

**Using Digital Video in Rural Indian Schools:
A Study of Teacher Development and Student Achievement**

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Using Digital Video in Rural Indian Schools: A Study of Teacher Development and Student Achievement¹

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Abstract

This research explores the deployment of model lessons through digital video as part of an in-service effort to engage teachers in government and private rural Indian schools and non-formal educational settings. Our mixed method design combined tests of skills in English and math with participant observation and videotaping of English and math instruction for 100 children in 3 rural schools and 1 non-formal setting over eight months. In this paper we present analyses of test score data and interactional patterns, followed by a qualitative examination of how one teacher appropriated pedagogical and subject matter knowledge from the model video lessons. Specifically, the data show gains in test scores of subject matter knowledge; children in classes that were part of the intervention scored almost 400% higher in English and almost 300% higher in math than did children in a comparison school. There were changes as well in classroom interactional patterns, suggesting that teachers became more student-centered in their approaches. The qualitative data illustrate how one teacher used and learned from the model lessons over time—for example, acquiring pedagogical strategies for interacting with the children and learning to connect classroom topics to the children’s local social worlds. Most generally, the data demonstrate how a network of teachers, schools, computer professionals, and teacher educators can reconfigure flows of information, tools, people, and texts, creating a band of geospatial opportunity within which the educational and social spaces of inhabitants of remote villages can be improved, allowing them hopeful entry to some of the advantages of a digital information age.

Introduction

India, with its unsurpassed linguistic, cultural, and social diversity, stands as a beacon, signaling not only its own citizens but developing and transforming societies throughout the world that improved social and economic futures can indeed be theirs. To be sure, India is a country both of vast potential, hope, and energy, and enormous problems. Its literacy rate is among the lowest in the world, especially among women, 46.8% (www.uis.UNESCO.org). Its government schools suffer low enrollment, high

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dropout rates, and both teacher shortages and extreme disengagement, while their infrastructure is so lacking that children are often without classrooms (Sahni, 2006). Given the poor state of education for the majority of its citizens, it is indeed ironic that India has acquired the status of an information technology super power, producing computer professionals renowned the world over.

The research reported in this paper investigates an effort to use information and communication technologies (ICT) to address some of the problems of Indian education, and thereby, to partially redistribute the information wealth of the digital revolution to those who are currently disenfranchised. We explore how recent advances in ICT, in particular digital video and cheap and readily available hardware, can be deployed as part of an in-service effort to engage teachers in rural Indian schools to substantively improve pedagogy and lesson content. Such a network of teachers, schools, computer professionals, and teacher educators, has the potential, we argue, to reconfigure flows of information, tools, people, and texts, creating a band of geospatial opportunity within which the educational and social spaces of inhabitants of remote villages are improved, allowing hopeful entry to some of the advantages of a digital information age.

Theoretical Framework and Related Literature

We study teaching and learning from a socio-cultural perspective, believing it essential to understand how such activities occur within particular social, cultural, political, and economic contexts. (Bakhtin, 1981; Vygotsky, 1978, 1986; cf. Cole, 1996; Wertsch, 1991). Our socio-cultural perspective not only situates teaching and learning within multiple contexts but also has a critical edge in that we emphasize the transformative functions of education, keeping in constant view its potential to effect social change and create more inclusive, democratic societies (cf. Dewey, 1995; Freire, 1970; Kellner, 1989). Understanding the complex interminglings of social constraints, social opportunity, and sources for agency is at the heart of our work and our theoretical orientation. Finally, in our socio-cultural theoretical framework, especially significant are Vygotsky's formulations about the fundamental role of language and other symbolic systems in teaching and learning (cf. Dyson, 2003; Lantolf, 2000). Like others, (e.g., Cole, 1996), we extend his notion of "psychological tools" to include the variety of representational forms that are possible in a digital age, believing that one way agency can be fostered among teachers and students is by providing access to tools and social practices that themselves provide access to the creation and exchange of information and knowledge (cf. Hull & Katz, 2006). We view technology in general and digital media in particular as enabling rather than causal (cf. Finnegan, 1988), recognizing that it is the interplay of digital tools, social practices, participant structures, and material resources, as they are configured to best advantage in particular socio-historical contexts, that results in learning and positive change.

Most research on teacher education and teacher professional development has been conducted by academics in the US, Europe, and other Western and "developed" societies, and appropriately, that research is situated within the particular social contexts of those countries and communities and is designed to address issues that arise from the specific

social, cultural, and economic challenges: the push to privatize education, the accompanying swing toward increasingly stringent accountability systems, the challenges of achievement gaps that characterize the test scores of minority and majority populations. To be sure, the forces of globalization mean that schools in all parts of the world are influenced to an increasing degree by similar pressures, and they are held to a greater and greater extent to similar standards in terms of what youth need to be able to know and do. However, it is also the case that improving education in the Indian context, and of course the context of other transforming and developing societies, requires a similarly deep knowledge of local resources, traditions, and constraints.

Our research connects with several bodies of literature, including studies of teaching English as a second language (cf. Kern, 2006) and the use of digital video and other technologies in teaching and learning (cf. Goldman, Pea, Barron, & Derry, 2007). Broadly speaking, although there are helpful overlaps with our work, including compatibilities in theoretical approach, commitment to underserved populations, and an interest in deploying digital tools, much of the available research and development has limited applicability in rural India. For example, the “Making Teaching Public” project (<http://quest.carnegiefoundation.org>; cf. Lampert & Ball, 1998) makes it possible for teachers to view multimedia representations on websites and thereby to come to appreciate the complexity of classroom life. While such sites clearly have potential value as resources for teachers, it is as yet unclear what is gained by making them available for exploration, a concern that is amplified in the Indian context.

In the next section we describe the project that is the focus of our evaluation research and that similarly attempts to use digital technologies to expand teachers’ conceptions of pedagogy as well as their subject matter knowledge by offering them access to model lessons —digital recordings of live classes taught by master teachers. However, the approach underpinning this project was designed particularly to address the affordances and constraints of the rural Indian context and that of other “transforming” and “developing” societies.

