Research Article

Community Factors in Technology Adoption in Primary Education: Perspectives from Rural India

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Abstract

The role of information and communication technologies (ICTs), particularly in the domain of education (ICTE), has been recognized to benefit learning. This article aims to investigate the influential factors that affect the introduction of technology in an Indian rural primary school. The objective was to address current gaps in research by illuminating specific community factors that influence technology adoption. Anchored in the Technology–Community–Management (TCM) theoretical framework as a guide to analysis of community aspects, the main research question investigated the factors that contributed to, or detracted from, technology impact on education in a developing country context. Primary data were gathered during one month of fieldwork in the Indian village of Pudur. From June to July 2009, fieldwork was conducted in a rural primary school to validate the community claims of ownership, needs, and training. Qualitative research methods were employed; the respondents were 10 randomly selected children, between the ages of six and nine, studying in grades 1 through 4, and of both genders. In-depth interviews and focus group discussions were conducted with three school teachers, and nine parents. Findings revealed that community factors that influence the adoption of ICTs in the rural education context can be translated into three claims, as suggested by the community dimension of the TCM model: a provision for unbiased technology access to children; the need to maximize application of local language within technology and content; and equipping teachers with technological skills while creating positive attitudes toward technology adoption. Implications for the needs, training, and ownership factors are discussed.

Introduction

A fundamental challenge for developing countries has been the provision of access to primary education for the young. Globally, almost 115 million children between the ages of 6 and 14 have no access to basic primary education (World Bank, 2009). Of those who do attend school, close to one-third drop out before completing the primary education cycle (Ordonez & Maclean, 2000). These trends, which deny one in every five children the opportunity to attend school (United Nations Development Programme [UNDP], 2005), have drawn international commitment toward the second Millennium Development Goal (MDG) of achieving universal primary education by 2015 (United Nations, 2003). Despite various governmental efforts to provide affordable schooling and school supplies (United States Agency for International Development [USAID], 2005), progress remains slow. Information and communication technologies (ICTs) are increasingly recognized to promote the achievement of develop-

mental goals, especially in the education domain. With the United Nations Millennium Declaration to "make available the benefits of new technologies, specifically information and communication" (United Nations, 2005, p. 41), it is timely to address issues in the adoption of ICTs in primary education. This study does not address fundamental scholastic issues existing prior to technology introduction. Rather, it investigates the factors that most influence the potential beneficial impact that ICTs may have for those communities hitherto unfamiliar with technology.

Educating the young not only facilitates the acquisition of basic skills such as literacy and numeracy, but enables a nation's long-term social and economic development (Organisation for Economic Co-Operation and Development [OECD], 2005). The future workforce gets equipped with the necessary skills to succeed in 21st-century global economies (International Society for Technology in Education [ISTE], 2007), while simultaneously contributing to poverty reduction and human development (UNDP, 2009). However, the ability to reap much of the benefits of educational growth has, for the most part, been limited to the developed economies and to affluent pockets of developing regions. Developing countries have been unable to seize these advantages fully, as a combined consequence of poverty, inadequately qualified teachers, substandard instruction materials and facilities, and gender discrimination (Department for International Development, 2001; infoDev, 2003). For these reasons, there is a growing need to expand the capacity of the educational system within developing countries that fall short in meeting the MDG's indicators for educational progress, namely, net enrollment, completion rate, and literacy rate (United Nations, 2003).

The role of ICTs, particularly in the domain of education, has been recognized to benefit learning (Banerjee, Cole, Duflo, & Linden, 2005). In addition to facilitating technological literacy and familiarity, students who participate in computer-connected learning environments show increased motivation, greater willingness to tackle difficult questions, and deeper understanding of concepts (Riel, 1992; Weir, 1992). As the development of children's technological competence is increasingly associated with their future employment (Kinyanjui, 2002) in the global knowledge-based workforce (Delannoy, 2000),

significant attention has been centered on introducing ICTs in rural schools to assist in leapfrogging educational challenges (International Telecommunication Union [ITU], 2009).

As computer technology becomes increasingly diffused throughout society, especially for populations in resource-constrained settings for whom these tools have long been financially and practically unfeasible, concerns have been raised about the differing access to learning using this technology, and the varying conditions that affect how children experience learning. Much debate surrounds the use of ICTs in education (ICTE), with advocates for (Negroponte, 1995; Papert, 1996), and campaigners against (Oppenheimer, 1997; Peat & Franklin, 2003) the pedagogical benefits ICTs can bring. These views are balanced by researchers (Apkan, 2002; Bork, 2003) who contend that, if properly implemented, ICTs have the potential to enhance teaching and learning in rural classrooms.

