The Digital StudyHall

The DSH Team

The shortage of qualified teachers in rural and slum schools is one of the most challenging problems faced by over-burdened education systems such as the one in India. It is not unusual for a government village school housing 200-500 students to have fewer than half a dozen teachers, who are not well-qualified to teach many of the subjects that they are required to teach. And it is not unusual for quite a few of even these teachers to be absent due to various reasons on any given day. In this paper, we discuss a system that seeks to offer resource-starved schools in villages and urban slums of India human and content resources comparable to what is available to middle-class students in cities. To avoid retracing the missteps of earlier “wire-the-schools” projects, we follow two important principles: (1) cost realism, essential if we are to scale the system up to a significant number of schools and students; and (2) building systems that solve end-to-end education problems, so the twin pillars of technology and pedagogy must develop side by side, and content and people relationships must play leading roles.

We discuss four key aspects of the Digital StudyHall system (DSH): (1) a digital video database of K-12 curricula in local languages; (2) an architecture of a network of hubs and spokes for scalable content production, teacher training, monitoring, and evaluation; (3) mediation-based pedagogy that puts local teachers and students in the drivers’ seats, and allows the teachers to be trained in an ongoing and specific manner; (4) a communication infrastructure based on cheap and practical components that seeks to approximate the philosophy behind the web without incurring the high cost of a conventional network- and computer-based infrastructure. We close the paper with a brief status report and some conclusions.

1. A “People’s Database of Everything”

The Google book scanning project is attempting to create a digital database of all books ever written by humans. In a similar spirit, in the Digital StudyHall project, we are working on creating a digital video database of “everything.” (Figure 1 shows one page from the DSH database.) While sharing the philosophy and potential impact of the Google book scanning project, the DSH database has some important unique characteristics.

First, the DSH database is video-centric. This is important for a developing and predominantly rural country like India, which, by optimistic estimates, has an adult literacy rate of about only 60%. Second, at least at the beginning, the DSH database is being populated with systematic and coherent sequences of lessons based on curricula designed and sanctioned by state boards. The video recordings adhere to the curriculum topic by topic, lesson by lesson, and chapter by chapter, so it is well-structured. This is in contrast to unstructured and nearly random collections of snippets of knowledge that is difficult to find easy adoption and acceptance in existing schools. Third, the recordings in the DSH database are made by the best teachers at grassroots level. These include the best teachers in middle-class urban schools, the best teachers in rural schools, and other idealistic and enthusiastic volunteers such as university professors, scientists, college students, and NGO staff members. Like Wikipedia, over time, this database should become an open-source and evolving community resource. (Unlike the existing text-based and unstructured Wikipedia, however, the DSH database, as mentioned above, is video-centric and highly structured.) In short, the database is created by the people, and for the people.
This approach has important advantages compared to traditional forms of content creation, which is typified by flash-ware and slide-ware (Powerpoint slides). A quick glance at any accomplished teacher should convince even the most casual observer that it is difficult (if not impossible) to encapsulate what a good teacher can accomplish in a piece of flash-ware. Good teachers are often the best “performers.” It is their “showmanship,” their way of relating to their audience, their “people skills,” which are their most potent tool, a tool that is beyond the reach of flash-ware or slide-ware. Although adhering to the guidelines of state board syllabus, the lessons taught by the best teachers are highly interactive and activity-based. Video, though not perfect, comes closest to capturing the “performance” in flesh. Another problem with the flash-ware and slide-ware approach is that it is slow and expensive. One must insert a technical professional into the authoring process, who not only introduces an additional element of disconnect between the producer (the teacher) and the consumer (the students), but is also a scalability bottleneck—-it is simply impossible to build a database of “everything” quickly and cheaply based on this approach. Video is one of the few means that enables almost anyone to become an effective author.

We envision building a database that contains all subjects, encompassing all grades, spoken in all local languages, covering all state and national boards. This is a database that every child (and adult, for that matter) should have access to. We believe such a database will have profound implications for liberating knowledge, democratizing learning, and revolutionizing education.

2. A Network of Hubs and Spokes

The “People’s Database of Everything” discussed above is not intended to be a physically centralized system. Instead, DSH is designed to work as a decentralized network of hubs and spokes as shown in Figure 2. Each hub is a center of excellence and the hubs themselves are “networked” together. (We will discuss later what we mean by “networking.”) The spokes are
typically the poor rural and urban slum schools that need help the most, schools that lack good teachers, good content, and other resources. Each hub is responsible for content production (typically in a local language), content dissemination in its neighborhood, teacher training, monitoring, and evaluation, and interacting and sharing with other hubs. The hubs-and-spokes model is how we may effectively scale up the DSH system.