Digital StudyHall Project

The Digital StudyHall (DSH) is a research and development project carried out collaboratively by computer scientists and educators whose aim is to improve education for the poor children in slum and rural schools in India. Their approach is to digitally record live classes by the best grassroots teachers, transmit them on the "Postmanet" (through DVDs sent in the postal system), collect them in a large online database, and distribute them on DVDs to poor rural and slum schools. There are several distinctive features of their approach. (1) The first is the nature of the database. This collection, which the developers characterize as “the people’s database,” is video-centric, important for places like rural India, where adult literacy rates are approximately 60%. It consists of structured and systematic sequences of lessons that correspond to curricula designed and sanctioned by state boards, to make it easily adaptable. The lessons are live recordings of expert teachers at work in Indian schools. (2) A second crucial feature is providing a model of “mediation” for the video-recordings. That is, instead of simply directing

teachers to play the recordings for students or to watch the lesson and learn from them themselves, they are taught through in-service sessions to mediate the recordings. To do so, the teacher might periodically pause the video and engage students in various activities, such as asking questions, inviting children to do board work, or 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. Another variation of the theme is "peer-mediation," the approach of recruiting students to serve as mediators during periods when the local teachers are absent, which are common occurrences in government schools in India. (3) A third feature has to do with production and distribution of materials through a decentralized network of hubs and spokes. Each hub is a center of education excellence, and the hubs themselves "talk" to each other. 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 works on content production (typically in a local language), content dissemination in its neighborhood, teacher training, monitoring, and evaluation, and interacting and sharing with other hubs. One of the most important roles played by a hub is to ensure that the content generated at the hub is appropriate for the target audience of the underprivileged children to be served by the hub. (For more information on Digital Study Hall's approach, see, <http://dsh.cs.washington.edu/>.)

DSH has been operating in India since the summer of 2005. As of Spring 2007, "hubs" are operative in three cities in India (Lucknow, Calcutta, and Pune), covering approximately 30 rural and slum schools. During this time, some 1000 recordings of lessons in English, math, and science, in Hindi, Kannada, Marathi, Tamil, and English, have been made, and approximately 500 other pieces of content have been generated, including science courseware, digital stories, and recordings of drama performances, all of which have been contributed by grassroots teachers, students, NGO staff, and other volunteers (such as retired university professors and scientists working for government labs.) The same approach is now also being adapted to agriculture extension and rural health care information dissemination and is called the Digital Green project. Concomitant with the creation and deployment of model lessons and the expansion of the network to additional hubs and spokes is an ongoing research effort that seeks to document the impact of the project on teaching, learning, teachers, students, and communities. This paper reports the initial findings of the first formal evaluation of the work of DSH.

Methods

This empirical study relied on mixed methods: ethnographic descriptions of schools and contiguous communities; qualitative data consisting of weekly field notes, video recordings of classroom teaching, and semi-structured interviews with teachers and children; and quantitative data consisting of pre- and post-tests of subject matter knowledge and skill in English and math.

As described in more detail in the previous section, the context for the study was the Digital StudyHall project, whose purpose is to extend good teaching practices to rural areas that are resource poor and highly underserved. The approach was to video lessons taught by highly skilled teachers and to distribute them in resource-poor areas via DVD's, as well as to support teachers and students in the use of the materials. Each of the three selected schools was given a video curriculum which adhered to the UP state board curriculum. The video curriculum associated specific digital video lessons with specific dates during the school year. The video content matched the requirements of local government curriculum in such a way that if the teachers were to follow the digital curriculum guidelines exactly, they would cover all of their state-mandated material in the allotted time.

The purpose of the current study was to assess the effectiveness of the DSH program—its materials, pedagogy, and the learning gains by students and teachers. We documented, for example, how teachers and students used the materials and how these patterns of use changed over time. We looked as well at academic and social benefits, asking how teachers appropriated the modeled pedagogy, whether their own and their students' engagement with subject matters increased, and what learning gains could be identified. We sought finally to describe the impact of the resulting network of rural teachers on professional identity and collective practice.

Specifically, we asked the following questions:

1. What academic gains for children result?

How do children from DSH programs perform in math and English on pre-, post- and monthly tests of subject matter knowledge? How do they perform in comparison to children who don't have access to such materials?

2. What pedagogical gains for teachers result?

What patterns of growth are discernable in teaching across time through an analysis of field notes and videotapes? For example, do teachers demonstrate changes in types of questions asked? In variety of activities used? In connecting curriculum to children's everyday lives? Do teachers use what is modeled on the videotapes in their own classrooms?

3. What social gains result for children and teachers?

What evidence is available from videotapes, field notes, and interviews that children and teachers are engaged with the materials? That teachers use materials confidently?

Data were collected at four sites in the State of Uttar Pradesh (UP), the most populated of India's 30-odd states, and despite its adjacency to the capital of New Delhi, one of the poorest states in the country. These sites are representative of the diversity of settings in which the program is located—public/private and formal/non-formal. They included 2 public formal schools (1 of which served as a comparison or control site), 1 rural private school, and 1 rural private non-formal learning center.

(1) Prathmik Vidyalaya, Madantoosi, is a government (or public) school located in the village of Madantoosi, about 8km from Bacchrawan in the Rae Bareli district of Uttar Pradesh (UP). The school has a total student population of 200 (with 110 girls). It has 5 teachers and 2 *shiksha mitras* and uses the UP Board curriculum in Hindi medium. The students are mainly from Scheduled Castes and come from low-income families (higher income families can send their wards to the more expensive private schools). The teachers belong to middle class families. This school is comprised of a building with 4 rooms for the primary section and 1 office. Another building with 5 rooms has Class 2, Class 6, Class 7 and Class 8 (the equivalent of US grade levels). The junior classes have a table and chair benches, while the primary classes have floor mats for the students. Madantoosi has been the site of intervention efforts for a number of years, beginning with the contribution of a sole computer run by a solar panel, since electricity had not yet reached the village, along with software on science written in Hindi. Currently the school has the initial computer as well as the DVD player and Television required to demonstrate model lessons provided by DSH.