However, along with the recognition that rural schools lack the financial resources to support extensive ICT deployments (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2004), concerns have been raised about the need for appropriate educational content and software development (Farrell & Wachholz, 2004). On an infrastructural level, the existence of barriers such as the absence of Internet connectivity and the lack of time and resources for technical support and maintenance, compounded by regular disruptions in power supply, significantly affect ICT use in rural locations (Cope & Ward, 2002; Martins, Steil, & Todesco, 2004). Structural requisites, such as ensuring that computer rooms are clean, dust-free, and dry, can also be important considerations often overlooked in the rural context (Tinio, 2002). Moreover, limited physical scholastic infrastructure (Global E-Schools and Communities Initiative [GESCI], 2009), inadequately trained teachers from a technological perspective (Carlson, 2002), and difficulties in integrating ICT within existing curricula (Brock, 2001) are fundamental challenges that need to be addressed.

This study investigates the potential of introducing technology within a rural primary school in India. To do so, we identified initial factors for success via a literature review and situated the research within the Technology–Community–Management (Chib & Zhao, 2009; Lee & Chib, 2008) model.

Literature Review

Installing the hardware infrastructure in schools is often the starting point for ICTE initiatives addressing the first level of the digital divide (Attewell, 2001; Hawkins & Oblinger, 2006). Nonetheless, introducing technology alone may not be sufficient to achieve educational objectives. In most Asian programs, emphasis is often placed on acquiring hardware in schools, with limited consideration given to how it would be used by teachers and students, how it would be incorporated into the curriculum, or the community's attitudes toward technology adoption. Scholars have therefore suggested that access to hardware alone rarely leads to change (Adeya, 2002; Bracey, 2005).

It is essential to recognize that factors influencing communities in the Asian rural context differ considerably from those influencing their urban counterparts, who have an upper hand in using technology due to existing technological familiarity, and economic and educational privileges (Chib & Zhao, 2009; Jhurree, 2005). Studies from technologically advanced countries have found that ICTs support problem-based learning and critical thinking, and that children should be exposed to a variety of more complex programs and approaches that encourage higher-level learning (McGhee & Kozma, 1999). In reality, however, rural children who might not have had the chance even to get basic exposure to technological devices might struggle to engage in higher-level learning. In this case, equipping children with basic technology knowledge and skill-sets should be prioritized (Kozma, 2006). Therefore, it is essential that projects are designed with attention paid to the needs of the users, as opposed to the commonly adopted one-size-fits-all approach.

There have been several instances of governments and manufacturers adopting a one-size-fits-all approach that prioritizes technology over users, where consideration for end-user needs and involvement of the local community have been ignored (Hollow & Masperi, 2009). While many such projects have, for the most part, succeeded in providing ICT access to previously unserved groups, an equal and rising number of failed initiatives, often due to the lack of timely, accurate evaluations (Heeks, 2002), point toward a common criticism of ICTE research and implementation: the need to understand the rural communities within which the technologies are

implemented. Further, the ICTE literature has focused on technology adoption rather than developing a comprehensive understanding of the factors that influence adoption and, eventually, the impact of ICTs on educational outcome measures.

To develop such an understanding requires a twofold approach: 1) investigating the mechanisms underlying the process of effects and 2) developing rigorous metrics that capture the influence of technology on educational outcomes. This study focuses on the first objective.

Supporting the current claims within the ICTE literature, the present study emphasizes that specific community aspects need to be addressed, along with underlying cultural, psychological, and community factors that influence technology adoption. First, the ability to have physical access to technology is captured in the ownership aspect. Community training for technology use and catering to contextually relevant needs represent the other two factors.

Ownership

Prior research suggests that the more children use technology, the higher their academic achievement (Middleton & Murray, 1999). Access can be explained in terms of the amount of time one gets to use the technology, the frequency with which it is used, the extent of engagement during usage, as well as the extent of barriers to usage (Hohlfeld, Ritzhaupt, Barron, & Kemker, 2008). Of these components of access, barriers to use due to sociocultural factors, particularly gender, are often highlighted in the ICT literature (Chib, 2010). Often, implementations do not take into account the need to ensure that girls are given equal contact time with ICTs, or even the challenges they might face in a setting that privileges education for boys (Mark, 1992).

Training

While students are the primary beneficiaries of ICTE interventions, teachers remain the gatekeepers of students' access to the educational opportunities afforded by technology (Carlson & Gadio, 2002). Thus, teachers play an important role in the use of computers in classrooms (Baki, 2000). Teachers in rural areas, who are not trained in the instructional use of technology, face constant challenges in obtaining computer skills and using them for pedagogical purposes (Fontaine, 2000). In such situa-

tions, children might take on the role as leaders in learning to use the computers in classrooms (Abi-Raad, 1997). However, providing formal technological training to teachers would better address the challenges in integrating ICT in teaching in a productive manner.

