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Mistaking Computers for Technology: Technology Literacy and the Digital Divide

TEL AMIEL
University of Georgia
Athens, GA USA
tamiel@uga.edu

No other information and communication technology has swept the globe with greater speed than the Internet, having the potential to promote vast social, economic, and political transformations. As new technologies become available the pattern of adoption and diffusion creates disparities in access and ownership. At the most basic this gap is termed the digital divide and its most common antidote has been the computer. To close this divide, sizeable capital has been spent on deploying computer integration into public schools around the globe. This article uses the case of Brazil to analyze the role of computers in schools as tools to close the digital divide and promote pedagogical change. Massive computer integration will not be the cure for to the digital gap. As new technological tools continue to develop, new gaps will arise. An approach focusing on technology literacy is the only sustainable way to avoid present and future technological divides.

The growth of the Internet over the past decade has affected the way people in wealthy nations communicate, interact, and gather information. Anyone who has lived through the 1990s can testify to the swiftness with which this network of computers has changed the very essence of the way we live. It is estimated that more than 450 million people use the Internet (Nielsen Netratings, 2004b). The growth rate of the World Wide Web (WWW or Web) has been staggering, reaching more than 50 million users in less than five years—radio took 38 years, broadcast television needed 16 years, and cable television took 10 years to reach the same number of users world-wide (ANATEL, 2000b).

Though most people in developed nations see the television set as low-cost technology, and even as a commodity, a large contingent of citizens in poorer countries still do not own a television set. Roughly 20 televisions exist for every 100 Brazilians. Compare this to almost 62 in Germany, and 78 in the United States (Central Intelligence Agency, 2002; IBGE, 2000a). If a device such as the television set (and its associated media), over 50 years old, has failed to reach critical mass in many countries around the world, what is the outlook for this century's new medium, the Internet? If developed nations such as the United States are concerned about unequal access to new technologies, how do developing countries grapple with the problem of inequality?

This article analyzes Brazil as an illustration of the digital divide in third-world countries, criticizing educational technologies and the integration of computers into schools as resolutions to the digital divide. It is ultimately argued that the integration of computing technologies into the educational system is not an effective way to promote equality. It is naïve to expect that yet another "new" tool will be able to stop the cycle of exclusion promoted by new technological tools. Radio, television, and cable were once new, and were promoted as great educational equalizers. Making use of more multifaceted definitions of the digital divide, an argument is made for the conceptualization of technological divides as a factor of technology literacy, instead of access or use of technological tools. As such, educators have a crucial role to play in addressing the digital divide.

The article begins with an introduction and a conceptualization of the *digital divide*. Next, an analysis of the Brazilian digital divide is presented, with an overview of policies that have targeted the gap. Finally, an argument is made in favor of pedagogical change, leading to technologically literate individuals. A technology literacy agenda, as opposed to the frantic integration of computers into the classroom, can provide effective, long-term solutions to the digital divide. This entails making use of all available technological tools to promote a sustainable and valid tactic in achieving educational reform and closing the digital gap. It is argued that students should not need to wait for a computer in order to gain entry into the world of the digitally literate.

EDUCATIONAL TECHNOLOGIES

Substantial effort and money has been paid to promoting the integration of the personal computer and Internet access into schools around the globe. Learning how to use a computer has been seen as an effective way to bridge the digital divide, producing computer-savvy students and future workers prepared to enter the highly computerized workforce. Technology integration has also been promoted as a key to the shift towards constructivist pedagogy in the classroom (for a worldwide review, see Pelgrum, 2001).

A comprehensive survey of technology integration in K-12 classrooms around the United States demonstrated that though the number of computers in classrooms was sizeable, approximately 5.8 million computers in 1995, the equipment was generally underused. Though many expected constructivist pedagogical principles to reign, teachers tended to use the computer as an instructivist tool. Teachers were forced to use computers in specific laboratories that were not conducive to partnering technologies with specific subjects. Computers were found to be obsolete—49% were considered outdated and unable to run appropriate software. Moreover, computers were used mostly to teach and learn about applications, such as word processing, rather than a tool for other subjects (Office of Technology Assessment, 1995). This report is over 10 years old, but teachers and administrators continue to mistake computers for technology. Since then, American policy towards educational technologies has called for every student to have access to a computer, at the risk being left behind (Department of Education, 1996, 2000). It is necessary to expand the understanding of technological devices to include other tools besides the computer, though this has not been the case.