(2) About 35km from Lucknow, on the Lucknow–Malihabad road, and beyond a very big lush green mango orchard, lies Vidyasthali School in the village Kannar, district Malihabad. This is a non-government (private) co-educational school that follows the CBSE Board curriculum. Eleven teachers are responsible for 235 students (of which about 40% or 95 are girls) who are distributed among classes Nursery to Class 11. The medium of instruction for the students until Class 5 is English, while those in higher classes are taught in Hindi. The students are mainly from the backward caste (80% - Yadavs, Bania, SCs, etc.) and come from lower middle class families. The teachers are mostly from the upper middle class. The L-shaped school building has 13 classrooms, 1 office, 1 staff room, 1 Computer Room, and 1 Science Laboratory.

(3) Our third site was a non-formal education center located in the modest home of a couple who live in the village of Mauthri. Although Madantoosi is remote, requiring an hour's travel on a crowded highway and a shorter journey on an unpaved path, Mauthri is more isolated still. On the Lucknow to Barabanki road, just about 5 km short of the town, a narrow road on the right joins the main road. Four km down this bumpy narrow road, an even narrower lanes brings us to a house that is hidden from any prying eyes by a big bright yellow plastic sheet. From this house can be heard the very excited chatter of young female voices. These voices belong to 25 girls in the age group of 14 – 18 years, whose nimble fingers are busily creating 'Chikankari' embroidery work on cloth, a handicraft for which the region is famous. This is a vocational training centre to teach embroidery skills to girls, but it also now serves as a non-formal education centre that was set up by DSH. The DSH equipment (television monitor, DVD player etc) is in the small front room (7ft.x6ft.) of the house. The girls of this centre belong mostly to the lower middle class; 15 are Muslims and 7 are from the backward class (Yadav, Kori etc). They have had no earlier formal education, and DSH is nearly their first academic grounding. Besides the girls, who work in the rice fields during the day and come to this center for their entire education, there are many younger children who race to the center after their formal school ends, spilling out of

the house and onto the porch as they vie to watch the instructional videos. The lone teacher is also lower middle class.

(4) Our fourth site, like Madantoosi, is a government (or public) school. This school, Sorojni Nagar, served as a comparison site. As described below, we collected pre-test data on children's performance in English and mathematics at this school, as we did at the other schools, as well as a baseline videotape of a teacher's English lesson and mathematics lesson. We also collected post-test data on English and mathematics. However, we did not collect additional qualitative or video-based data across the school year as we did with the other schools. Government schools in India are extremely poorly resourced, and student achievement is discouragingly, depressingly low in these settings. We felt it was neither appropriate nor ethical to return to this school throughout the year in order to document its lack of achievement and its deficit in human and material resources while withholding participation in the Digital StudyHall network for the purposes of making a comparison to the schools that had been included. In the future Digital StudyHall will include this school in its network; at that time its growth and not simply its deficiencies can be documented. In the current study, reference is made to this comparison school only in the pre-test, mid-term, and post-test analyses of data.

The duration of study was eight months, beginning in July and ending the following February. In addition, we report here on qualitative data that continued to collect at the rural government school through May. In each setting we focused on the teaching of English as a second language and on mathematics, foundational skills and ones that teachers and children needed the most help with. In the formal schools we studied mathematics teaching and learning in grade 5, and English teaching in grade 3, selecting one class and one teacher as primary informants in both subjects. In the non-formal learning center, where the ages of students ranged from 9 to 14, the entire cohort and one teacher were studied. Participants numbered approximately 100, almost equally divided between boys and girls. All came from poor backgrounds socio-economically, representing families who earned less than \$100 a month and who were predominantly lower caste. At the time that we began the study, all of the classrooms had had some experience with DSH, with Madantoosi having the longest history (which is outlined in the case study portion of the findings section below). Once the study began, the DSH program was standardized, with each of the teachers receiving only minor amounts of pedagogical feedback from the DSH staff from time to time.

Baseline data for the comparison school and for the DSH schools included pre-tests constructed on students' subject matter knowledge (see Appendix A); classroom observations focusing on the pedagogy used by the teacher before or at the early stages of the intervention; and interviews with teachers and students. In addition, for the three DSH schools, we studied the program in process through weekly videotaped observations of teaching, and we conducted monthly subject matter tests as well (at the end of August, September, October, February); the latter were designed to test students' understanding of material that was expected to be covered by the time of the test, according to the timing of the introduced curriculum. In February, we post-tested students' subject matter knowledge

at all schools, and we interviewed teachers, students, and parents at the three DSH sites. Quantitative scores on tests of subject matter knowledge were analyzed using descriptive statistical techniques. Qualitative field notes were written in English, and interviews and videotapes of classroom talk were translated into English. We analyzed field notes and transcriptions of videotapes using open-ended and focused thematic codings (Bogdan & Biklin, 1998).

Analyses of Test Scores

We present here descriptive statistics of quantitative test data for students and classroom interaction patterns for teachers and students. In addition, we provide a qualitative analysis of videos collected across six months in the classroom of the English teacher at the rural government school.

Our pre-test data showed that in the government schools, where children begin to learn English as a second language by grade 3, as well as in the informal school, teachers could read and write very minimal English and had almost non-existent speaking skills. In the government schools teachers were also ill-prepared simply to teach rural students. Our pre-tests of oral and written English showed that children in the government schools and the informal setting had minimal “recitation” skills, whereby they could call out the pronunciation of simple words and copy words and brief sentences (“this is a girl”) onto their pads, but had no experience with comprehension or writing or conversation. In the rural private school, the teacher had better English skills, and the children, though showing a range, scored significantly higher on tests of writing and speech. (Average scores on written English were 11%, 6%, and 56% for the DSH government school, the comparison government school, and the private school respectively.) Interestingly, in the informal learning center, where teacher and students had minimal English, the teacher showed great engagement in her work, in great contrast to the teachers at the government schools, and children voted with their feet by attending this voluntary program except when work in the rice paddies or wheat fields kept them away.