There are psychological barriers to teachers' willingness to use technology, beyond having the requisite technological skills (Zhao, 2008). This is illustrated in the Chinese case, where elder teachers were afraid to use the technology, being worried about not being able to learn the required skills. Though children were able to grasp computer skills faster, additional training courses were designed to make teachers both comfortable and knowledgeable (Zhao, 2008).

Thus, teacher training needs to look at equipping teachers with the right skills and knowledge to subsequently train children by themselves. Further, some studies reported that females tend to exhibit higher levels of computer anxiety (Chou, 2001; Harris & Davison, 1999; Todman, 2000) and more negative attitudes toward technology adoption (Durndell & Thompson, 1997) than males. This fact is especially significant in rural schools, where most teachers are female.

Needs

The human capabilities approach of Nobel laureate Amartya Sen (1999) prioritizes the role education plays in the enhancement of capacities and opportunities for human development (Saito, 2003). Applying the capabilities approach to ICT diffusion in marginalized communities would then entail the distribution of relevant information that makes access usable and impactful (Garnham, 1997). Access to ICT materials in such communities may be limited by the lack of information in local languages and on locally relevant subjects (UNESCO, 2007). Providing information with technical details or terminologies that users might not need or understand (Keniston, 2002) leads to significant barriers in ICT adoption.

Therefore, the provision of locally relevant content, particularly with language that is familiar, would make content that is easy to find, understand, and navigate (Hollow & Masperi, 2009). Since the majority of computing technologies do not offer software to translate text, some initiatives use cus-

tomized programs for learning that use local languages. Though limited in quantity, there is some software for children that serves specific learning objectives, in subjects such as mathematics and science, and that incorporates graphics and text. This software does not, however, place much emphasis on the operation of technology (Becker, 2000).

Next, we critically review theoretical models that address the use of ICTs in education. The objective is to select a critical framework within which to situate a study that captures the key factors of ownership, training, and needs.

Theoretical Review

The value-of-ICT-to-education model of Banuri, Zaidi, and Spanger-Siegfried (UNDP, 2005) proposes that learning using ICTs, unlike the traditional approach in education, is able to produce four benefits: as a producer of opportunity, as an enhancer of capabilities, as an enabler of social ties, and as a generator of knowledge. This model focuses on outcomes, rather than the mechanics that lead to successful outcomes. It can be critiqued for failing to identify the distinguishing factors that enable community adoption, instead assuming a homogeneous outcome of ICT adoption across users. This positivist stance of the model veers toward a technological determinism in guiding the design of implementations and sheds little light on how projects should be managed across a variety of stakeholders.

Conversely, actor-network theory (Callon, 1986) supports the theoretical review to recognize the social entities involved in education, such as teachers, students, families, village leaders, government bodies, and technology manufacturers. It recognizes the mutual roles of technology and community within the civic and educational systems (Esnault, 2007). This symmetric view of people and technology as occurring in a network of interactions is especially meaningful to the study of ICTE, where communities, stakeholders, and technologies interact simultaneously to direct the overall impact of effective implementations. Nevertheless, this perspective fails to capture the community characteristics of how training needs to be considered alongside acknowledging different needs of users, while providing undivided access to educational technologies.
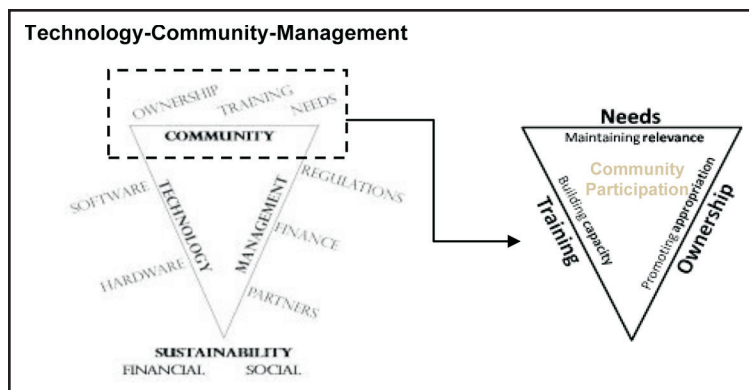
Figure 1. Community Focus of Technology–Community–Management Model.

Technology–Community–Management Model

One possible basis for the examination of ICTs in education, and quite possibly for other development contexts as well, is the Technology–Community–Management (TCM) model (refer to Figure 1; Chib & Zhao, 2009; Lee & Chib, 2008), which brings together three components that influence participation in ICT initiatives relevant to the various stakeholders involved: technology, community, and management, branching out to specific characteristics within each component (Chib & Zhao, 2009; Lee & Chib, 2008). The model is useful in identifying components that operate within a social context from a community perspective. It is worthwhile to note that the model focuses on the mechanisms or factors influencing successful technological adoption and is not designed to evaluate ICT projects.