Reports on the state of technology in schools continues to demonstrate that even in the most sophisticated and rich parts of the nation, computers have been appallingly oversold and underused in schools (Cuban, 2001; Oppenheimer, 1997, 2003). The pedagogical promises simply have not been fulfilled,

> …nor has a technological revolution in teaching and learning occurred in the vast majority of American classrooms. Teachers have been infrequent and limited users of the new technologies for classroom instruction. If anything, in the midst of the swift spread of computers and the Internet to all facets of American life, "e-learning" in public schools has turned out to be word processing and Internet searches. (Cuban, 2001, p. 178)

In relationship to the digital divide, some contend that "the key is education. Providing schools with the [sic] Internet access is a necessary first step" (Sipior, Ward, & Marzec, 2001). This truism, evidenced in feverish purchase of computer technologies for education around the globe, is misguided. As Light (2001) demonstrated, similar rhetoric surrounded the educational potential of cable television in closing racial and urban/rural gaps, to no end. Though most schools in the United States now have access to the Internet, the issue of digital inequality has not disappeared.

The personal computer and the Internet have become important tools within the information age. Nevertheless, the significance of the personal computer in bridging the digital divide has been touted too highly. While the *potential* exists for the computer to facilitate pedagogical change and diminishing the access gap, the path to success is at best, unclear.

The computer is simply not needed to promote pedagogical change towards a student-centered classroom, collaboration, problem-based learning, and other developments in pedagogy (for an overview of emerging theories, see Orey, 2002). Few seem to question the computer as a tool of choice to help close the digital divide, or to provide every citizen with the necessary skills to live in the 21st century. The solution to this problem does not lie in devices such as the computer, but increased technology literacy.

IT IS NOT THE COMPUTER THAT DIVIDES US

Schools should not depend on expensive and rapidly aging computer equipment to modify teaching and learning. Governments should not expect computer access to bridge the digital divide—the gap is far more complex than it seems. For one, it is concerned with the implementation of a technology infrastructure. Second, it deals with the ability to access these technologies, including the capability to make successful use of new technologies in a social and cultural context. Some have readily dismissed the issue of access as nothing more than an economic gap that will soon be closed by progressively cheaper technologies (Morrisett, 2001). Others argue that the digital divide is similar to many other economic or social gaps (Compaine, 2001). While the issue of access to hardware has the potential to swiftly fade-away in richer societies, research indicates otherwise. While billions of dollars have been invested in the United States to equip schools with computers, access to th˜ese machines remains scarce so teachers and students make little use of the available equipment (Dijk & Hacker, 2003; Martin, 2003; Norris, Sullvian, Poirot, & Soloway, 2003). Considering the rapidly decaying nature of the computer and its applications, not even heavy continuous funding has been able to provide access to all students, and equally equip all schools and classes with computers. As such, access to the computer cannot be promoted as the great equalizer.

Recognizing the existence of a digital divide does not imply that every citizen must be given the opportunity to use the Internet in an attempt to close the gap between the "haves" and "have nots" (Kenny, 2003). This binary differentiation has come under contention, and more comprehensive definitions of the digital divide have arisen (Baker, 2001; Dijk & Hacker, 2003; Hargittai, 2002; Warschauer, 2003a, 2003b). Warschauer (2002) has proposed a more accurate and intricate definition of the digital divide that is examined from the perspective of *technologies for social inclusion*, emphasizing the need to focus on the social and cultural aspects of the implementation of technology in society. This revised notion is a function of four variables: (a) physical resources, such as computers and other hardware; (b) digital resources or materials available online, including software; (c) human resources, including education and literacy; and (d) social resources, that include community, social, and institutional structures.

