The Role of ICT in Enhancing Education in Developing Countries:

Findings from an Evaluation of The Intel® Teach Essentials Course in India, Turkey, and Chile

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Abstract: This paper presents findings from case studies of the introduction of the Intel® Teach Essentials Course—a professional development program focused on integrating information and communication technologies (ICT) into project-based learning—into six schools in Chile, India, and Turkey. We describe four common dimensions of change in learning environments that emerged across the countries: changes in teachers' knowledge, beliefs, and attitudes; changes in how students engage with content; changes in relationships among students, teachers, and parents; and changes in the use of ICT tools to promote students' learning. Three of these dimensions relate to shifts in pedagogical paradigms that appear to be prerequisites to effectively using ICT to support students' learning. Our findings indicate that these shifts must not just occur at the teacher level, but must take hold throughout the educational system and must accompany sustained investment in infrastructure, human resources, curricular frameworks, and assessment.

Introduction

Understanding how technology fits into the complex realities of classrooms has been a critical factor in creating real change in schools in the industrialized nations (Cuban, 1993; Honey, McMillan Culp, & Carrigg, 2000; Somekh et al., 2003), yet little is known about educational technology projects in the classrooms of the developing world. This paper examines the influence of an information and communication technologies (ICT)-focused professional development program—the Intel® Teach Essentials Course—on classroom learning environments in six schools in Chile, India, and Turkey. Over the years, program evaluations have found that teachers across a variety of countries value their experience in the Essentials Course and report using ICT and/or making changes in their teaching practice following the program (Light, McMillan Culp, Menon, & Shulman, 2006; Light, Menon, & Shulman, 2007). However, the evaluations have also suggested that the ways in which teachers in different countries follow up vary, depending largely on factors in their school contexts. The research presented in this paper sought to examine more deeply the nature of the changes that schools in different contexts have made to integrate ICT and student-centered practices and how these changes affect the classroom (Light, Polin, & Strother, 2009). In all three countries, we found that the educators we interviewed and observed felt they had been able to implement new ICT activities and teaching approaches with their students after the Course. We also identified a consistent set of programs and policies that, combined with the motivation and skills of educators, enabled these schools to innovate.

We selected the six schools in the study (two from each country) which key local stakeholders—the training agencies, the ministries of education, and the Intel Education Managers—considered

to be "good examples" of using the Essentials Course to create school-level change within their national contexts. In pursuit of the ideals established by their ministries, the teachers and administrators in these schools are attempting to transform the instructional strategies and the educational tools they use. Although each country is unique and each school is at a different starting place, all are moving toward more student-centered, project-based, and ICT-rich classroom learning activities. Across the diversity of their situations, educators in each school connected the ideas and tools offered in the Essentials Course with their own needs. From our case studies of the six schools, we identified four common dimensions of changes that are emerging to support more project-based and ICT-rich activities in the classroom: changes in teachers' knowledge, beliefs, and attitudes; changes in how students engage with content; changes in relationships among students, teachers, and parents; and changes in the use of ICT tools to promote students' learning. Three of these dimensions of change that emerged across schools are pedagogical in nature, supporting the idea that an appropriate pedagogical context is key to successful ICT integration.

Theoretical Perspective

When effectively integrated into a high-quality learning environment, researchers have demonstrated that ICT can help deepen students' content knowledge, engage them in constructing their own knowledge, and support the development of complex thinking skills (Kozma, 2005; Kulik, 2003; Webb & Cox, 2004). However, ICT alone cannot create this kind of teaching and learning environment. Teachers must know how to structure lessons, select resources, guide activities, and support this learning process; many traditionally-trained teachers are not prepared to take on these tasks. As Bransford, Brown, and Cocking (2000) point out, to

use technology effectively, the pedagogical paradigm needs to shift toward more student-centered learning. This shift is not trivial or easily accomplished, particularly in countries with teacher-centered educational traditions. The literature suggests that four broad sets of changes should accompany the integration of ICT and the move toward a constructivist model of teaching and learning.

1. *Changes in teachers' knowledge, beliefs, and attitudes*: The literature on education reform highlights the importance of changing teachers' beliefs and attitudes to create long-term sustainable change (Fullan, 1993). Many studies on ICT integration find that projects fall short of expectations because the educators continue working within a traditional vision of rote learning (Gersten, Chard, & Baker, 2000; Honey & Moeller, 1990; Teacher Foundation, 2005). Teachers need to believe that new approaches to teaching are effective and will make a difference for their students in order for them to continue using new approaches. Teachers' understanding and commitment are particularly important to sustain changes in areas such as project-based learning or student-centered techniques, which require core changes to a teacher's instructional practice (Gersten et al., 2000).