Developing countries, faced with the challenges of using ICTs as learning tools to improve and re-form education, first have to deal with the challenges involved in managing these endeavors (Kozma, 2006). First, the model depicts the relationships, roles, and constraints involved in the management of ICTE deployments, arguing that stakeholders interact to play three primary roles as regulators, financiers, and partners. Although the magnitude of the demands and influences of these roles vary, the critical assessment of community-level needs inevitably affects community participation—particularly in rural communities, where parents, peers, opinion leaders, and village heads are pivotal

in directing the needs of children as well as the management priorities of other stakeholders.

Second, the model states that the hardware and software components of technology subsequently drive the information used in teaching and learning. Hardware, beyond a device-centric view, includes establishing the communication and physical infrastructures within rural areas. However, as argued earlier, some actors behind ICTE initiatives have tended to prioritize technology, viewing computers as standalone entities to solve problems in rural education. Furthermore, technological resources incorporated in schools lack relevant content; hence teachers in third-world countries struggle to integrate the programs available into existing curricula (UNDP, 2005). Scholars have argued that the plethora of computer-based content resources available, such as online databases and websites, educational games, CD-ROMs, e-books, open-source software, and multimedia applications, does not often cater to specific informational needs of rural learners (UNESCO, 2007).

Finally, children as the central beneficiaries in ICTE programs, accompanied by their teachers, form the core community connecting to issues of management and technology. The model highlights that training for the acquisition of technology literacy, and direct or indirect ownership of the technology, in accordance with needs is essential in community-centric development of ICT initiatives.

The community dimension of the TCM model stresses that the process of technology adoption can be enabled with the involvement of the users. Community-centric interventions consequently require an understanding of (1) ownership (that is, promoting ownership by making access available), (2) needs (that is, making ICTs relevant to user needs), and (3) training (that is, building capacity through technology training), which are influential factors that impact the introduction of technology in a given context. These aspects should not be regarded as distinct entities, as they are likely to be interrelated.

Research Focus

The purpose of this article is to address current gaps in research by illuminating specific community factors that influence technology adoption in rural schools of developing countries. Specifically, the Technology–Community–Management model (Chib & Zhao, 2009; Lee & Chib, 2008) focuses on the community component to illustrate the three claims of ownership, needs, and training. Anchored in the TCM theoretical framework as a guide to analysis of community aspects, the main research question is: What factors contribute to, or detract from, technology impact on educational outcomes in a developing country context?

Method

Context

India has more than 190 million school-going children from the ages of six to 14 (Panda & Chaudhary, 2001), and some eight million children do not have access to education (UNICEF, 2009). In response to the global call for Education for All, India established the *Sarva Shiksha Abhiyan* ("Education for All" Movement) in an effort to make primary education universally available. In reality, however, India has a limited basic school infrastructure in place, with an education system facing challenges similar to those in other developing countries (Manzar, Phalachandra, & Sinha, 2005). Key stakeholders, such as government bodies, nongovernmental organizations (NGOs), school administrators, donors, and policy makers, recognize the need to shift from traditional brick-and-mortar scholastic systems to an approach that leverages ICTs as tools for learning. Hence, NGOs were receptive when approached for collaboration on the project.

From June to July 2009, fieldwork was conducted in an Indian primary school to validate the community claims of ownership, needs, and training proposed in the TCM model. A short list of NGOs with access to village schools was created. The NGO Asha Chennai was selected based on a review of their work conducted in rural areas, especially in several village primary schools—a criterion other NGOs failed to fulfill. Using convenience sampling, a government-run primary school located in Pudur village in the Thiruvallur district of Tamil Nadu was identified. This state-run primary school had condi-

tions and facilities that were representative of most state-run elementary schools in rural India. While many village schools suffer from overcrowding, a number of schools in remote villages have a student population ranging from 20 to 50 learners. The shortage of qualified teachers, typical to this context, often results in teachers handling multiple grade-levels simultaneously. Finally, prevailing poverty and lack of resources deny most schools the luxury of acquiring mainstream ICTs. The availability of power supply for charging the laptops was the main criterion under which the school was shortlisted. While most schools were located in extremely remote locations, access to this school for research was possible via local suburban buses. Another important selection criterion was that the school principal was agreeable to the research being conducted during school hours, while other schools were not keen on disrupting their daily curriculum timetables.

The Pudur village elementary school was located at the center of the village, with a total student capacity of 30 children. Two teachers conducted lessons for grades 1 to 4 en masse in a common room, while the third teacher held fifth-grade classes in another classroom. The children belonged to a community of lower-caste Hindus and spoke dialects of either the Tamil or the Telugu language. The families lived below the poverty line; about one in 12 households owned a mobile phone, and every household had a government-sponsored television set. School amenities and learning materials were supplemented by the NGO. There was no Internet access available in the vicinity of the village. Neither the principal nor the NGO was keen on establishing an Internet connection to the school through a local service provider, because of the expenses involved.