While providing access to hardware and software resources remains important, the real digital divide remains at the level of understanding. What has kept large sections of the population on the unfortunate side of every technological divide is an inability to comprehend the significance and role of these tools in their life and community. This in turn, leads to citizens who are unable to make choices regarding technological infusion in their communities and schools. When the next generation of technologies arrives (as the television and the computer once did) will another generation of technologically "unfortunate" citizens be created? Even if access were to be provided to all, there is crucial need to understand the complex nature of technology before making use of it effectively (Kling, 2000). As Brendan Lyut (2004) has thoughtfully suggested, if these technologies are to truly make a difference then we must:

> …re–construct the nature of the digital divide as a policy issue, to frame it as more than access, skills, or even content, but rather as part of a

> challenge to the global order itself so that solutions to the problem consciously tilt the balance of benefits away from those already privileged (information capital, the state, and the development industry) towards those currently excluded from not only new information and communication technology, but the basic requirements of a dignified human existence.

The educational community can address the technological divide by promoting a sustainable agenda emphasizing technology literacy; an agenda that does not depend on the computer, but can benefit from it if available. Educational technology and technology education curricula diverge in specifics, but invariably promote, among other things, what is broadly termed *technology literacy* (Petrina, 2003). Rasinen (2003), demonstrated that the same emphasis on technology literacy holds when examining the curricula of a number of different countries. A technology literacy agenda focuses on educating “a person that understands—with increasing sophistication—what technology is, how it is created, how it shapes society and in turn is shaped by society” (ITEA, 2000). This includes vast areas of study such as the cultural, social, economic, and political effects of technology and the influence of technology in history, engineering design, information and communication, among others (ISTE, 2003; ITEA, 2000; Petrina, 2003). The concept of technology literacy clearly aligns with a program of technologies for social inclusion (Warschauer, 2002), providing a set of guidelines for schools and educators—critical agents of change in regards to the digital divide.

Developing countries can avoid the pitfalls experienced by more seasoned national technology integration programs, such as that of the United States—but has this happened? In order to provide a context for the framework of *technologies for social inclusion* and *technology literacy*, the case of Brazil is analyzed. The case of Brazil is especially insightful because it exhibits a clear divide in terms of *access*, and *conditions for access* by the general population; moreover, the government has provided substantial resources for computer integration as a way to bridge the digital gap and to promote pedagogical change. A number of steps have been taken to build a strong and cohesive process of technology integration. A short analysis of the Brazilian digital divide, the process of computer integration into schools, and Brazilian educational policy, suggests that we must rethink the use of the computer the solution to our social and educational ills. Finally, a framework for technology literacy is proposed, that deemphasizes the importance of the computer in promoting digital equity.

THE NATURE OF THE DIVIDE

Brazil has exhibited substantial growth in the implementation of its communication technology infrastructure. One such indicator is the number of Internet hosts and Internet users. As of August 2004, Brazil held 3,163.349 hosts, the largest number of hosts in Latin America, and 8th largest worldwide (Network Wizards, 2004). The number of Internet users has grown to more than 19 million (from a total population of approximately 170 million) in June 2004 (Nielsen Netratings, 2004a). Though statistics indicate a substantial number of people use the Internet, availability is still considerably segregated. The National Telecommunications and Information Administration (NTIA) points to income and education as two important variables that help us define the digitally deprived (McConnaughey & Lader, 1997; Robinson, DiMaggio, & Hargittai, 2003). These factors will help provide an overview of the Brazilian digital divide. This overview is not meant to describe all the facets of social and economic inequality. Instead, it is meant to provide a glimpse at some of the disparities that exist and are being targeted in part by educational reform and educational technologies.

Economic Factors

A historically uneven distribution of telephone service by the national telephone monopoly (Telebrás), led by nominal universal access policies, left a sizeable portion of the population without the most basic means to access the Internet. The move towards privatization in the late 1990s provided increased investment and a larger information and communications technology (ICT) infrastructure. The cost of basic telephone service went down roughly 20% from 1994 to 1999, to R$42,00 or US$14.00 per month (conversion henceforth based on R$3.00 per U$1.00, ANATEL, 2000a). However, this apparent low cost is deceiving. A closer look at the difference in purchasing power between people from different geographical locations helps us understand who falls on the unfortunate side of the digital divide.

The Brazilian GDP per capita was approximately R$6.000 (US$2,000) in 2000 (ANATEL, 2000a), which points to a middle-class economy, but masks the extreme income inequality that characterizes the Brazilian economic landscape (Tigre, 2003). The latest census statistics show that the poorest 10% earn approximately R$28.26 (US$9.42) monthly, compared to the richest 10% who make 50 times more, averaging R$1,511.67 (US$503.89) (IBGE, 2000d).