2. *Changes in how students engage with content*: Research in the learning sciences has established that constructivist theories of learning provide a more reliable understanding of how humans learn then previous behaviorist (Bransford et al., 2000). Studies have identified a variety of constructivist learning strategies (e.g., students work in collaborative groups or students create products that represent what they are learning) that can change the way students interact with the content (Windschitl, 2002). The

introduction of ICT into schools and project-based approaches should change how students interact with the content through new types of learning activities.

3. *Changes in relationships among teachers, students, and parents:* Recent studies suggest that, specifically, a supportive and cooperative relationship with the teacher can be very important for learning (Marzano, 2007). Research in many different countries has found that the introduction of technology into learning environments changes teachers' and students' roles and relationships (Hennessy, Deaney, & Ruthven, 2003; Kozma & McGhee, 2003).

4. *Changes in the use of ICT tools to promote students' learning*: The ICT integration in developing country classrooms is challenging (Akbaba-Altun, 2006; Comenius, 2008; Grant, Ross, Weiping, & Potter, 2005; Light & Rockman, 2008; Somekh et al., 2003; Vyasulu Reddi & Sinha, 2003). A number of factors—such as teacher knowledge, time, access to ICT tools, and the alignment of ICT use with pedagogical goals—appear to help teachers integrate ICT and to support students' increased use of ICT tools for learning (Light & Manso, 2006; Pérez et al., 2003).

Overview of the Three National Contexts

India

Of the three countries, India is perhaps the country that has most recently begun reforms to promote new teaching approaches and ICT. Across India's decentralized education system, national and state leaders face big challenges in their efforts to support an education system that must reach so many students (Cheney, Ruzzi, & Muralidharan, 2005; PROBE Team, 1999). Efforts to shift curricula from behaviorist approaches to learning to a constructivist approach that emphasizes the personal experiences of learners are recent (India—National Council of

Educational Research and Training, 2006; Pandley, 2007). A growing number of policies support ICT integration, but one expert review (Vyasulu & Sinha, 2003) found that there is still great variation in implementation of these policies and access to ICT is still limited for most students. Although there is variation by state, the duration of the standard school day is five hours, divided into 35-minute lessons. The class sizes tend to be large; the classes we visited ranged from 45 to 60 students. Indian teachers are expected to cover a lot of content, and the textbook often becomes the center of the learning process (PROBE Team, 1999; Rampal, 2002). The state curriculum varies, but in Maharashtra State, for example, the students have a very full schedule by the upper grades and study 11 compulsory subjects.

Chile

Since 1990, successive Chilean governments have pursued a consistent reform effort to modernize teaching and learning, improve and expand school infrastructure, promote student-centered curricula, institute full-day schooling, develop a national examination, invest heavily in teacher professional development, and integrate ICT into schools (Cox, 2004; Ferrer, 2004; Valenzuela, Labarrera, & Rodríguez, 2008). The Chilean school day is eight hours, with the amount of time students spend in core areas (math, language, and science) twice that spent on other disciplines, and there is reserved time for students to engage in enrichment activities or project-based learning experiences. Class periods are typically 50 minutes, with two-hour classes in core content areas. Every school is required to have a Unidad Técnica Pedagógica (UTP—the Technical Pedagogical Unit) that provides pedagogical support to improve teachers' practice.

Chile also has an ICT program, *Enlaces* (Links) that, by 2007, had provided hardware, software, and connectivity to 94% of schools in Chile and trained 110,000 teachers (Cancino & Donoso Díaz, 2004; Chile—Ministerio de Educación, 2008). Thus, most schools have a certain level of ICT infrastructure available in computer labs.

Turkey

Turkey has been instituting educational reforms to modernize and expand its school system and align it with European Union norms since the late 1990s (Baki & Gokçek, 2005). The reforms include the expansion of compulsory education, efforts to decrease class size, introduction of a new curricular approach and materials, the use of ICT, and efforts to provide teachers with professional development. Announced in 2005, the new curriculum draws upon constructivist pedagogical principles and the theory of multiple intelligences and promotes more student-centered techniques—such as individual and group work—to encourage students to explore and develop skills (Gomleksiz, 2005). As Phase 1 of the Basic Education Program, 1998–2003, the government distributed thousands of computers to schools (Akbaba-Altun, 2006), and many schools now have labs.