Participants

Ten children, between the ages of six and nine, in grades 1 to 4, and including both genders, were randomly selected to participate in the study. The selection was guided by the criteria that all children were to be from similar socioeconomic backgrounds and had no prior exposure to any form of computing technologies. For the in-depth interviews, three school teachers were selected. The teachers were all in their 30s and had one to five years of teaching experience. Nine parents, represented by mothers of

Table 1. Examples of Topics and Sample Questions Asked.

Respondents	Topics	Sample Question
Children	• Attitudes toward learning to use computers • Issues faced in having physical access to/use of computers	• What do you like or dislike most about using the computer? • What are your biggest problems in using the computer?
Teachers	• Attitudes toward computer use in classroom • Attitudes toward technology training	• What do you think would be some of the challenges you might face in using computers to teach? • How do you think children will respond to computer use? • How do you think computers can be made relevant to children's learning?
Parents	• Attitudes toward technology adoption by children	• How do you think computers can help/not help children with learning? • What do you think will be some issues in giving children access to computers?

the participating children, participated in the focus-group discussions conducted.

Procedure

Ethnographic research is a qualitative research method that allows the researcher to interpret the context under study from the perspective of the participants in the investigation (Dobbert, 1982), through making inferences from probing questions and observing people in their natural setting (Spradley, 1979). The ethnographic focus was explored through semistructured and in-depth interviews, focus-group discussions, and participant observations that emerged from the community aspects addressed in the theoretical framework. A sample of questions, aimed at specific respondent groups and categorized by identified themes, can be seen in Table 1.

Over the course of a month, the children interacted with two laptop computers for approximately 30 minutes to two hours during each school day, in the presence of the principal investigator. Daily time schedules were negotiated with respective teachers so as not to interrupt the established school curricula. They gathered either as a large group or at intervals in self-selected smaller groups, comprising two to four children to each computer. It is important to note that the focus was not on the type of program used or how technologically literate the children were, but on understanding how students used ICTs and the mechanism affecting productive use.

The principal investigator assumed the role of a detached observer; presenting the hardware and observing the interactions between teachers and children alike. In some instances, due to teachers' lack of computer literacy, the principal investigator gave basic instructions on computer usage, such as switching on the laptops, and moving the on-screen cursor. Subsequently, children's usage of the devices, and their interactions with one another during usage were observed. Their attitudes toward learning and the kinds of problems faced while getting familiar with the technology were noted. Informal, semistructured interview questions, ranging from broad to specific queries, were asked, with sessions lasting between 10 and 30 minutes per child. To ensure that these interviews did not disrupt student computer use, questions were asked either at various intervals during their interactions with the laptops, or at the end of a session. The observations were also used to form future questions to be asked during the informal interview sessions. Field and interview notes were regularly reviewed to determine issues that needed to be expanded on and included in subsequent sessions with children. Specifically, issues limited to equality in technology access, particularly for those triggered by gender bias were investigated. In addition, difficulties in navigation and content-comprehension in devices

that used the English language as the primary medium were observed.

In-depth interviews were conducted with the three teachers at various points during the fieldwork. The first round of interviews was aimed at getting a better understanding of the children's lifestyle and attitudes. The questions to teachers probed the challenges and involvement of parents, since teachers had maximum contact with the local community. The teachers were later interviewed to understand how training in technology could be made appropriate for them. They were asked if they were, first and foremost, interested in being trained to use the ICT, and further, about their attitudes and concerns toward using technology in the classrooms.

For the focus-group discussion, parents of participating children were interviewed in the village gathering area for about two hours. The questions focused on the theme of education for the poor, ownership and acquisition of ICTs for the children, and their attitudes toward technology adoption. All interviews and focus group discussions were conducted in Tamil by the principal investigator, as the level of English literacy was low with both teachers and students despite the language being taught in schools. The participants, from this Tamil-medium school, were more comfortable conversing in the local language.

The principal approved the study and was briefed on the project procedure and the expected time allocation during school hours. The purpose of the research and protections from possible risks were explained to the teachers and the parents of prospective participants. Parents of each child were informed that participation was voluntary and that participants would be able to withdraw from the study at any time. A consent form was translated into Tamil to obtain formal parental signed consent for their child to participate in the study. Individual names have been withheld for reasons of confidentiality.

All questions were developed around the theme of the community aspects. The questions were translated into colloquial Tamil and back-translated to check for errors.

