For two months, Monica, an English teacher at the Kannar village school in the State of Uttar Pradesh had been receiving a video feed of recordings of live lessons given by some of the best teachers at a highly regarded urban school in the capital city of Lucknow, some 30 km away. During a routine monitoring visit by us in November of 2005, fully expecting to see Monica using the videos in front of the village children while she actively interacted with them as she was trained to, we were surprised to see that Monica had decided on her own initiative not to use the videos in front of the children at all. Instead, she had carefully studied the videos on her own ahead of the scheduled classes and took copious notes to the point that she could largely replicate what the videoed model teachers had been doing without actually playing the videos. We learned that the thrill of self-improvement was very much fueling Monica’s enthusiasm for learning both the subject matters as well as the teaching methodology.

To us, the creators of a new project called the Digital StudyHall that aims to “network” the best urban schools with their surrounding village counterparts to improve rural education, Monica is a best-case scenario, as both children and teachers are gaining access and learning from the best teachers in a way that they could not have done before.

In the remainder of this article, we briefly describe the twin pillars of the project that are behind Monica’s success story: the technology and the pedagogy. In many ways, this is not “yet another distance-learning project.” Technology-wise, a key principle is cost-realism through innovative use of what is available; and pedagogy-wise, the main principles are recognizing and working to bridge the gaps between schools of different backgrounds, and proactively involving people in the loop, instead of their being overshadowed by technology.

Technology
The e-learning landscape is littered with misguided and expensive “wire-the-school” projects that have little to show for in the end. To avoid retracing those missteps, one of the most important principles that we follow is cost realism. A conventional “wire-the-school” attempt is not feasible for large-scale replication in rural India today. Our Digital StudyHall system has three key novel components: the Postmanet, EdTV, and the Learning eBay.

In essence, in the Postmanet, our first key component, computer network packets normally placed on wires are now placed on DVDs transported by the postal system. The Postmanet allows us to have pervasive, high-bandwidth, and low-cost asynchronous connectivity to just about any place, including the remotest areas. No existing conventional networking technology possesses this combination of features. Such a high-latency and high-bandwidth channel can also be complemented by a low-latency and low-bandwidth link, such as a cellular or a packet radio link. A key use of this approach in the Digital StudyHall is a Postmanet-based http (or phttp) mechanism that allows village schools to interact with a web-based content repository housed at the Lucknow headquarters via the postal system. A robotic arm-operated DVD processor connected to the server allows us to automate almost all aspects of the phttp operations. (See Figure 1.)
The second component, *EdTV*, allows us to turn regular TVs into “thin client displays” driven by a shared computer (or a cheaper player device). The most immediate benefit of this approach is that it provides a low-cost solution to the “display problem” in village school classrooms: the problem of not having enough computer displays for all students to see clearly. The implication of the EdTV approach, however, can reach beyond the classrooms. (See Figure 2.) The one-time setup cost per village school can be as low as $300 if the village has relatively stable electricity supply, or $500 if electricity supply is intermittent.

The third component is a digital repository, today housed at the Lucknow headquarters school, accessible by both the conventional Internet and the Postmanet. In the space of about four months since the deployment of the project, we have already rapidly populated the repository with about 50 GB of content, which includes 120 digital recordings of lessons staged by the best teachers at the headquarters school. The remainder includes Hindi science courseware developed by our staff. The content accumulation continues and we are beginning to experiment with an even richer variety. As the high-quality content is quickly and cheaply generated, it is being continuously pushed out to two village schools: one in Kannar, and one in Madantoosi. We are also beginning dialogues with other educational NGOs on exploratory expansions of the system, and a similar repository will next be started in Calcutta. We envision the system growing into a network of hubs and spokes, which over time may become a *Learning eBay* that connects students and teaching staff and volunteers across time and space, bridging the rural-urban and public-private school gaps. (See Figure 3.)
It is useful to compare the Digital StudyHall against satellite-based approaches. Satellite-based approaches are expensive and they require a great deal of support infrastructure. Satellites are a good broadcast medium: a small number of one-way streams consumed by a vast number of content consumers. But broadcast models are poor ways of delivering customized content and allowing two-way exchanges. Satellites can also be used to support non-broadcast or even two-way communication. If we do that, however, we face a severe bandwidth problem: each of a large number of communication channels only gets a small fraction of the aggregate bandwidth. The bandwidth limitation is especially serious on the uplinks. One important advantage of the Digital StudyHall is that it allows high-bandwidth, any-to-any, point-to-point communication, which in turn enables a high degree of content customization and rich two-way exchanges (such as student submissions and feedback).