At a regional level, the results are even more noteworthy and show a sharp economic gap between the more rural northern (Rondônia, Acre, Amazonas, Roraima, Pará, Amapá, and Tocantins) and northeastern (Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia) states, as compared to the urban southern (Paraná, Santa Catarina, and Rio Grande do Sul), central (Mato Grosso, Mato Grosso do Sul, Goiás, Distrito Federal), and southeastern (Minas Gerais, Espírito Santo, Rio de Janeiro, and São Paulo) states (Figure 1). This effectively divides the country across a north/south line. Rural population accounts for approximately 30.1% of the 60.6 million people living in the northern and northeastern regions of Brazil, and only 12.1% of the 109 million people living in the more urban southern, central, and southeastern regions (IBGE, 2000b).

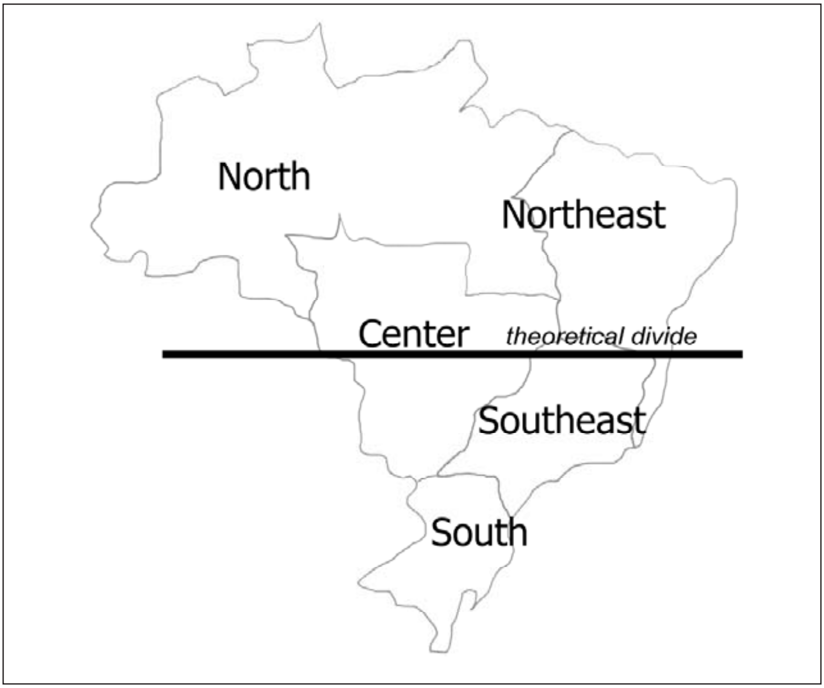

Figure 1. Theoretical geographic digital divide in Brazil

Average income for the poorest 10% in the northeastern states is R$17.48 (US$ 5.83), which is approximately half of that in the same economic group in southern, central, and southeastern states. The difference in income is similar when widening the comparison to the poorest 40%, and is slightly smaller when analyzing the richest 10% (IBGE, 2000d). The data is especially striking when taking into consideration that federal law required a minimum wage of R$151.00 (US$50.33) in 2000 (Banco Central do Brasil, 2000). Though census data suffers from shortcomings, the patterns of inequality are unmistakable. It is clear then, that an economic gap exists between those in southern and northern regions of Brazil, greatly impacting the purchasing power and investment attractiveness of those with lower income and those living in rural areas. Economic and geographical divides help us identify those who have clearly been much slower in benefiting from economic progress.

Education

As Robison, DiMaggio and Hargittai (2003) demonstrated, a person's level of education provides strong indication of how much he or she will benefit from the tools available through the Internet. Literacy data show a wide gap between those in rural and urban areas nationwide, and a clear divide between northern and southern rural citizens. Census data shows that 9.7% of urban citizens and 29% of rural citizens (not including data for rural areas of northern states) of age 15 or older were considered illiterate (IBGE, 2000c). Numbers in both categories have been consistently reduced, but great disparity still exists between rural and urban literacy rates. The regional divide points to a severe disparity in literacy rates between regions of the country. While only incomplete data is available for the northern states, 41% of those in the rural areas of northeastern states, and between 12.4 and 19.4% of those in rural areas of southern, central, and southeastern states were considered illiterate. The gap is reduced but remains large when considering the urban areas in the same regions of the country: 19.1% (northeast), 11.6 (north), and between 6.4 and 9.1% for the remaining regions of the country (IBGE, 2000c).