Turkey is moving toward full-day schooling, but many schools—including the two we visited—still have two, five-hour shifts because they cannot otherwise meet their communities' demand. The demand for schools also means that Turkey has not yet reduced class size to 30 students. Nationally, the average primary school class size is 38.6 students (Otaran, Sayn, Güven, Gürkaynak, & Satakul, 2003) but in the schools we observed classes ranged from 50 to 60 students.

Overview of the Essentials Course

The core goal of the Essentials Course is to prepare teachers to integrate ICT across the curricula as a tool for learning and to design and implement inquiry-driven, project-based learning activities. The Essentials Course involves teachers in a process of developing a complete unit plan that utilizes a project-based approach, engages students in a variety of ICT activities, and organizes learning around an "essential question" that guides students' inquiry and exploration of a given topic. Teachers are encouraged to designate time in their unit plans for students to use ICT to conduct research and to create a final product to share their research findings. The Essentials Course also discusses crucial factors for creating high-quality, issues in student-centered learning environments (e.g., classroom management issues with technology), and approaches to assessing students' technology products. During the unit plan development process, teachers expand their technical skills and prepare to implement their units back in the classroom. This is a vital feature of the Essentials Course, as it allows teachers to experience and evaluate the new teaching approaches (Guskey, 2002). In addition to Web resources, the Essentials Course uses commonly available software, primarily word processing software and presentation software, to support students in creating presentations, Web pages, brochures, reports, and newsletters.

Core Components of the Intel Teach Essentials Course	
Content	**Structural Features**
• Linking ICT use to deeper learning • Essential Questions or curricular framing questions • Project-based approaches • Student created products • Internet resources • Group work • Holistic assessment strategies	• 40 to 60 hour training • Focus on commonly available software • Teachers create a sample unit plan • Teachers learn by doing • Trainer is in the same school • Emphasis on building communities of trained teachers

Intel, in collaboration with ministries of education worldwide, has offered the Essentials Course to more than 6 million teachers in 45 countries. The collaborative approach to course delivery is important. Although the core messages and goals of the program do not change, Intel works with the ministries and local educational experts to adapt Essentials Course materials to fit local needs; a local agency in each country implements the Course. In Chile, the ministry created a network of universities throughout the country that offers the Course in their regions, and the Pontificia Universidad Católica de Chile in Santiago oversees the network. In India, the non-profit Learning Links Foundation oversees the program in the participating states. In Turkey, the Ministry of National Education (MNE) oversees the program, and trainers are based at the provincial education directorates and in larger towns.

Methodology

In this study, we used an instrumental case study approach (Stake, 1995) to examine how successful schools and teachers have been able to integrate ICT and new teaching strategies into their classrooms. This approach allowed us to work directly with schools that have been making changes, talk with teachers about the aspects of the Essentials Course that are useful to their practice, and develop an understanding of what teachers are actually able to do in typical schools in each country. During a two- to four-day site visit at each of the six schools, we interviewed school leaders, the Essentials Senior Trainer (ST) or Master Teacher (MT), technology-using teachers, students, and representatives of students' parents whenever possible. As shown in Table 1, classroom observations of both typical classrooms and students engaged in the computer lab or ICT activities complemented the interviews.

As noted, to identify a sample of exemplary schools, we gained input from local stakeholders. We requested that the local training agency, the ministries, and the Intel Education Managers in each country compile a list of schools. We asked that they exclude schools with privileged access to resources, technology, or funds. *Success* was defined by the local stakeholders to represent what they felt would be reasonable expectations for schools and teachers in their country. From the list of schools, the research team made a final selection of two schools in each country.

To carry out the fieldwork, we collaborated with local partners. In Chile, we worked with researchers from the Centro Costadigital at the Pontificia Universidad Católica de Valparaiso, and in Turkey, we teamed with GLOKAL Research Consulting. Unfortunately, the arrangements for a local research partner in India fell through.