**Pedagogy**

Having briefly described the hardware and software technologies underlying the system, we now examine how we can teach effectively using the system. On day one, we were facing three very different schools that we have close relationships with: the private StudyHall morning school attended by upper-middle class students, the Prerna afternoon school attended by girls from neighboring slums, and the public Madantoori village school, all shown in Figure 4.
Figure 4: a tale of three schools. (a) The urban StudyHall (morning) school. (b) The afternoon school for girls from slums, the Prerna school, housed in the same premises of the morning school. (c) The Mandantoosi village school.

One may naively believe that the content transfer strategy is straightforward: we just need to digitally capture classes in the morning school and transmit them to the village school for viewing by students, as indicated by arrow #1 in Figure 4. A realistic practitioner, however, would see that the story is not so simple. The morning school uses English-medium instruction and follows a national board for textbooks and syllabus; the village school uses Hindi-based instruction and follows a state board. Students of these two schools also have vastly different backgrounds. Content captured in the morning school would mean little to a village student.

Another alternative is to capture content in the afternoon school for girls from slums and to transmit that to village schools, as indicated by arrow #2 in the figure. The rationale is that the backgrounds of these girls may be more similar to those of their village counterparts. Unfortunately, the economic reality is such that we cannot afford to employ a large number of highly-skilled teachers to staff the afternoon school, so the content captured in the afternoon school is not of sufficiently high quality. This observation also implies that if we could find a meaningful way of transferring high-quality instruction from the morning school to the afternoon school, as indicated by arrow #3 in the figure, we can also significantly raise the quality of instruction received by the girls from slums.

One should realize that the complexities described above are by no means unique to this particular three-school environment. Indeed, this phenomenon is highly representative of the systemic difficulties one would face when attempting to build a system that aims to bridge the vast education gaps faced by schools and children of different backgrounds. Aware of this set of complexities, after several iterations of experimentations, we have developed a set of methodologies based on the understanding that in order to successfully exploit the technology platform described earlier, we must pay special attention to the following issues.

- **Contextually meaningful and coherent content.** Instead of recording the existing classes in the morning or afternoon school, we recruit the best teachers from the morning school to teach specially staged classes in the afternoon school. This is economically feasible because this is a one-time effort and the recorded content is to be reused. This approach allows us to combine the best of the morning and afternoon school environments: highly-skilled teachers in front of an audience whose background is similar to that of the rural audience. These staged lessons are systematic sequences based on the U.P. state board textbooks, and the teachers use the appropriate combination of Hindi and English for their classes. The recorded content is reused in both the target village schools and in later iterations of the afternoon school.
• **Active mediation by local teachers.** Obviously, playing the recorded videos alone in front of the village children, by itself, is not an effective teaching vehicle. We require the local teachers (in the village school and in the afternoon school) to proactively engage their students while playing the pre-recorded videos. For example, when questions are asked, when role-playing occurs, when poems are recited, or when songs are sung on the video, the local teachers would pause the video and get their students to perform similar activities, so the class watching the video is as dynamic and as interactive. In a sense, the video and the local teacher form a “team:” the video provides a framework, an agenda, and a content and methodology model; while the local teacher supplies the crucial interactive component.

• **Continuous training, monitoring, and support for local teachers.** The local teacher training occurs in at least two ways. First, the best teachers at the headquarters school provide in-person demonstrations to the local teachers on how to actively engage their students when using the video content. Second, the local teachers study the videos on their own to improve their mastery of both the subject matters and the methodology in the specific contexts of each lesson. Unlike conventional training workshops that last only for a short period of time and can be too abstract, the kind of training a local teacher receives from the supplied videos is ongoing, continuous, and highly specific. As the local teachers gain know-how and confidence, they may choose to use less help from the videos during live classes and improvise more. “Graduating” the teachers in this way, in some sense, can have a bigger impact than graduating students. The headquarters staff periodically visits the village schools to provide in-person feedback. For the local teachers who have gained a large degree of independence, we provide additional supplementary materials (such as complementary digital stories) to allow them to be even more effective.

We first tried this model in front of the girls from the afternoon school (Figure 5(a)). As we engaged the students and trained their regular Prerna school teachers, we saw encouraging signs of the system working well. We then replicated the system and the process in the Kannar village school (Figure 5(b)) and in the Madantoosi village school (Figure 5(c) and (d)). Preliminary results appear promising. More rigorous evaluations are part of our ongoing work, as we continue to accumulate more content, study how to encapsulate effective interactive instigations in digital forms, and prepare the system for scale-up.
In this article, we have described the Digital StudyHall system, a system that strives to deliver the best instruction digitally to rural children in a highly cost-effective manner. A key to the success of this project is to proactively engage both students and local teachers in a continuous dialogue so they learn by doing. We hope to eventually scale up the system to cover a far greater number of villages and children, contributing toward the Millennium Development Goal of universal primary education.

For more information about the project, please visit: http://www.cs.princeton.edu/~rywang/distance.