Illiteracy within these strata of society translates to an inability to use of new technologies that are dependent on basic literacy. The same pattern of inequality exists between rural and urban schools in terms of computer availability and Internet access. A 2000 census of *ensino médio* (high schools) by the *Ministério da Educação* (Ministry of Education; MEC) and the *Instituto Nacional de Estudos e Pesquisas Educacionais* (National Institute of Educational Research; INEP) shows that nationally, less than

0.3% of rural and 14% of urban 1st-8th grade (basic education; *Ensino Fundamental*) public schools (federal, state, and municipal) had computer labs. The numbers are further reduced when considering those with Internet access: less than 0.1% in rural, and approximately 12% in urban schools. The gap in computer integration is substantial across the rural/urban divide, and is evidence across the different regions of the country: the northern and northeastern states averaged less then 0.4% of all *Ensino Fundamental* schools with Internet access, while the southeastern states averaged over 17% (southern = 2.5%, and central = 3.3%; INEP, 2000).

This regional divide in education is also extended by the discrepancy in the schooling level in these regions. Educators in the public schools in the northern and northeastern regions are considerably less schooled than those in the other regions of the country. In the northern and northeastern part of the country, less than 30% of teachers in public *Ensino Fundamental* have a college diploma; the percentages nearly double for the remainder for the country (INEP, 1999, 2002). In essence, a noticeable gap exists between those in rural and urban areas, and those living in the northern and north-eastern states in comparison to the central, southern, and southeastern regions.

CLOSING THE GAP

Colossal disparities exist across the country when measuring both *conditions for access* and potential ability to *make use* of computer technology. These measures point to a digital divide that has resulted from, and added to, social and economic inequalities. Apple (2002) noted that emphasis on economic development at the cost of public and social equality can be understood within the influence of neo-liberal policies in education. This is very much in line with Brazilian neo-liberal economic policies since the mid 1990s, which included privatization, increased foreign investment and reduction in import tariffs (Amann & Baer, 2002; Tigre, 2003). During this time, government policies focused on large-scale privatization of public institutions and radical openness to foreign investment**.** While one could argue that these policies have improved the standard of living for those of the lowest income bracket, the situation of the poor did not undergo a substantial improvement, so far as can be detected from absolute poverty indicators (Amann & Baer; Tigre)**.**

Barros, Henriques, and Mendonça (2002) have demonstrated that educational heterogeneity in Brazil is the principal determinant of economic disparity in Brazil, accounting for almost 40% of the difference in salary among the population. In light of this evidence and taking into consideration the dismal quality of the Brazilian educational system, the government has devised long-term educational goals aimed at improving the quality and equality of the educational system. These goals include increasing the number of students in schools, boosting teacher salaries, increasing completion rates, and augmenting teacher training (MEC, 2003a).

Within the scope of these reforms, the move towards the integration of computing technologies in school is strong (for a pioneering effort see project EDUCOM). The Ministry of Education has implemented a national technology integration program termed *Programa de Informática na Educação* (Educational Informatics Program; PROINFO) beginning 1996 with ambitious goals through the deployment of computing technology in both classrooms and Núcleos de Tecnologia Educacionais (Educational Technology Centers, NTE), which serve as training and support facilities. Some of its initial goals included preparing 25,000 teachers to work with technology in education, in 6,000 schools; installing 105,000 Microsoft Windows-based computers (100,000 in schools, 5,000 in NTE), and creating 200 NTEs around the country by the end of 2002. Ultimately the government hopes to provide Internet access to all schools, and access to the local community. By 2002, 53,895 computers had been installed in 4,629 schools. Brazil has approximately 150,000 schools dedicated to basic education (INEP, 2003). Approximately 137,911 teachers had been schooled to use the implemented technology, and over 262 NTEs had been implemented by 2002 (Departamento de Informática na Educação a Distância, 2002).