On average, at each of three schools that participated in the DSH project, in both English and math, class scores increased 174% between July (Pretest) and December (mid-term):

Madantoosi Math:	264%
Madantoosi English:	240%
Kannar Math:	174%
Kannar English:	127%
Mauthri English:	120%
Mauthri Math:	121%

To analyze students’ individual improvement, we calculated the percentage difference between the pretest and the mid-term, when the student was present for both tests. For students who were absent on the test dates (absenteeism is a common problem), but were present for at least three of the months between August and December, we calculated the

percentage difference between their last test taken and their first. For all of the schools and both of the subjects, 72% of children showed an improvement in their test scores; 44% showed an increase that was greater than 150%, and 31% showed an increase in greater than 200%. (See Table 1.)

All Classes	Pretest (July)	Aug.	Sep.	Oct.	Midterm (Dec.)	% Inc	% Ind. Pos. Increase	% Ind. ≥150%	% Ind. ≥200%
Mauthri									
Math	69	NA	72	36	84	121	70	40	00
English	63	NA	84	70	75	120	41	00	00
Madantoosi									
Math	15	13	5	20	40	264	100	80	71
English	11	16	14	50	26	240	75	70	70
Kannar									
Math	39	NA	52	37	49	126	77	33	16
English	56	NA	66	56	72	127	70	15	5
Average	39	NA	47	43	55	166	72	44	31

Table 1: Individual Test Results Between July and December (measured in percentages) Each row indicates the average class score. % Inc. indicates the % difference between the midterm (in December), and the pretest (in July). % Ind. Pos. Increase indicates the percentage of students in the class whose score positively increased. % Ind. ≥ 150% indicates the percentage of students scores who increased more than 150% between the midterm and the pretest. % Ind. ≥ 200% indicates the percentage of students scores who increased more than 200% between the midterm and the pretest. Note: If the student was not present on either the midterm or the pretest, as long as the student had been present for (3) of the (5) exams given, the percentage was calculated between the last and the first of those three exams.

As noted above, at the comparison or control school, Sarojni Nagar, we administered a pre-test of subject matter knowledge in English and Math in July and a post-test in February. In comparison to the DSH settings, the comparison school began with lower pretest scores. This is likely attributable to the fact that the interventions in the DSH settings had begun prior to the formal start of the study. At the comparison school, post-test scores were considerably lower in comparison to DSH sites. In fact, at DSH sites, the post-test averages were 380% higher for English and 297% higher in math.

Sarojni Nagar	Pre-test	Post-test
Math	7	15
English	16	19
DSH Sites		
Math	41	58
English	43	58

Table 2: Comparison of Pre-test and Post-test Averages for Control and DSH Sites

Analyses of Classroom Interaction

To describe pedagogical gains made by teachers, we created a coding scheme to capture interactional patterns and types of classroom activity observed in videotapes. Among the 39 codes, some focused on teacher actions: for example, the teacher asks the entire class a question; the teacher asks an individual student a question; the teacher gives some form of praise; the teacher takes some form of disciplinary actions. Other codes captured student actions: the class responds in unison in English; the class responds in unison in Hindi; an individual student responds in English; and individual student responds in Hindi. (See Appendix B for the complete list of codes.) In addition, the total number of minutes the video lesson was played during a class session was also tallied. (for example, during a 30-minute class, video playback may have occurred for 14 minutes total).

These analyses suggested first that, at all three DSH schools, teachers adopted *more participatory pedagogical practices* over time. There was a dramatic shift away from classrooms whose dominant form of pedagogy consisted of a lecturer and an inactive listening audience toward interactions and pedagogies that were more dynamic and collaborative in nature. In some cases, teachers began to interact with their students by asking additional questions that were relevant to the subject material, while in other cases, the teacher learned to ask more sophisticated questions that seemed to require more complex thinking from the students. Additionally, we noticed that the instructors over time used a greater variety of representational tools to facilitate learning, such as drawing pictures on the blackboard, or writing verbally spoken questions on the blackboard. The teachers also showed increases in requests that students think critically about the subject material, approach the blackboard, solve equations, answer questions, and assist other students in solving a difficult question through group-work and group-activities.

At the Madantoosi school the English teacher began the school year by spending a majority of his time in class reading sentences from the English textbook and asking students to repeat after him. His own ability to speak English was limited, and he appeared timid about going beyond the textbook. For example, when the teacher asked questions related to the content material in the textbook, the questions were very short and extremely simple to answer. In one class, observed on July 17, 2007, on “colors” and “location,” the teacher asked questions such as “What is this?” to which the students responded “chalk.” Or he prompted, “This is...”, and the students responded “red.” Throughout this particular class period, 37 such questions were posed, and students responded to 29 of these in English. In that class, the teacher did not use the chalkboard at all and called upon individual students to answer questions on only three times. After six months of using DSH content in his classroom, the same teacher not only asked 57 different questions in a 30-minute period, but the quality and complexity of those questions increased as well. For example, the teacher asked the students, “Student X is thin, but student Y is...” and the students responded “thinner.” This transformation was noticeable in various other ways, as well. Over time the class began to speak more English (measured as instances of a student or the entire student population speaking an English phrase). Between the first three months of the study in August, September, and October, an average of 17.5 such

instances occurred, whereas in the last three months of the study, in November, December, and January, an average of 49.5 such instances occurred. Additionally, beyond increased sophistication and occurrences of questions and answers, a greater number of what we term “learning demonstrations” happened over time. These were participatory moments in which teachers and students collaborated to explain or demonstrate an idea or term or concept. Learning demonstrations might consist of plays or dramas conducted in class; occasions when a student or group of students approached the front of the class and the teacher used the pupils to explain a certain concept; or any other scenario in which the students and the teacher were involved in a hands-on activity. Such moments were significant in our data because of their infrequency in traditional Indian classrooms and their predominance in the DSH materials. At Madantoosi, during the first three months of the study there was an average of 1.6 learning demonstrations per class, whereas in the last three months of the study, there was an average of 6.6.