Table 1: Data Collected		
India		
Mumbai School	**Interviews**	2 school leaders; 5 teachers
	Observations	5 classes
	Focus groups	14 parents; 37 students; 12 teachers
Village School	**Interviews**	4 school leaders; 3 teachers
	Observations	5 classes
	Focus groups	3 parents; 5 students
Chile		
Santiago School	**Interviews**	2 school leaders; 3 teachers
	Observations	4 classes
	Focus groups	7 students
Village School	**Interviews**	3 school leaders; 2 teachers
	Observations	3 classes
	Focus groups	5 students
Turkey		
Ankara School	**Interviews**	2 school leaders; 8 teachers
	Observations	3 classes
	Focus groups	3 parents; 5 students
Village School	**Interviews**	5 school leaders; 7 teachers
	Observations	5 classes
	Focus groups	5 parents; 19 students

Sites

India

We selected a private school in a middle-class neighborhood of Mumbai and a government

school in a Gujarati village. The Mumbai school, with 2,000 students, is an English-medium

private school from pre-K to Grade 10 and the village school is a Grade 1 to 8 Gujarati-medium

public school with 309 students. In the Mumbai school, every classroom has a computer

connected to a TV, there are two computer laboratories each with 60 computers, and there is a

computer in the library. The labs have broadband Internet. The Gujarati village school has a lab

with 14 computers and a computer on a wheeled table with an LCD projector. The lab is connected to the Internet through a dial-up modem.

Chile

We selected a government-subsidized private school in a lower middle class neighborhood of Santiago Chile and a small municipal school in a rural town. The private school has 2,500 students from pre-K to Grade 12, and the municipal school serves 97 students from pre-K to Grade 8. The private school has five ICT labs, some with as many as 20 computers. The municipal school has a lab with 15 computers, plus four laptops, a digital camera, a TV, a printer, two LCD projectors, and a wireless network.

Turkey

We selected two public schools that serve students from K to Grade 8. One school, in an outlying neighborhood of Ankara, serves 2,300 students. The second school, located in a small provincial capital on the Anatolian Plateau, serves 1,410 neighborhood children and has a population of female boarding students from villages in the province. The school in Ankara has one computer laboratory with 21 computers, 15 classrooms have a computer, and there are 350 Classmate PCs donated by Intel. The lab has broadband Internet and a wireless hub. The Anatolian school has three computer labs with 15 computers each, and five or six teachers also have a computer in their classrooms. The labs have wireless connectivity.

Findings: Four Common Themes

The Essentials Course was not the only source of information or support for the new student-centered practices and ICT-based activities we observed in these schools, as all three ministries of education are engaged in reform with various changes such as new curricula, new standards, and new in-service training programs. Education reform is a long and complex process that needs to be supported with multiple strategies, and our findings suggest that the Essentials Course can be one part of that puzzle.

Changes in Teachers' Knowledge, Beliefs, and Attitudes

Because all schools in the study were considered successful, we explored what teachers had changed in their own practice. In the interviews, we asked teachers to discuss what they had learned from the Essentials Course that was useful for their classroom practice. Three themes emerged across all six schools as the teachers spoke about what they found to be valuable for their teaching: (a) their beliefs about how students learn were shifting; (b) they had a deeper understanding of new teaching strategies; and (c) they had improved their knowledge of how to use ICT as a learning tool, as well as strengthening their ICT skills.

a. Teachers' beliefs shifted to a constructivist paradigm of teaching and learning.

Teachers expressed a growing belief that students can learn through exploration and discovery. The Essentials Course and, more importantly, the experience of implementing a project-based or ICT-rich learning activity appear to influence teachers' understanding of how children learn. The interviews suggested the teachers began to value learning as different from memorization and to see that students can learn by exploring content, conducting research, and applying knowledge to real problems. For example, a Chilean history teacher remarked upon the difference from the

traditional approaches of having students memorize information: "By following a question, the students acquire a lot of content through research."

In all six schools, teachers also expressed their belief that students learn more than just content with projects and Internet research. Many teachers recounted what they did "before" and "after Intel," and their descriptions consistently included how students "learn more deeply," "have more confidence," and "are more motivated" by the new ways of learning. They reported that students were developing skills and attitudes such as self-assurance, curiosity, collaboration and teamwork skills, presentation skills, and organizational skills. In appreciating how effective group work had been, a teacher in Turkey reported that, "Before Intel, students did not do teamwork. […] In Turkey—kids want to learn from teachers, now they have to do research on their own and can learn more deeply. Otherwise students aren't motivated to learn." A second Turkish teacher commented that students "were sharing ideas and thoughts with each other" and learning to "trust themselves."

   b. *Teachers deepened their understanding of student-centered practices.* Teachers reported improving their skills with innovative teaching practices. Although some countries had more experience than others, across the board, nearly all the teachers we interviewed valued project-based approaches and reported doing projects with their students. Teachers had very clear ideas about how project-based approaches can support student learning by allowing students to explore content as they respond to a research question or problem posed by the teacher. They felt the project approaches made the content more relevant to students and required greater intellectual effort for students to find and synthesize information, which led to students learning and retaining more information.