To benefit from the experience and pitfalls of pioneering technology integration programs, important issues have been concomitantly addressed, including the need for teacher professional development, creation of standards reinforcing pedagogical change, and formation of centers for pedagogical and technical support (e.g., Sette, Aguiar, & Sette, n.d). Still, many problems exist in the race towards computer integration, including the placement of computers in remote locations (Morgado, Cavenaghi, & Reinhard, n.d.), and the problems of dealing with a rapidly aging technology such as the computer. Analyses of the efficacy of the program are limited, but Paulo Gileno Cynseiros (2001), a long time researcher of educational technologies in Brazil offers some reasons why the program is not reaching its expected goals. One of the largest problems occurred in providing professional development for practicing teachers:

> The promise made by Proinfo of first training teachers in the schools which received computers did not take effect, since the NTEs were not functioning to their full capacity, and the majority of school systems did not have the transportation infrastructure, teacher substitutes, materials, etc. The computers were delivered, and the labs in many schools remained closed for one or two semesters…. (Cysneiros, 2001, p. 134, author's translation)

In distributing funds for the purchase of computing equipment, the government intended to promote regional equity. Computers were allocated to states based on the average of schools with over 150 students and the number of registered students in each state. As a consequence of this distribution policy, the richest state in the nation, São Paulo, received more computers than the 11 states of the north and central regions combined. Other problems existed, such as the lack of preparation to use and evaluate educational software, and a lack of computer support personnel.

The technology integration program has also led to opposing views towards educational technologies, a problem faced by many developing nations with geographically and economically unbalanced national ICT infrastructures. Current government policy has dictated investment towards the more developed regions of the country where the infrastructure is present and can accommodate the implementation of educational technologies. The opposition would argue that this stand will increase the already substantial divide between the northern and southern regions of the country, and the rural and urban populations. Instead, new technologies should be implemented in those locations that could most benefit from a boost in access to information and greater inclusion.

To succeed in the implementation of new technologies in schools, a level of infrastructure must be present, including a secure building to house any such technology, such as a computer laboratory (Morgado et al., n.d.). It is unarguable that a school with proper electricity, building infrastructure, security, and monetary stability will better support the installation of a technology infrastructure. Unfortunately, most of the schools with the necessary infrastructure to house such technologies lie in the southern, richer, and more urban locales. A statement by the secretary for distance education (under the auspices of MEC) points to this essential dilemma. In essence, the secretary acknowledges the conundrum but states that the digital divide in developing countries must be accepted as a temporary drawback in light of the need for technological advancement and global competition (Poppovic, 2001).

This strategy, quite plainly, leads to the continuation of the access gap. Communication and computing technologies evolve rapidly and degrade (equipment renewal is commonly four to five years). A compromise must be found between the need to implement technologies in order to maintain a competitive global edge while addressing the needs of the disenfranchised within the country. A strong governmental objective is the use of information technologies to help alleviate social problems (Takahashi, 2000). If his is to be the case, a policy that balances both social and economic interest must be employed.

If access to a computer is vital to the 21st century student and citizen, as the policies of Brazil and United States advise, then first possible resolution to this issue is to invest in the poorest regions of the country more heavily to bring them up to the standard of the more advanced locations. The *Projeto Dinheiro Direto na Escola* (Project for Direct School Funding; PDDE) directed by the federal government has followed this rationale. It is aimed at directly at public schools, funding small projects directed at school improvement and small purchases (explicitly listed options are items such as the computers, printers, modems, diskettes). The program has invested over R$2 billion (US$ 666 million) in schools with over 20 students from 1995-2002 (MEC, 2003b). One of its biggest goals is to bridge the geographical divide between the north, northeastern and central, and southern and southeastern regions of the country. To do so, the program explicitly dedicates more money to the poorest states of the country (northern, northeastern, and central—excluding the federal district of Brasília).

Legislation proposes that the smallest school unit in a poor state (with 21 to 50 students) would receive R$600 (U$200) yearly, while one in a rich state would receive R$500 (U$ 166.67). The largest units (over 2000 students) in a poor state would receive R$19,000 (U$6,333.33), and in a rich state, R$14,500 (U$4833.33) annually (MEC, 2003c). While the money may be used to purchase almost anything from basic paper supplies, plumbing, evaluation, and technological tools, the amount nor the difference between the funding levels is enough to promote school equality, especially insofar as educational technologies are concerned. In a country where schools suffer from lack of teachers and pedagogical coordinators, school supplies and security, among other problems, this meager amount can only begin to tackle some of its more pressing issues (see Paro, 2000 for a detailed portrayal of a Brazilian public school). It is hard to imagine that these funds would be used to purchase a computer, a printer, or a hard drive. This is a notable effort that has promoted the improvement of schools in many poor and rural regions of the country, but will do little to promote equity.