Interviews and discussions were audio-recorded for transcription and translation purposes with the respondents' informed consent. The comments have been summarized as examples. The translations and

transcriptions for analysis were conducted by the primary investigator, who is bilingual in English and Tamil. Throughout this project, the Asha Chennai team in India provided logistical support, and specific procedures were followed. All the respondents involved in the study were given either stationery or food hampers in appreciation of participation.

Data Analysis

Thematic coding, involving the interpretation and categorization of information with reference to the themes in the context of the TCM model's community framework, was used for data analysis. Data were collected and reviewed concurrently, with transcripts reviewed and topics catalogued based on recurring issues. These thematic patterns were used as a guideline to explain the community factors that influence the impact of ICTE in rural India. A triangulation of methods such as interviews and observations allowed for the cross-validation of the findings and to add to the emerging descriptions. Respondent comments and interpretations of observation notes are provided in the next section to highlight the analysis.

Findings

Applying the participatory-technology design perspective of the TCM model requires a holistic understanding of the community involved. Rather than adopting a technological deterministic approach, this user-centered perspective emphasizes the need to consider communities' potential responses to technology introduction. First, with "ownership" defined as providing access to ICTs, sociocultural barriers such as gender discrimination and power issues influenced access. Second, the informational barriers that teachers faced extended to their attitudes toward training, as well as psychologically impeded their perceptions of the importance of ICT in education. Finally, a fundamental user need to understand the provided information surfaced from the inability of computer programs to function in the local language.

Ownership Aspect: Unbiased Access

In the rural context, girls were sometimes kept home from attending school and instead expected to perform domestic duties. This disparity carried over to parents' attitudes toward computer learning where one said, "It will be better for our sons to

Figure 2. Boys dominating computer use over time, from all children gathering around the PC to fewer girls managing to stay, until only the boys remained.

learn how to use the computer. [Boys] are the ones who will be furthering their studies . . . computers will be useful to them."

Responses from a teacher interview confirmed this sociocultural barrier to access, reinforcing the gender divide, although teachers acknowledged that many girls were more academically capable than their peer group of boys. This historical bias in favor of male children stems from the belief that boys inherit the family wealth and take care of the parents in their old age. Girls, on the other hand, are expected to leave the ancestral property once married. Thus, greater resources, such as education, are devoted to the upbringing of male children. Teacher 1 commented:

> Given a choice, we [teachers] would have chosen only boys for this project. I am not saying that this is not necessary for the girls . . . since in my class itself the girls perform much better than boys because they are sharper and learn fast. . . . Maybe it might be more useful for boys to learn since it has been so difficult to keep their attention . . . or to make them study as hard as the girls.

Some teachers held the opinion that academically stronger children would be better able to grasp computer skills, and subsequently benefit from it, as compared to academically weaker children. This is illustrated in a teacher's comment, "Give the computers to the smarter kids; they will be able to learn better than the rest."

This biased attitude translated to a lack of attention from the teachers in coordinating equal access to the technology between both gender groups. Gender discrimination was even exhibited by children, when boys enforced a sense of power and control over the girls in the classroom. Conse-

quently, boys tended to dominate laptop use, often resorting to aggressive methods to gain control and deter girls from using the devices (see Figure 2).

Older boys took "charge" during sessions when the group had access to the laptops, and ordered their peers, largely composed of girls, to "sit around and watch." After many such failed attempts, the girls got distracted and moved away to engage in alternative play activities among themselves. A student from grade-level 3 commented:

> You see how the boys are hitting us?! They don't even want to let me see or even touch the computer no matter how much we ask. . . . There is no use for me to stand here and wait anymore.

Training Aspect: Teacher Training

While teachers were enthusiastic about technological training, they expressed resistance to learning about the laptop for two reasons. Firstly, teachers were under the impression that ICT training would be too complex and that instructions and expectations would be beyond their capabilities. A teacher recalled, "At home, my older kids use it and my husband also knows how to use the computer, but it seems so difficult. . . . The government did say that we teachers will be given some kind of computer training . . . but I don't think I can do it."

Second, teachers were reluctant to make the extra effort or create time for training. In a number of rural schools, due to the shortage of human resources, one teacher might have to perform both administrative and teaching duties, often across all grade levels. As one teacher described it, "We have so much work to do and syllabus to cover. How do you expect us to learn something new on top of all this?"

Figure 3. Teacher Dominating the Use of the Laptop.

A more pressing issue might be teachers' core attitudes toward the adoption of ICT for pedagogical purposes. Teachers unanimously maintained that primary-level children would not benefit from technologies, stating, "What are children going to do by learning how to use computers? They are only in the primary level. It is us teachers who need to learn, not them."