Similar observations were made in Kannar. Here, the teacher generated additional questions that were based on questions in the video lessons. In September, sixteen questions were asked on average, whereas in November, thirty questions were asked, and in December, thirty-six questions were asked. Additionally, the Kannar English teacher began asking individual students to answer questions more frequently, mimicking the style of teaching found in the video content. In September, two questions were asked to individual students, in November, seven, and in December, ten. Even more interestingly, with time, the teacher began to ask individual questions of a greater percentage of the class. That is, she gradually stopped restricting her individual questions to star students. In September, only one student was asked questions; in November, four students were asked questions; and by December, seven students were called on. In this case we see how the teacher appeared to be learning new pedagogical practices from the teacher in the video.

Finally, in Mauthri, the teacher began the project by not being able to speak English to any extent, having difficulty even pronouncing English words. Over the course of our study, she learned to use the video teacher as a reference point and to generate variations of the questions that were asked in the videos. During the first 3 months, she repeated questions from the video an average of 3.3 times per video, but during the second three-month period, this average had increased to 12.3. During the first three months, the teacher asked a variation of a question posed in the video an average of 3.6 times per video; during the second three-month period, this average had increased to 8.3. Similar trends were observed in math classes at Mauthri. The teacher began asking more questions to the class (6.3 questions per class for first three months of the study compared to 16.3 for last three months of the study) and also began to ask individual students more questions (4 questions per class for the first three months of the study compared to 13.5 for the last three months of the study). Overall student responsiveness in the class also increased over time (an average of 13.6 instances of students responding in unison per class for the first three months versus 25 instances for the last three months).

Our analyses of interactional patterns also demonstrated *increased student participation* over time. Students voiced their opinions in the classroom more frequently,

responded spontaneously to questions more often, and asked for clarification more frequently. For example, in Mauthri, students gradually began to interact more frequently with the video teachers over time, responding to their questions, and repeating after them.

Interestingly, we noticed that, not only did students increase and improve their interactions with their regular teachers, but they also were increasingly able to benefit from interactions with the “digital teachers” pictured in the videos. These digital teachers played especially important roles when regular teachers lacked subject matter knowledge. In Madantoosi, because the English teacher did not speak English well, the video lessons turned out to be crucial. The regular teacher encouraged students to respond to questions posed by the video teacher and to repeat sentences or phrases after the video teacher. In the first three months of the study, there were only an average 4.3 instances per class in which students responded to a question posed by the digital teacher, while in the second three months of the study, there was an average of 8.3 instances per class. Likewise, in the first three months of the study, while there was an average of 7.3 instances per class in which students repeated a sentence after the digital teacher, in the last three months of the study, there was an average of 14.3 instances per class.

At Mauthri, where the teacher also did not speak English competently, similar trends were observed. While in the first three months of the study, there was only an average of 2.6 instances per class in which students responded to questions posed by the digital teacher, in the last three months of the study, there were on average 18 such instances. Additionally, students repeated sentences and phrases after the video teacher more often. In the first three months of the study, there were on average 9.6 instances in each class in which a student or group of students repeated a sentence after the video teacher, whereas in the last three months of the study, there was an average of 22.6 instances per class. This likely accounts for why over time the teacher gave a larger percentage of her class over to the digital teacher: in the first three months of the study, an average of 8.5 minutes of the digital lesson was played during a class, whereas in the second three months of the study, an average of 17.2 minutes of the digital lesson was played in a class. Similar patterns held for math. During the first three months, students responded to a question the digital teacher was asking an average of 17 times per class, but this grew to 21.5 times for the last three months of the study. Repeating after the video teacher also increased dramatically, starting with 12.5 times per class in the first three months and ending with 38 times per class for the last three months of the study.

In Mandantoosi there was a different but related pedagogical trend. While the Madantoosi English teacher appeared to ask fewer questions over time, the sophistication and difficulty of the questions increased. So, while the average numbers of questions posted to the class decreased from an average of 37 per class to 26.6, the complexity of the questions increased, with the teacher repeating questions or using variations from the video more frequently. The questions posed by the digital math instructor from the video were, in almost all of the cases, more sophisticated and more difficult to answer than the questions posed in the first half of the study by the Madantoosi regular math teacher. In the first three months of the study, while only an average of 1.6 questions were repeated by the Madantoosi math teacher from the digital lesson, in the second three months of the

study, 5.3 questions per class were repeated. Likewise, while the Madantoosi math teacher only asked a variation of a question posed by the digital teacher twice per class during the first three months of the study, in the second three months of the study, the Madantoosi math teacher asked an average of 8.6 such questions per class.

The data presented above suggest that students at each of the DSH sites increased in subject matter knowledge and took part more frequently and more interactively in classroom lessons across a period of several months. They suggest as well that some teachers increased their subject matter knowledge, especially in English, and that all shifted their pedagogies toward somewhat more dialogic participant structures. What these comparisons and examinations of test scores and counts of activities don't reveal, however, is the dynamic process by means of which teachers appropriated knowledge about English and math and a variety of pedagogical strategies. Most importantly, the initial categories and counts conceal many of the challenges involved in this endeavor. We most assuredly do not want to overstate the power of the approach or underestimate the challenges involved in rural Indian contexts, all of which of course remain to a great extent after this year-long intervention. At Mauthri, for example, although the teacher increased the amount of mediation in her lessons, such statistics don't document the quality of the mediation and could obscure the fact that her questions were repetitive or simplistic and that they secured only immediate recall, as we observed on some occasions. Further, although the girls at Mauthri made gains on the achievement tests that we administered, the tests were themselves necessarily geared to the knowledge the girls were currently acquiring, which would be far below their expected grade level, were they attending regular school. The scores themselves we believe to be more a testament to their collective knowledge rather than individual knowledge, since in this informal setting it is difficult to require participants to work independently. And at all sites, even though we see clear evidence that pedagogical practices having changed in the sense that the teachers began to ask more questions and to interact more with the children, the kinds of questions they asked were still, in the initial qualitative data we analyzed, quite simple and meant only to demonstrate that children could immediately recall or call up facts and figures.