At schools in Turkey and India, principals and teachers credited the Essentials Course with helping them learn how to do projects for the first time. In Turkey, teachers told us the Course helped them better utilize the project ideas offered in their new national curricula. One school in India had been experimenting with projects prior to participation in the Essentials Course, but the teachers reported that this professional development experience gave them a solid template and a set of strategies for project-based approaches. In Chile, teachers told us that the Course helped them learn about inquiry-driven project-based strategies in addition to the problem-based approach supported by their ministry.

While teachers from all three countries agreed that the Essentials Course supported their use of student-centered practices, each country's context and educational goals influenced which topics were of most interest to teachers. For example, while all the teachers spoke about using group work and collaborative learning, the teachers in Turkey were very excited about the collaboration strategies presented in the Essentials Course. Turkey's traditional approach to teaching is lecture-based and emphasizes individual student activities, and teachers reported that they did not have any previous experience with collaborative learning. Group work and collaboration are, however, part of the new Turkish curriculum and reform efforts and teachers expressed appreciation for how the two programs supported each other. The curriculum contains many group activities, and the Essentials Course offers strategies to facilitate group work, as well as follow-up support to practice these strategies with coaching from their MT.

In India, teachers found the "Essential Questions" strategy to be compelling. Essential Questions (e.g., "Why do we need others?") are intriguing, open-ended questions that organize a project and are an effective way to encourage students to think deeply and to provide them with a meaningful context for learning (Wiggins & McTighe, 2001). The Indian curriculum is very demanding and the school day is crowded, so teachers felt that they could not easily integrate project work into every class. While they could not do projects during the class period, they were, however, exploring the use of questioning strategies to push students' critical thinking and to allow students to share their perspectives and formulate their own conceptual understandings of the content. For example, one teacher asked her students what they thought the impacts of British Colonial policies were on the farmers, and a social studies teacher asked students what they valued about their community. Teachers felt that asking for student input was a significant change. As one teacher commented, they no longer just "stand and teach," but facilitate discussions and encourage children to share their knowledge. The teachers we visited felt the open-ended questions and ensuing dialogue between teachers and students might be the foundation of a new relationship between teachers and students.

One of the schools in Chile, which already had a lot of experience with ICT and projects, focused on the use of rubric assessments presented in the Essentials Course. The principal noted that teachers were facing increasing challenges in assessing students' work as the school moved toward complex, technology-rich student products such as presentations and websites. Through these products, students master more than just content and teachers wanted to value all aspects of students' learning. They considered the rubrics—designed to capture the range of skills, attitudes, and content that students develop—as a key way to address these challenges. The

teachers were also using rubrics to put students more directly in control of their learning process; students know from the beginning which aspects of the content teachers will evaluate.

c. Teachers improved their ICT knowledge and skills. Teachers reported that they had developed the skills needed to initiate or increase the use of ICT with students. Most of the teachers in India and Turkey reported little ICT experience before Essentials, whereas most Chilean teachers had previous trainings and experience using ICT. Regardless of their experience with ICT, all teachers we interviewed who took the Essentials Course reported they increased their knowledge of how to use ICT as an educational tool. For teachers with no prior experience, the Course helped them acquire basic skills. However, all of the teachers commented on how the Course helped them see ICT as a pedagogical tool. The strategy of having teachers design a model unit of their own choice appears to allow teachers to work on skills and areas that are new and challenging for them.