![Figure 2: The distributed hubs-and-spokes model.](image)

In addition to being a scaling vehicle, another role served by the hubs-and-spokes model is what we call “impedance matching.” This term refers to the need of ensuring that the content being produced at each hub is appropriate for the audience in its neighborhood. The hubs are frequently co-located with good urban schools that target a middle-class student population from affluent families. In one of our earliest attempts, we made recordings of regular classes in such a school and learned that such content was not appropriate for the target audience in poor schools. Factors such as language (English-medium instruction in rich schools vs. Hindi-medium), syllabus (CBSE national board vs. UP state board), and student background differences contributed to a big gap between middle class urban schools and poor schools. After several experiments, we settled on a “hybrid model” that was intended to bridge this gap (Figure 3). We recruited the best teachers from the middle class schools, but instead of filming their regular classes in front of the middle class students, we staged specially designed classes for poor girls from the neighboring slums. The best teachers always know to adapt to their audience and adjust their style and content accordingly, so this hybrid model combines the best of both worlds: top-quality teachers and an appropriate student audience, allowing us to produce content and experiment with pedagogy that is meaningful in the spoke schools in rural and slum areas.

Yet another way for a hub to accomplish scalable content production and ensuring its relevance is to involve the poor spoke schools in the content production process. Under this approach, the hub identifies the best teachers in the spoke schools served by the hub, organizes them into a regular recording schedule, and the resulting content is shared with the other peer spoke schools. This approach not only ensures content relevance, but also motivates the spoke school teachers and allows them to gain confidence: the teachers being recorded strive to learn and use the best methodology to put on the best shows they can, and the peer teachers who receive the content are inspired to match their peers. Involving the spoke school teachers in this manner is perhaps an even truer manifestation of the philosophy behind the “People’s Database.”
4

3. Mediation-Based Pedagogy

The principal means of disseminating the content in the DSH database is shipping DVDs to spoke schools. Each spoke school is given at least a TV and a DVD player. (Many schools also need a big lead-acid battery and DC-to-AC inverter for dealing with intermittent electricity. We are also working with some engineers to experiment with a bike pedal-powered generator.) An obvious question is whether kids can learn by just watching TV. The short answer is no. The long answer starts with the note that effective pedagogy beyond TV-watching is a crucial component of the whole DSH strategy. In this section, we discuss what “mediation-based pedagogy” is.

Put simply, “mediation-based pedagogy” refers to the need of placing a teacher (or a “mediator”) in between the students and the TV. The mediator periodically pauses the video and engages the students in various activities based on what has just occurred on TV. These activities may include asking questions, inviting kids to do board work, and organizing role-playing activities. The mediator’s job is to make his or her class as lively, dynamic, and interactive as the one conducted by the model teacher on TV. In effect, the video and the mediator form a “team”: the video provides an example, a framework, a lesson plan, and a content and methodology model; while the mediator, who may not be highly skilled in some domain-specific knowledge, supplies the crucial interactive element. Neither half is sufficient by itself, but an effective combination of the two can become a powerful instrument for addressing the critical problem we face: the acute shortage of trained and qualified teachers, especially in rural and slum schools. (Features such as allowing the mediator to play and pause the video in a way he or she sees fit, and the need of delivering highly customized local content, are what makes the DSH system more similar to an on-demand Internet-based video system than traditional broadcast TV that does not allow any of these flexibilities.)

While placing the local village school or slum school teacher as a mediator in between a TV and the students (Figure 4(a)) may be the most obvious choice, there are several other ways the mediation can work. One is “peer-mediation,” the approach of recruiting the brightest fellow students to serve as mediators during periods when the local teachers are absent (Figure 4(b)), which are common occurrences in government schools in India. In our experience, the student mediators appear to universally display a high degree of responsibility and enthusiasm when they are put in charge.

Figure 3: A tale of three schools. (a) The urban StudyHall (middle-class) school. (b) The afternoon school for girls from slums, the Prerna school, housed in the same premises of the middle-class school. (c) The Mandantoosi village school. The direct transfer of content from school (a) to school (c), labeled as arrow (1), does not work well. Instead, we use a combination of arrow (3) and arrow (2), as we film the middle-class teachers in front of the slum school audience, and transmit the resulting content to other poor schools.
Yet a third way for the content to have a positive impact is for the local teachers to study the supplied videos on their own, ahead of the live classes. This typically happens with teachers who are highly motivated and want to improve themselves. Without DSH, such motivated teachers do not have an effective means of self-improvement; with DSH, a path is open to them as long as they are willing to work hard. This path leads to a best-case scenario, when we end up “graduating” the teachers, who may indeed choose to cast aside the live mediation crutch and become effective teachers in their own right.