Funds stemming from the *Fundo de Universalização dos Serviços de Telecomunicações* (Fund for the Universalization of Telecommunication Services; FUST), maintained by monies originating from the telecommunications sector now total approximately R$3 billion. These substantial funds are earmarked for the educational technology infrastructure. Four years after its inception, politicians contemplated the use of these funds to connect public institutions (including schools) to the Internet. To date, none of the riches have been put to use (Folha de São Paulo, 2004).

This short overview of the Brazilian condition is meant to demonstrate that the government has enthusiastically promoted the integration of computing into schools. It had been described as a contributor to the eradication of educational and social ills, an objective which has not materialized. These attempts have not, and will not bridge the educational divide. Regions with more advanced computing equipment will continue to prosper, purchase, and renovate; they will not simply stand still. The demands of the global economy will not wait remain the same. A long drawn cycle of inequality between these regions is poised to continue. If one is to assume that the digital divide is about *devices* such as the computer, then equal *access* is the initial condition for promoting digital equity. If computing technologies are not deployed in favor of the unfortunate, then these policies are doomed from the beginning. Equality will not be reached until substantial funds are designated in favor of the poor.

Access issues have not been resolved, and will continue to arise from newer technological tools. Providing access to these tools is important, but will not resolve the digital divide; the gap lies before and beneath these tools. Even if equal access was reached, computing tools age, leading again to inequality as newer tools and applications are made available.

History has shown us that few pedagogical advances have been made by the introduction of computing technologies into the classroom (Cuban, 2001; Oppenheimer, 2003). Decades of computer integration have not resolved issues of access (Norris et al., 2003), and trend data demonstrates that the computer access gap might take decades to close in a pioneering country like the United States (Martin, 2003). Why then, should third world countries such as Brazil deposit such faith in these technologies as tools for pedagogical change, or for the production of more computer savvy, marketable students? In a country where at the basic educational level (1^{st}-8^{th} grade) only approximately one-fifth of the schools have a library, 5% have a science laboratory, and less than two-thirds of rural schools have electricity, is this mentality justified (INEP, 2003)? Have books and better-prepared teachers been debunked by the awe-inspiring potential of the computer as an agent of educational change? Divides (digital or otherwise) will continue to arise through the patterns of technological adoption. Technological inequities, such as the digital divide, will not be solved by more technology. To resolve the digital divide, a chance must occur on how we understand and teach about the relationship between technology and schooling.

The Role of Education

A more realistic and effective approach to technology integration includes investing in the poorest regions without producing a dependence on the personal computer as the technology of choice for education. This is a call for socially meaningful technologies, those which are solicited by the community who will make use of it—a bottom-up approach to technological deployment (Baker, 2001; for a comprehensive review, see Hickman, 2001). Hence, local communities should be the ones to make decisions regarding the benefits of new technologies once they are aware of their functionality. This model promotes the use of community-based decisions regarding their technological future. Indeed, the community should be able to decide whether to create a computer lab or to hire more teachers, whichever might be deemed more effective and worthy. Projects such as *PDDE* described earlier already ascribe the duty of selecting the use of funds to community-based organizations, such as school councils and *Associações de Pais e Mestres* (Parents and Teachers Associations; APM), which has led to a large increase in the number of such associations in Brazilian schools.

In order for communities to decide on their technological progress, an agenda for technology literacy must be emphasized in schools. Without the prerequisite (technology) literacy, the community would not be able to make conscious decisions regarding the use of funds in local schools. Topics such as the reason for the implementation of ICT, how these technologies function, and their social and economic impacts can promote the type of citizen, which is able to make choices regarding technological implementation in his or her environment. This type of instruction *does not* depend on the computer, an expensive and high maintenance technology. The computer *can* be used to promote new learning environments incorporating student-centered and active instruction, multimedia, and critical thinking (ISTE, 2002). The computer is, nevertheless, just a tool, not a pedagogy. These same objectives can be attained by making use of other technologies, including the television, radio, and many other resources. It must be clear that a race towards the integration of computers into the classroom is not a necessity, and is only one alternative in promoting technological literacy, as well as pedagogical change.