Changes in How Students Engage with Content

The introduction of ICT into schools and the use of project-based approaches and Internet research have changed how students interact with the content in a number of ways. In the site visits, teachers and students spoke about three types of new learning activities that would, according to the literature, contribute to a constructivist learning environment: (a) learning through projects; (b) conducting Internet research; and (c) connecting school content to students' lives (Windschitl, 2002).

a. Project-based work gave students a chance to collaborate, use multiple resources, and direct their own learning. In all the schools, student projects were fundamental to bringing student-centered instructional strategies into the classrooms. The Essentials-trained teachers we

interviewed spoke of doing projects with their students. Despite variations among project designs, a few core features emerged. In almost every site, projects gave students chances to work collaboratively and challenged them to take on new roles and responsibilities; students worked in groups and often had to coordinate efforts to complete the projects. Also, all of the projects described included research and culminated in a final product that required students to synthesize and share what they learned. For example, in the Gujarati village, the students did a project about water use and irrigation. They visited local experts, surveyed the community, collected data, and researched solutions. As a result of the students' examination of drip irrigation, and their proposal of how farmers could use this new strategy, the village converted to drip irrigation. Again, the teachers in India could not fit the project into the class time, so students did a lot of the work before and after school. The municipal school in Chile did a multi-grade project on insects in which the younger grades collected bugs and wrote reports and the older grades helped them create a website.

  b. Independent Internet research gave students autonomy and a chance to develop and share their own perspectives. Internet research was a constant theme in these schools. Teachers, students, and parents all spoke about having students do Internet research for homework and as part of the projects. Teachers often asked students to bring in additional information on topics in the textbook (e.g., in a Turkish project students researched systems of the human body). Or, teachers asked students to research additional topics or themes (e.g., after a lesson on farmers under the British Empire, a history teacher in India asked students to research the condition of Indian farmers today).

  c. Connecting school content to students' lives made learning more meaningful to students. We found that many of the projects teachers designed connected students' school work

to their home life and the community more broadly. In a very simple sense, the increased use of practices such as open-ended questions and group work allowed students to share the perspectives and knowledge they bring from home. For example, a teacher in India asked her students what they had eaten for breakfast and then used this as the start of a nutrition lesson, and a Turkish teacher had his first grade students discuss how an animated story related to their own families and lives.

Yet many of the project topics also engaged students in examining real-world issues or concerns that gave them an opportunity to connect "school learning" with the real world and allowed them to develop their own opinions and perspectives about the issues. For example, the Indian village that did the irrigation project mentioned above also did projects on clean water and public health. Other projects were less ambitious, but still meaningful, such as the Chilean school where students collected stories and images from the community to publish in a booklet for their families.

Our interviews with parents in the Indian and Turkish sites also supported the perception that students were becoming a source of new information for their families. Parents credited their children's increased use of Internet research with providing them with current information to which they would not otherwise have had access. Students are generally more excited by information they find themselves than the contents of a textbook, and parents reported that their children were rushing home, eager to share what they had discovered.

Changes in Relationships among Teachers, Students, and Parents

In keeping with the new activities and roles for students, the teachers and students in the schools we visited reported that they were transforming how they interact. The changes in teaching practices in these schools are part of a broader change in relationships within the school and between the school and the community. The educators and students described changes in the ways they collaborate with each other that grew out of the new teaching practices (e.g., project-based approaches, open-ended questions), integrating ICT into the schools (e.g., Internet research or presentations), or both. We noticed that teachers, students, and parents reported changes in three sets of relationships: (a) among the students; (b) between students and teachers; and (c) between the school, the parents, and sometimes the community.

a. Projects and ICT activities fostered collaborative relationships among students. Many of the teachers and parents interviewed said that students were developing a range of social and interpersonal skills that they attributed to the projects and the new roles that students were taking on. As noted, students in every school were taking on new responsibilities as they worked on projects—leading teams, conducting research, writing reports, debating with peers, and making presentations to peers, teachers, and parents. A Chilean fifth grade teacher explained how her students were developing the skills and maturity to work as a team, even across grade levels, because of the collaborative techniques she learned in the Essentials Course. Some of the parents also commented on their children's maturity and responsibility. A Turkish father noticed a change in his daughter's attitudes since doing the "Intel projects." He observed that before teachers participated in the Essentials Course, his daughter did not share her things with anyone. After her teachers participated in the Course, his daughter began to share more with friends and

she enjoyed working in teams. The father also said that, as a result of her involvement in projects and team work, his daughter completed her school assignments independently at home and no longer asked him for help.

   b. *New teaching strategies allowed teachers to develop more collaborative and interactive relationships with their students.* The teachers reported that, as their teaching practices changed, their relationships with their students also became more open and supportive. Teachers began to allow more intellectual discussions between themselves and their students, and students were more willing to approach teachers and share concerns and opinions. The teachers and parents in Mumbai were, perhaps, the most eloquent. One group of teachers commented that, as children, they had been afraid of their teachers and they were happy that their students no longer "fear the teacher" but gladly ask questions and give opinions.