“Drink tea hot or cold?” A Case Study of the Appropriation of Language Pedagogy via Video

We believe that, to most accurately document the sorts of learning that teachers and students can do in the context of an intervention project such as DSH, as well as the kinds of challenges that accompany the gains, frequency counts must be contextualized via qualitative and ethnographic fieldwork. Toward that end, we turn now to a more detailed account of the Madantoosi English instructor's use of the DSH videos. To build this case study, we analyzed six videotaped English lessons collected between August and May. Five of these lessons were “mediated”; that is, during class, the Madantoosi teacher played and referred to a DSH video of an expert teacher who had been recorded conducting the very same English lesson that the Madantoosi teacher was then attempting himself with his own students. We juxtaposed these five lessons to a videotaped non-mediated English lesson that we collected at the beginning of the school year in July, in which the

Madantoosi teacher conducted his class on his own without the support of the digital teacher. In our analysis we noted both the teacher's growth and difficulties with English vocabulary and syntax; his shifts in interactional patterns and participant structures toward a pedagogy that was more dialogic and activity-based as well as his slippages to more familiar didactic patterns; and his hints of increased confidence and ease in his newly configured classroom along with indications of his struggles to enact a different developing persona as teacher.

Written across the small black board were the date (17-07,07), "sub-English" and "Class V." On the walls of the small dark classroom were painted the days of the week in English and Hindi as well as other mathematical tables. Four boys sat in one row on mats on the floor, and nine girls sat across from them. None had books, and the children looked thin and small to be in Class 5. However, it was clear that these children were ready to apply themselves in their English lesson and even to take part eagerly, whatever the resources in their surroundings. A young male teacher in his early 30's, Mr. Mohitlal announced the lesson, reading in a heavily accented and high-pitched voice from a well-worn textbook: "Let's make friends." He also wrote these words on the board. He then proceeded through the dialogue provided in the book, beginning with "Hello, I am Arjun. I am 10 years old." "What is your name?" he then asked a girl. She answered, the class applauded, and the teacher said "very good." They proceeded on with colors and fruits: "Do you like mango?" "What is mango's color?" "What is ice cream's color?" "Which color do you like?" "Please stand up." He queried another girl, "Drink tea cold or hot," and after several promptings she replied "hot." "What is the color of tree?" "Green, ok!" "Tree's name, tell me!" And a child answered "orange, banana," and then there was a long pause as Mr. Mohitlal figured out how to proceed.

In many ways this English lesson was a remarkable performance, and the pedagogy and language skills demonstrated far more salutary and advanced than is the case in most government (or public) school of India. This teacher's school and community had, in fact, for a number of years been in conversation and collaboration with an educator from a nearby city, who had by then introduced a number of innovations into the community. The collaboration began in 1995 with a project in support of village women—in particular, the provision of a tractor by means of which they could support themselves through machine-enhanced agricultural work, a vocational path, by the way, that was a radical departure in terms of gender roles. The school's principal later invited the educator to return and work with the school itself. In 2000, a solar panel was installed on top of the school, and thereby the school's one donated computer could operate in a village that then still lacked dependable electricity. In 2006 the DSH project was begun, and training and materials were provided for two teachers during 2007. The English teacher, whose classroom is introduced above, could at the beginning of the project read and write in English at elementary levels, but could speak English hardly at all. This is not unusual situation in Indian public school teachers, especially rural schools. Mr. Mohitlal's pedagogy at the start of the project involved no interaction with the children and instead focused, as is still customary in most Indian government schools, on recitation and copying. He expected children to copy down isolated words and sentences from a textbook and then to read them aloud in English and Hindi.

By the time of the lesson described above, Mr. Mohitlal still had limited proficiency in spoken English, struggling noticeably with pronunciation and grammar. Our field notes from this period indicate that his spoken English, even simple sentences drawn from the Class 5 text, was frequently indecipherable to our ears. He had clearly begun to alter his pedagogy, in line with the models provided through DSH materials and training, to be described more fully below. In particular, he attempted to connect English language instruction with children's lives— asking them, for example, about local fruits—and he was learning to be more interactive and activity-based, through organizing small skits, such as having children act out putting objects *on* or *under* or *beside* a table, to illustrate the meaning of prepositions. It was also clear, however, that Mr. Mohitlal was still at the very beginning of his pedagogical and knowledge transformation. It remained difficult for him to move beyond a reliance on a traditional “translation” approach to language-learning whereby a Hindi word, sentence, or phrase, is translated into English and spoken aloud or copied, and whereby Hindi dominates as the language of instruction in English class. The proof of the efficacy of the materials and approach supplied via the DSH videos would come from a demonstration that children were actually learning, such as we suggested above through our reports of improvements in test scores, and a demonstration that the teacher continued to engage with the materials, to reorganize his teaching practices, and to acquire and foster the learning of increasingly sophisticated, complex, and sound knowledge, concepts, and skills. We hoped, then, to see a movement from the merely didactic, rote, and authoritative, toward a model that is more engaged, dynamic, critical, child-sensitive, and meaning-focused. The beginnings of this transformation we document below, as well as provide a sense of the distance that remains to be traveled in the journey of this teacher's growth.

As described briefly in the methods section above, the videos provided to Mr. Mohitlal consisted of actual lessons taught by expert teachers in a school for urban girls from very low socio-economic backgrounds. The content of lessons was based on state-mandated textbooks prescribed by the state education department. In the case of the English videos, the teacher was a very experienced, skilled, and dynamic teacher of language, particularly for primary school. Pedagogically and ideologically, the lessons centered on teaching practices that are associated with the “whole language” approach—that is, that instruction on reading, writing, listening, and speaking should be meaning-driven and situated in children's lives rather than predominantly skills-based and decontextualized. Although this approach has of late fallen on hard times in the US, being challenged in “reading wars” by critics who privilege phonics-based approaches to literacy development, the foundational premises of whole language are widely respected, and both warring camps seem to be moving toward a rapprochement usually termed a “balanced” approach. Neither whole language nor “balanced” approaches are at all common in India, where skills-based, decontextualized, and didactic instruction is the norm.