Teachers' perception of the lack of ICTs' value to the children, in addition to a latent curiosity, resulted in teachers interrupting sessions when children used the laptops, trying to "snatch" the devices away from the children. Figure 3 shows a teacher trying to dominate the computer use in the midst of children's learning sessions. One teacher ordered the students, "You go away! Let me see what this can do." She would then perform an action, which if incorrect and corrected by a child, she would state, "You don't know! This is how you do it." The teacher would thereupon continue to perform the incorrect action.

Furthermore, teachers would criticize children who raised doubts about using the laptops. These observations suggest that teachers did not have sufficient prior knowledge of computer use. Initia-

tives such as the "Hole in the wall" computing project allowed informal, unsupervised learning for children alone or in groups (Simmons, 2005) without instructional aids. However, in a classroom context, teachers played an important role as knowledge providers and guides. Thus, it becomes necessary that they be well equipped with the necessary skills and information to enable learning for students using ICT. In this particular case, teachers monopolized the computers, both to enforce their authority and to attempt to instruct. It was observed that teachers who were not computer literate were not open to being guided by students, and instead delivered incorrect information.

Needs Aspect: Local Language

Children were not able to read the English text on the laptops, but referred to corresponding picture icons to navigate some programs. However, without basic computer literacy, children were not able to decipher the meanings or purposes of various computer terms and symbols necessary to use the technology efficiently. This often resulted in children randomly hitting buttons or keys. Many children ultimately gave up on constantly trying to figure out the uses of the icons. Once basic information was provided in the local language, students were able to grasp the meaning of particular icons enough to proceed. This was especially significant in an educational system where learners were trained and accustomed to reading and writing in the local language. More importantly, the informational barrier due to language unfamiliarity posed an additional psychological impediment to children who deemed the laptops as "more difficult to use." In other words, the language barrier added to the sense of unfamiliarity toward a device completely new to children's understanding. In such conditions, maximizing the application of local language within the technology was necessary to make children more familiar with technology use and operation, while reducing informational barriers to technology adoption.

Discussion

This exploratory study intended to better understand existing values and attitudes toward technology adoption on the part of teachers and children—the principal users of technology in the classrooms. While existing studies examine the integration of

technology for pedagogical purposes, typically in the developed urban context, we have tried to fill a research gap by answering how technology adoption can be enabled within a community of rural users. It was found that community factors that influence the adoption of ICTs in the rural education context can be translated into three claims, as suggested by the community dimension of the Technology–Community–Management model—a need for provision of unbiased technology access to children; a need for maximizing application of local language within technology and content; and a need for equipping teachers with technological skills while creating positive attitudes toward technology adoption.

Recognizing the imperatives of technology adoption as a fundamental issue in achieving developmental goals, this study contributed to an understanding of community factors within technology that need to be addressed, especially in efforts that seek to use ICTs to improve the educational system in developing countries. The theoretical claims were subsequently validated in the fieldwork findings and raised questions about the implementation of ICTE initiatives and policy adjustments. This Indian case study may help guide rural educational policy in a broader global context. It is important to note that the successful implementations of these recommendations are dependent on understanding the complex social and cultural systems in various developing country contexts.

Implications for Ownership

One of the possible conditions of equal access in scholastic conditions would be to maintain gender segregation in ICT use. ICTE projects should ensure that every boy and girl is allowed equal opportunities for use in the classroom, enabling them to work either individually or collaboratively in groups. However, the benefits of gender segregation need to be investigated further. We hesitate to endorse gender segregation categorically as an ideal model for optimum learning in a rural educational setting. This is for two reasons. Firstly, enough studies point to the benefits arising from collaboration in technology usage. Second, there are social implications of gender segregation at an early age that may have repercussions on gender dynamics. Although we may witness increased access to computing, the negative unintended consequence of biasing the gender hier-

archy against women needs to be a serious consideration.

Children and teachers need to be informed from the time of project commencement that girls and boys are to use the computers equally—separately if required, but only if absolutely necessary. Therefore, an ICTE intervention would ideally allow for unbiased usage. Ideally, usage should take place in a mixed-gender environment, with project managers and teachers ensuring that girls are given equal opportunities for technological access, without interruption or interference by boys.

Further, realities in technology adoption in schools also require attention. Beyond issues of social status relating to gender, which is only a single dimension on which discrimination could occur, it was observed that power associated with age also plays an important role in technology adoption. It was observed that in a setting where children of more than one age group are taught together, the older children tended to dominate laptop use habitually. Older boys would inevitably be on the winning end. In addition, children from grades 1 to 3 were found to be less receptive to laptop use. Perhaps they had been newly exposed to the school's learning materials and were still in the process of assimilating into a formal education system. Further, it was also observed that children in these classes were not as forthcoming about technology use as their older peers, probably in response to the dominating seniors. Hence, alongside existing gender disparities, age, too, becomes a factor that needs to be taken into account.