The students we interviewed echoed these sentiments. A group of high school students from the school in Santiago, Chile explained that a good teacher is one who encourages students to disagree when they have a well-reasoned argument. A student from Mumbai shared a similar perspective: "I like that whenever I do a report I can include my own critical opinion—it is not just cut and paste. And I can learn many things outside of the textbook."

   c. *Innovating with projects and ICT strengthened the relationships between the school, parents, and the community.* The parents we interviewed were excited by the introduction of community-focused projects and student research, and they expressed pride in what the schools were doing for their children with technology. A group of parents in India praised their school "because of the new technology, [the school] is innovative. They have very high performance, but it is not just academics-oriented." In the four public schools we visited, parents and the

community had also initiated efforts to bring additional ICT resources to the schools by donating equipment or paying for improved Internet connections. However, the parents also remarked on the new teaching practices and what these changes mean for their children. All of the parents we interviewed commented on how the school was developing the whole child since the project work was supporting teamwork, independence, and self–confidence. Parents in India and Turkey highlighted their children's growing confidence and independence to do research or make public presentations, and they also noted the caring relationships between students and teachers.

Changes in the Use of ICT Tools to Promote Students' Learning

A core aim of the Essentials Course and a central objective for the ministries in Chile, Turkey, and India is to encourage the use of ICT as a learning aid for students. Although the administrators and teachers we interviewed in all six schools told us they wished they could do more, to the extent permitted by resources, space, and time, students were using ICT for learning activities. PowerPoint presentations and Internet research were, by far, the most common ICT tools that students used.

All six schools promoted student use of ICT, but each adopted different strategies to realize its goals. In Turkey and India, with short school days and tight schedules, the teachers had to strategically make time—either by working outside of class, or rationing access—for students to complete their ICT projects. For example, the teachers at the Anatolian school in Turkey told us that they meet as a team each semester to decide which classes will do long-term projects to ensure every student gets a chance each year. The Chilean teachers had more flexibility to schedule lab time during school hours, although they also did afterschool activities. Perhaps the clearest change is that, in all six schools, teachers gave students Internet research activities for

homework. For instance, a math teacher in India assigned students to calculate average rainfall in different parts of the world using online databases, and a Chilean history teacher had students analyze online photos for life conditions in 1900s Chile.

Conclusion

This paper presents the findings from our fieldwork that describe the nature of the changes taking place in the classrooms in these six schools as they integrate ICT activities. Since the governments point to these schools as positive examples, their experiences can help contribute to an understanding of the process of integrating ICT into the schools of developing countries. While some educators we observed are more skilled than others, and some changes in practice are just emerging, all six schools are making changes beyond just the use of new tools. They are developing: new beliefs about learning and new practices, new ways to engage with content, changing relationships, and new ICT tools for learning. That three of the four common dimensions of change are pedagogical shifts, and that they are changes in pedagogy that are supported by the ICT, illustrate the paradigm shifted required for effective ICT integration (Bransford et al., 1999; Hepp et al., 2004). These findings illustrate the complex sets of changes that have to occur for ICT to be deeply and meaningfully used to support student learning. This would explain why technology integration is so difficult to achieve but also points the way forward.

Our findings suggest that necessary changes are much broader than just the introduction of a new tool or one new practice. Instead, change begins by deeply reshaping life in the classrooms—from educators' beliefs about learning to the relationships that make up the school community. In each context, the teachers found points of engagement between the model of ICT use and

teaching in the Essentials Course and the possibilities and limits of their context. For Indian teachers, it was most feasible to integrate aspects of the teaching model (i.e., open-ended questions) into their classroom and the ICT into after-class time. In Turkey, schools brought ICT activities into scheduled lab time and group work into their class activities. And, Chilean teachers used holistic assessment strategies and inquiry-based projects in class because their school day provides a block of time for projects.

But, the responsibility for change cannot rest solely on the shoulders of the teachers; bringing about these changes is a long-term, incremental process. Effective reform requires sustained investment and support along multiple dimensions of the educational system, including physical and technical infrastructure, human resources, curricular frameworks, standards, and assessment. For example, the teachers in Chile and Turkey spoke of how things like new national curricula, national computerization efforts, and professional development opportunities helped them use ICT in their classrooms and apply what they learned from the Essentials Course to their practice.

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