The instruction provided through the DSH videos can be further characterized by the deep way it embraces Vygotskian principles on the importance of social interaction in linguistic and cognitive development. While there is of course abundant talk in traditional Indian classrooms, for they proceed by and large through rote repetition done in unison,

there is typically little effort to engage with individual students through Socratic dialogues or extended questions. Similarly, collaborative learning or other kinds of group activities are not officially sanctioned, although this kind of activity occur sub rosa in Indian schools, as it does virtually everywhere. The DSH videos, drawing primarily on the inspiration of Vygotsky and his ideas about how language and thought are internalized by individuals through social interaction, privileged participation in classroom discourse and the articulation of ideas by students as well as teachers. In DSH classrooms, this interaction occurred in multiple types of activities. In addition to the initiation-response-evaluation participant structure that seems to be a universal element of classroom talk, the teachers in DSH videos engaged students in dramatic activities, games, small group activities, hands-on experiments, and generally insist continually on children's active participation in their own learning. Further, in the videos of English lessons that mediated Mr. Mohitlal's classroom, not only were children asked to engage in multiple activities and participant structures, they were encouraged as well to engage with different modalities—oral language, to be sure, but also pictures, gestures, and writing. In this way children were immersed in the second language they were learning, positioned to hear it constantly and required to produce it with the teachers and their peers throughout class, and the video instructor eschewed the more traditional “translation” approach. (For examples of the English language videos used by Mr. Mohitlal as well as lessons on math and science and other instructional materials, see <http://pnet.cs.washington.edu/>.)

Now we turn to our analyses of the videos of Mr. Mohitlal's classroom, as he and his children watched and interacted with the DSH videos. The first mediated class that we analyzed was quite early in the school year, on August 27th, just over a month after school had begun. During this early phase of the project, Mr. Mohitlal relied on the video and the video teacher (VT) extensively. He paused the video frequently in order to use the English supplied by the VT, repeating the VT's questions and examples almost verbatim. Despite the attention he paid to the video, his own still developing English grammar frequently took control, resulting in syntactic and semantic errors and simplifications:

VT: “What is the meaning of opposite?”

Mr. M: “So opposite meaning?”

VT: “What is written?”

Mr. M: “What is write?”

VT: “What is baby doing?”

Mr. M: “Where is baby doing?”

At this stage Mr. Mohitlal did not seem to notice the VT's pronunciation even when words were pronounced quite differently, or perhaps more accurately, he was unable to monitor his own pronunciation sufficiently to correct it. Thus, “opposite” in the VT's speech becomes “opposeet” in Mr. Mohitlal's, and “ball” becomes “baal.” In fact, Mr. Mohitlal was so intent on listening to the video and repeating and translating its language, that he sometimes had difficulty concentrating on the children at all. He translated continuously, asking questions in English twice, and then, without waiting for the children to answer,

translating the question into Hindi and then answering it himself, all this without encouraging the children to participate:

Mr. M: “What is mother doing? What is mother doing?” Maa kya kar rahi hain?
Mother is cooking. Mother is cooking.”

Throughout the class, Mr. Mohitlal called successfully on only two girls, and then only twice; the rest of the class did not repeat after him or answer his questions. He extended the VT’s question only once:

Mr. M: “What is baby doing?”

Mr. M: (before the VT answered): “Playing the ball.”

Mr. M: (self-corrects after watching the video further): “Playing with the ball.”

Mr. Mohitlal did put some of the difficult words on the board, and he gave his own examples twice. To explain the contrast between “hard” and “soft,” he used the DVD player remote and the eraser: “The remote is soft or hard?” “The duster—this portion of it is....soft.” And he gave other examples too: “The wall is hard.” “Paper is soft.” “Bag is soft.” But because he was himself learning from the video as he taught, probably not having watched it beforehand in preparation for the class, Mr. Mohitlal didn’t engage with his students the way that the VT engaged with hers, and accordingly, he did not elicit the same level of participation. The children did not appear engaged very much by him and were fidgeting.

At this stage, then, Mr. Mohitlal was trying very hard to learn and understand the English as well as absorb the teaching methods demonstrated by the VT. Lacking confidence in his own control over English, he did not produce much language independently. Instead he stuck very close to the English produced by the VT and only ventured out on his own once or twice in the entire lesson. These, however, were the early days of the term.

Our analysis of a video of Mr. Mohitlal’s classroom one month later on September 24th 2007 demonstrated a very noticeable improvement. The teacher interacted with the whole class, and the whole class was involved in responding back, not just the children known to be the best students. The children also engaged with the video quite actively, trying to catch each word that the VT spoke. They read the subtitles and seemed to follow the activities with concentration. On this occasion, Mr. Mohitlal used the DVD more intensively and for a larger range of purposes. To be sure, he continued to use the video for English support for himself, repeating the VT’s questions, but he also extended those questions, as the following example demonstrates. In the video there were flowers arranged in a basket. Mr. Mohitlal extended the conversation to ask, “You know means flower, Indra! Dekha hai flowers many colors tell?” He intended to say, “Indra, you know the meaning of flower? Have you seen flowers? They are of many colors. Tell their color names.” Thus, he used the syntactical structure of Hindi, which is SOV or Subject-Object-Verb and which doesn’t map directly to the SVO structure of English. He translated the Hindi to English literally, a strategy apparent in his use of English

throughout. His control over grammar was still limited, but his confidence in using the language had grown, as he attempted longer, more complex sentences in his engagement with the students and ventured further away from the video than he had done previously.

In this lesson Mr. Mohitlal still used translation a great deal, and when he gave the students a more elaborate explanation of a word, he used Hindi. For example, “Where you see balloons? Market, fair, circus? Bachrava mein dekha tha? [Did you see in Bachrava?”] (Bachrava is a small town near Madantoosi village.) He then engaged the children in a small discussion about the circus in this town, bringing the text closer to their lives, as he does later in the lesson, too, when there was a discussion about cities. Then he extended the VT’s questions and included their village of Madantoosi in the conversation along with many neighbouring villages:

Mr. M: Phasitoosi is a

Children: ...village

Mr. M: Rohit Khera is a

Children: ...village

Mr. M: Paschimgaon is a...