SUSTAINABLE SOLUTIONS TO THE DIGITAL DIVIDE

What is missing from current rhetoric is a realization that the computer is unnecessary to promote technology literacy, and considering its high maintenance and price, it might well be an inadequate tool. A number of tools including the television, radio, telephone, allow for the implementation of a technology literacy agenda (ISTE, 2003; ITEA, 2000; MEC, 1998, 2000). Students can learn about engineering design by analyzing a radio, even if only one exists in the school. Though radios are ubiquitous in Brazil, they are not recognized as a tool to promote technological literacy. Instead, the standards for basic education recommend its use as yet another content-transmitting device (MEC, 1998). Could students not learn about network systems, the impact of technology, engineering design, and other topics from these technologies? *Why should a student have to wait for a computer to be integrated into his/her classroom to investigate and learn about information and communication technologies?* Computers, cellular phones, radios, televisions, and many other devices have become part of communities everywhere. They share commonalities that could easily be incorporated into the curriculum to teach the topics of data transmission, networking, social networks, long-distance communication, and so forth. A variety of questions arise, including *what would our life be like without radio, television, or telephones? What services do these and other devices* *provide? How do they work? What are their effects on our communication and interaction?* The type of knowledge gained from the understanding of existent technologies could well be the type of information necessary to decide whether computers or any other costly technologies should be implemented in their communities in the first place.

Many children from this and previous generations have learned to make use of computers with no formal instruction. If children with no understanding of communication infrastructures and networks, and no knowledge of computing can learn to interact with a computer in days, one can only imagine the level and speed of computer literacy that could be achieved by children *with* a background on these topics. In other words, computers are unnecessary tools in achieving technological literacy; the same goal can be achieved with other tools. Once the need for computer use becomes necessary, as in the work environment, the computer skills can be achieved (Cuban, 2001; Ernst, 1996; Oppenheimer, 1997; Strover, 2003).

The concept of digital networks, for example, can be explained within the context of a technology that now plays a substantial part of community life (e.g., a radio, a television). Discussions about the political, social, and economic aspects of the introduction of the cell phone can be grounded in authentic life examples and experiences. Discussion could be encouraged in class using student-centered, collaborative, and other emerging pedagogical approaches to learning—without a computer. Discussions surrounding the basic workings of this technology could lay the foundation for critical consideration. Technology literacy becomes a new type of literacy including the process of critically understanding and uncovering the world we live in (Freire, 1985). Transferring the kind of knowledge acquired by this process to understand how the Internet works, or how a computer might function should not require the student to *re-learn* but rather to build upon a foundation of understanding gathered from similar technologies.

CONCLUSION

Approximately 28% of Brazilians 11-years-old and older do not finish fourth grade (MEC, 2003a). For these 28% the addition of computers to the classroom holds no value measured either by increased job perspectives and social mobility or increased computer literacy. For these and many other

Brazilians, a computer would hold no meaning outside of school. Even the motivational aspects of computing could not encourage an impoverished student who needs to work, to stay in school.

Much is being done to transform schools to allow computing to reach full potential as an aid to pedagogical change, higher achievement, and new cognitive approaches. While these promises might eventually come to be, the previous decade has demonstrated that computing technologies have produced little to justify such substantial investment. A mental shift is required of teachers, schooling administrative culture must change, new pedagogical practices must be incorporated, and many other intangibles must be transformed for the computing revolution to occur. Even if the current computer integration plan is successful, a substantial portion of schools will not be exposed to computers within the next decade. Providing students with a curriculum that promotes technology literacy will create a new generation of student able to understand the impacts, effects, and uses of these technologies in their communities.

The debate on the digital divide must begin to focus on *people* rather than *devices*. Technological divides have existed and will continue to exist as new devices are developed and adopted. It is likely that the infatuation with technological devices will continue to point educators and administrators in the wrong direction. A focus on technology literacy, providing avenues for computer literacy at a later, more meaningful stage in life is tenable, and can be integrated to the national ICT infrastructure and educational goals. By focusing on literacy, students will be encouraged to understand the *process* of technology, rather than simply being affected by it.

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Notes

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