Regardless whether the local teachers use the DSH content to train themselves ahead of classes or to mediate live classes, they end up training themselves to be more effective teachers. There are three levels of skills involved. The first set of skills concern being an effective mediator. The individual DSH hubs are responsible for running live face-to-face training workshops, attended by the spoke teachers, as well as some of the model teachers appearing in the videos. Such a training workshop can be completed in a couple days. The second set of skills concern broader pedagogy, beyond what is required of a successful mediation session. Parts of these skills are covered by the face-to-face training workshops. The videos that the spoke school teachers carry home for their daily use, however, serve as a continuation of the training workshops, so the spoke school teachers get to observe and study on a daily basis how the best teachers teach. The third set of skills concern domain-specific knowledge, such as that is required to be a fluent English speaker for an English teacher or math knowledge for a math teacher. The spoke school teachers get to improve such knowledge through their daily use of the videos. In traditional teacher training workshops that last just a few days, the short duration necessitates that the topics covered must be kept at an abstract level, and it is not always clear how such abstract principles should relate to many of the daily topics. In DSH, the videos carried home by the participating teachers provide an ongoing and highly specific training, so this mode of training has the potential of being much more effective.

In short, the focus of DSH is not to replace people; instead, it is about amplifying the reach and the power of the relatively small number of the skilled teachers, and to train and empower the less skilled teachers, by involving all of them in all aspects of the system. In this sense, DSH is foremost a “people system,” not just a computer- or network-system.

4. Building a New Web that Includes the Poor

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. The question we raise is how we can
build a distributed video production and distribution system based on the “Web 2.0” philosophy, without having to replicate the expensive conventional physical web infrastructure.

A best example illustrating our approach is what we call the Postmanet, in which 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.

On top of the low-level connectivity provided by the Postmanet, we build the rest of the distributed DSH database in a way that is conceptually similar to how an existing peer-to-peer content sharing network works: there exists a single coherent DSH database name space that all the distributed sites can read from or write to (Figure 5).

![Diagram of a peer-to-peer content sharing database built on the Postmanet.](image)

While the above provides unconventional interconnect and database solutions, we also need to solve “input” and “output” problems for the system. As we have discussed earlier in Section 1, keyboard-based or text-based input is not appropriate for a literacy-challenged society; and we cannot even depend on people to acquire conventional computers as viewing devices. In DSH, we deploy a fleet of digital camcorders as the eyes and ears (or input devices) of the system. They are shared among the participants who contribute content into the system and they are constantly on the go. The resulting tapes are funneled to the nearby hubs for digitizing and uploading into the database. On the output side, shared TVs and DVD players economically serve as the output devices of the system.

Our vision is to build a web-like network, targeting the vast segment of the society in developing countries like India that is beyond the reach of the conventional web today. An observation that we are making is that to build a system that can fulfill the philosophy of "Web 2.0," we do not necessarily have to tie it to a conventional physical infrastructure based on traditional broadband connectivity or even computers. Instead, we can make it happen based on a more practical, affordable, and innovative approach of building it on a conglomeration of cheaper devices like DVDs, the postal system, TVs, DVD players, cell phone networks, SMS-based systems, and other new devices that we are working on. We like to think of it as “Web 3.0.”
While it shares the philosophy of “Web 2.0” in terms of harnessing user-created content and establishing user-to-user “connections,” the key aspects of what we call “Web 3.0” are leveraging these other devices and targeting a much bigger segment of the society that are not within the conventional web sphere today.

It is useful to compare the Digital StudyHall infrastructure 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 approach 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.

In addition to being a technical mismatch, satellites are also a poor pedagogy match. Satellite-based communication was originally intended for synchronous real-time applications such as live teleconferencing. What we have observed is that teleconferencing is a poor metaphor for enabling distance learning in rural areas: when an experienced remote teacher attempts to “teach” to a large number of rural sites over a live teleconferencing-style link, the many students at the many target schools cannot “pause” the remote teacher or participate in any meaningful interaction across distance on a large scale. The synchronous nature of the communication, paid for at a hefty price, ends up being a liability. The asynchronous nature of the DSH communication, in terms of DVDs that allow local teachers to take full control, to play and pause the content at will, at times and paces of their own choosing, to engage in meaningful dialogs with their local students, to train themselves after school hours, turns out to be a blessing.

5. Status and Conclusion

A live deployment of the DSH prototype has been in use by students and teachers in and around the Lucknow hub starting in July of 2005. Starting in the summer of 2006, we have launched two more hubs in Bangalore and in Pune. In the space of one and a half years, we have accumulated about 400 high-quality MPEG4 recordings of lessons staged by the best teachers at the hubs. The remaining 150 objects include science courseware, digital stories, and recordings of drama performances, all of which are produced by students and staff at the Lucknow hub school. The languages used in the content include Hindi, Kannada, Tamil, Marathi, and English. As the high-quality content is quickly and cheaply generated, it is being continuously pushed out to a variety of rural and urban slum pilot schools around the hubs. Preliminary results appear promising, and the system seems to be playing an effective but subtle role of blurring class differences in a highly stratified society. We plan to perform more rigorous and systematic evaluations in the future.

In this paper, we have described the Digital StudyHall system, a system that strives to deliver the best instruction digitally to rural and urban slum 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://dsh.cs.washington.edu.