing everywhere and if it remains a policy priority, it is possible to imagine high levels of access in the forseeable future.

Despite increasing levels of access in low-income areas, it is not a certainty that increased use of technology in schools will contribute to increased educational equality. The greatest challenges to equity, in terms of technology use, are likely to be the same as those that present themselves in education in general. It may be relatively easy to ensure that all students someday have access to computers in schools, regardless of their backgrounds (note: just family background here). It will most likely be much more difficult to ensure that the computers are used in equally effective ways for all students. Likewise, using technology as a tool for overcoming existing inequalities such as teacher qualification levels and institutional bias, especially as they relate to technology use has been difficult, even in situations where investment in technology and commitment to its use has been demonstrated.

In the Brazilian case, the problem of retention may be a major contributor to inequality of educational opportunity. Though access to basic education, as mentioned earlier, is nearly universal at the earliest levels, high retention rates have meant that only a limited number of students are able to move through the education system to reach the higher levels. Adding new technologies to schools with high retention rates could lead technology becoming integrated into these existing problems. Schools could use technology in ways that detract from the time available for developing the basic skills upon which grade promotion depends, for example by using school time for excessive remedial work without introducing new material. Alternatively, technology could be used in ways that have been shown the contribute to basic literacy skills with the potential to reduce retention rates. The decisions about how technology will be used may be as important as decisions about which technologies to introduce in predicting the impact of technology on equality outcomes.

Institutional bias plays a role in how computers are used. Schools serving low income communities have sets of expectations of what their students are capable of that are based heavily on the conditions of social inequality that students come from. Concerns about student and family commitment to education may shape decisions to focus heavily on motivational goals and on the products of student work in low income communities rather than concentrating on challenging students or on effective learning processes. Bias influence the choices that teachers make about technology use, often selecting less challenging activities for students of low-income backgrounds or using technology to draw focus away from basic literacy skills, toward less transferrable skills such as word processing with attention to the professional appearance (rather than the content) of student work. Goals for students in low-income areas are more likely to be influenced by the needs of the labor market since these students areless likely to attend college and most likely to wish to enter the labor force immediately after basic education, assumptions that teachers and students make about what students need to learn vary greatly between high and low income communities. These differences have an impact on how computers are used and the benefits they offer students.

It seems that the easiest way to add computers to basic education is to teach *informática* classes, this is especially popular in low-income communities where students are least likely to have computers at home or have the resources for attending paid computer classes. Even teachers whose aim to use technology to support existing curriculum goals often find themselves teaching computer skills in the beginning as they develop the skills necessary for working in the computer labs. The question of when it is appropriate to move away from a focus on basic literacy skills and begin devoting school time to technology training is a complicated one but regardless of the value of *informática* classes, it is clear that strong reading and writing skills are needed for true computer literacy. It is also clear that learning computer skills through use is as effective as specific software training in developing specific computer skills while offering the added advantage of being more easily transferable to new technologies as they emerge.

Teachers resort to offering *informática* classes even when they would prefer to integrate their computer lab use with the existing curriculum. In many cases they do this because integrating computer use with the curriculum is extremely difficult. Not only must teachers work with and often develop new materials for use in the computer labs but they must also learn to work outside of the lecture recitation format to which they are accustomed, learning how to manage classrooms and oversee learning activities outside of their usual routine. By turning the computer into the object of the lesson rather than a learning tool, the teacher maintains much of his or her usual role as lecturer and information source in the computer lab and manages to bring students to the computer lab with as little disruption from the usual school routines as possible.

The current situation, where computers are distributed to schools to support existing educational while the computers, in practice, are often used to teaching technology skills, has contributed to a situation in which teachers are on their own coming up with approaches to accomplish either goal. The discrepancy between discourse and practice on this single issue, with planners and funding agencies demanding the use of computers to support existing educational goals while classroom practice tends to emphasize teaching computer skills is just one example of how decisions about getting computers to schools are handled independently from decisions about how they will be used. Centralized planning is in place to get computers to schools but once the hardware is installed school directors and teachers are very much on their own to come up with uses for computer labs.

The teachers and students I observed and interviewed were very much in a transitional phase, most of them had less than two years of experience working with computers. While it is possible to draw conclusions about their current work with computers, it may be that many of the characteristics of computer use that I have observed are actually characteristics of this transition. The small number of teachers I met who have been using computers for longer than two years demonstrated that some forms of computer use that fit more easily with the school context can be stepping stones as teachers develop confidence working with computers. Future research in this area, especially in studying vetran teachers who were early sucessful adopters would help shed some light on how optimistic we can be about the future of technology use in schools following the present course.

Though it is widely accepted that traditional teaching tools like books don’t function independently of their environment, without substantial impact of student backgrounds and teacher effectiveness, it is easy to overlook the impact of context in the case of computer technologies in schools. In part this is because computer technology, in principle, can minimize the influence of certain factors that contribute to inequality such as geographic isolation. But this capacity is limited: computer technology does little to level the playing field between students with different literacy levels when they enter school and it seems that some factors that contribute to inequality, such as teacher quality, can have an even greater impact in classrooms that use computers. When we try to understand the doors that technology opens, for example access to research material for children who don't live near a library, we must understand that there are limitations to the impact of this change, Internet resources are outside of the reading level of much of the population.

Computers are being introduced in schools at the same time as schools have turned their attention increasingly toward the problem of labor force preparation and job skills. Public attention to education focuses on economic prospects for the future. For students and families, education is an opportunity for improving competitiveness in the labor force of the future while for the country as a whole, it is hoped that investment in education will lead to economic growth, making Brazil more competitive internationally. The positive experiences coming from some computer training programs for unemployed adults seem to indicate that certain computer skills do have a value in today's job market and make computer training appealing for educators and students alike.

Computers fit well with this market oriented approach to education because there is an expectation that computer skills are immediately valuable in the labor force. Even children as young as 11 years believe that their use of computers in school will eventually help them to find better jobs. But technology training aimed at meeting the unpredictable demands of a future job market are a more complicated matter than programs for adults entering the workforce today. Though a strong basic education may not be necessary for carrying out some specific computer tasks, the flexibility needed to respond to a changing IT labor market requires strong literacy skills and strategies for independent learning. Even with goals set specifically on workforce preparation, it may not be appropriate to teach specific computer skills to young students without helping them gain the independence to develop further skills in the future.

One characteristic of Brazilian education that may impact technology use and equity, is the day to day classroom practice focusing on fact retention and relying on lecture/recitation teaching. The changes that technology brings about in the classroom dynamics in schools are a radical departure from the most common classroom practices in Brazil. This is an area where computers have the potential of being catalysts for change, forcing teachers and administrators to seek alternative teaching methods that are a better match for computer use and bringing about dramatic changes in the role of the teacher and the importance of memorization. But so far the reliance on lecture recitation is also a tendency that strongly limits the ways computers are used, encouraging teachers to hold computer classes with highly structured activities and memorizable content or discouraging teachers, whose prior experience don't prepare them well for the changes computer can bring, from using computers at all.

As public agencies continue to focus on increasing computer use as a means of improving equality in education, greater attention to the role of social context on the way technology is used becomes key to understanding the real impact of technology. Sociologists of education in the United States and Great Britain have uncovered a set of areas where the relationship between context and the way technology is used may constrain the power of technology to facilitate social change but many of these factors have different levels of importance in the Brazilian education system. In Brazil it is important to be aware of local realities, especially those related to everyday classroom practices, inequalities of educational goals, and existing school inequalities, in considering how technology use and educational equality interact.

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