Although the selected school was a good fit with the required criteria of studying the rural village context, the similarities between the participants in terms of the widely practiced Indian caste make-up limited the exploration of a host of complex sociocultural issues common in this context. Others that could be considered include social, economic, religious, cultural, geographic, and national dimensions.

Implications for Training

Interventions aiming to train teachers in technological usage should focus on two issues. Firstly, ICTE program managers should try to reduce technological anxiety, including computer anxiety (Chua, Chen, & Wong, 1999), by conducting training using a less intimidating approach wherein teachers are both

comfortable and confident of their capabilities to learn. In addition, it is essential to promote positive approaches in teaching technology to children. It has to be instilled in teachers that computer learning could benefit primary school children and that teachers would have to take on the role as expert mentors who guide, not compete with, children's use of the technology.

The evidence supports the notion of the TCM model that teachers should be trained on how to operate the laptops, as well as be made familiar with the programs available before children are introduced to them. In doing so, they would be well equipped to answer queries arising from children and optimally facilitate ICT use in the classroom. To achieve this, the training sessions need to incorporate a guide on how teachers should ideally approach students, in addition to the focus on developing teachers' technological abilities. Essentially, teachers need to be constantly encouraged to treat all students fairly, regardless of differences in gender or academic achievement.

In rural schools, which normally adopt a teacher-directed instructional approach, teachers might find it difficult to change to the role of facilitator or to allow play and experimentation in a new ICT-enabled setting. Claims of enabling collaborative learning among children with minimal involvement of these authority figures might not be relevant in this context. Hence, as emphasized in the TCM model, effectiveness depends on providing suitably devised training to teachers. In addition to preparing teachers to take on the role as informed mentors in the classroom, it is also important to communicate the usefulness of a technology in helping to increase their work efficiency and to reduce labor. Thus, training would equip teachers with the technological know-how, along with fostering positive attitudes toward adoption.

Implications for Needs

Information and communication technology in education (ICTE) projects should consider devices that provide the option of translation to local languages, in the absence of which translated instructions and content for schools should be provided in hard-copy formats. It is important to ensure that these translations do not potentially lead to a confusion in navigation or impede use of existing content based predominantly in English. The design of ICTE projects needs to consider measures to reduce the

potential risk of children being unable to understand complex technical words, even when presented in the local text.

To assess community needs holistically, ICTE program managers should consider the role of parents in influencing technology adoption. Conversely, there may be situations where parents' role is made less important. For instance, although parents acknowledged the possible benefits of ICTs for their children's education, the mothers interviewed were of the opinion that laptop use and learning ought to be confined to schools and monitored solely by teachers. Parents were not prepared to take responsibility for a laptop should the child bring it home. This hierarchy, and possible fear, could also be due to low formal studying and literacy levels of parents, themselves unfamiliar with the technology. It is for these reasons that the focus of an ICTE intervention often turns to the community of teachers and students.

Conclusion

The study attempted to prove, with research carried out in a specific context where the use of technology in education is very relevant, the potential value in the adoption of technology for learning. The thorough review of sources within the Asian rural context, which is largely generalizable to the Indian perspective, demonstrated and supported the claims of underlying cultural, psychological, and practical community factors that influence ICT adoption.

Addressing the second objective of developing rigorous measures that capture the impact of technology on educational outcomes is certainly a direction for future research. At the World Economic Forum in 2005, the imagination of the world was captured by the excitement surrounding the idea of a $100 laptop. Since then, numerous initiatives have targeted affordable computing devices catering to marginalized populations in a rural situation that could not previously afford computing technologies (Ali & Langendoen, 2007; Goldstein, 2004). Explicitly targeting the education sector, low-cost computers distinguish themselves from the conventional personal computers and low-range commercial laptops, with a combination of proprietary and open-source software. These child-centric programs, along with lightweight, bright-colored device bodies, claim to be relevant and fun for young learners.

Although low-cost computers, such as the One

Laptop per Child (OLPC) laptops, have been consistently drawing international attention, academic research has only recently begun to understand the impact of these emerging educational technologies on rural populations. It is at this stage that findings on community influences on technology adoption could be used in the design of ICTE initiatives to examine the value of teaching using technology.

The TCM model shed light on community factors that need to be addressed in the design of an ICTE project. It pointed out that early training of teachers would equip them to be expert mentors in class. Contrary to popular claims that support individual ownership of the low-cost OLPC laptops, rural schools are not in the ideal financial situation to afford one laptop for each child. Consequently, this would call for a shared ownership or use of the laptops, which makes equal access critical. Finally, the importance of using local language to help familiarize students with technology has also been highlighted.

By addressing the community factors discussed in this article, and aligning implementation strategies to these considerations, ICTE initiatives have the potential not only to achieve the larger goal of improving the quality and access to education for all, but to improve the learning outcomes of children in developing countries. ∎

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