Children: ...village

Responding enthusiastically in chorus, the children seemed delighted as they realized that English could figure in their rural context, too.

In this lesson Mr. Mohitlal elaborated the meaning of vocabulary words instead of simply repeating them several times, as he had done earlier:

Mr. M: You know outside? Where is the garden? Outside na? (He points outside)

Mr. M: Where are you? Outside or inside?

Mr. Mohitlal showed evidence of beginning to incorporate some of the pedagogical techniques used by the VT into his own classroom. For example, he asked the children to bring their books to class (the books that were missing in July had since arrived) and showed them how to follow the VT in their books:

Mr. M: Vahi poem hai (It’s the same poem from your book.) Page number 21. Ok? Back of book. Look and read.

Then he directed them to look at the pictures in the video that the VT had drawn and finally asked them to stand and recite the poem, performing actions along with the children in the video, which the Madantoosi kids did enthusiastically.

Although Mr. Mohitlal had begun, as the previous examples illustrate, to access many of the pedagogical techniques used by the VT, in September he still did not use the full range. Our analysis of his class in October, however, showed that he had by then learned more about contextualizing the lesson in children's lives, and he had also begun to conduct much more of the lesson independently of the video. He paused the DVD player for longer amounts of time, as much as twelve minutes at a stretch. This class was about riddles, and he introduced it by saying in Hindi, "Riddles are what your fathers, grandfathers, and elders tell you in childhood." Throughout he engaged very well with the children. In this lesson he drew on the board a great deal and used the drawings to talk to the children.

He also wrote all of the sentences on the board, but involved them even in that activity by asking them to supply the spellings:

Mr. M: See it is sweet, it is (writes the sentence on the board)

Children: Sweet (in chorus)

Mr. M: Sweet spell?

Children: S W E E T (spell it out in chorus)

He expected the children to know the words and their spelling and called on them to help him write the words on the board and then read them out. He called on individual students and engaged the whole class in repeating as well.

On occasion Mr. Mohitlal still provided the answers himself too quickly:

Mr. M: It can run, it can climb, it can copy us, what is it? What is it? It is monkey. Can run, its tail is long, it can copy us and it can climb also. (He reads from his sentences on the board, which are themselves from the book. VT has also written these sentences on the board.) So what is it?

By this time in the school year Mr. Mohitlal had found a way to engage children in focusing their attention on multiple representations of the language being taught. He had children focus alternately on the video, the blackboard, and their textbooks. Interestingly, he did not direct them to write on their tablets, most likely because the teacher in the video did not direct her students to write.² He self-corrected his pronunciation of "trank" because the children who had been watching the video intently repeated correctly after the VT – "trunk." Generally, however, Mr. Mohitlal continued to pay almost no attention to the pronunciation of the VT, in favor of his own, as he had in September.

² This was a choice that the curriculum designers made because they believed that writing wasn't an activity that could be videoed to advantage and a decision that they will likely want to revisit.

After writing out two riddles on the board and getting the children to read them, he also used the video to model reading. The whole class participated, and he seemed to be able to venture out more independently. He still used translation, most likely because he used translation from Hindi to English while speaking. So he assumed that the children needed it too. His requests of the children continued to be fewer and less complex than the VT's. For example, in a later lesson in number, the following exchange occurred:

VT: Sometimes there is no cloud and the sun shines brightly. And some times there are clouds so the sun does not shine brightly. Yes?

Video Children: Yes

VT: So tell me, if there is no cloud then what happens?

VCh: The sun shines brightly.

Compare the complexity of this exchange with what Mr. Mohitlal is able to foster:

ML: The sun is shining brightly. Who is shining brightly?

Ch: The sun

He demanded and expected only single word answers to questions that were always very simple and direct. It is noteworthy as well that at this point still did not demand a more independent participation from the children. The language patterns were still fairly repetitive, possibly because he did not believe the children from his community could engage in more complex patterns, despite the fact that the VT was teaching children from a similar background, and the video clearly demonstrates that they could respond when called upon. Perhaps because he did not have faith that his kids could meet more complex communicative demands, he kept his language simple. Additionally, he himself could not independently construct the complex questions that the VT asked. As Mr. Mohitlal learns more English himself from the videos, and his own control over the language increases, we expect that he will ask more of his students.

We looked, finally, at a lesson taught by Mr. Mohitlal toward the end of the school year in April. To analyze this lesson, we transcribed, not only Mr. Mohitlal's speech and that of the children in his classroom, but the language of the video teacher as well, juxtaposing each in order to more clearly see how Mr. Mohitlal made use of model lesson. For example, Mr. Mohitlal started his class by playing the video lesson, which began as demonstrated in Table 3.

Table 3: Excerpt from transcript of Digital Lesson and Mediation of that Lesson by Teacher

Mediation	Digital Lesson
<p>Mr. Mohitlal starts the lesson by playing the DVD. < Kids watching the DVD> <teacher cleaning board and writing date, subject and lesson></p> <p><Teacher paused the Video></p>	<p><girls stand> Whole Class: Good afternoon auntie! VT: Good afternoon girls. Please sit down. Whole class: thank you auntie. VT: Now tell me something. Put your hands down. Very quietly. Alright...now tell me something. Do you remember the animals that we learnt? If I write the names will you be able to read it? Before the holidays, before the “desharo” holidays – we were learning about the animals – yes? Whole Class: Yes. VT: And we did a play also? Yes? Alright. <teacher approaches blackboard and begins to write> SH: Oh, ho this board is so bad. <teacher writes monkey> Whole class: Monkey. SH: Very good. Now... <teacher writes elephant> Whole class: Elephant SH: Now I will write and you will read.</p>
<p>M: You are see animals. C: Yes (Unison) M: Where lived animals, where live animals. C: In the jungle (Unison) M: You are see jungle. C: Yes (Unison) M: Where C: Roadside (One girl said) M: Roadside and village outside. OK what are write. <By gesturing he told the kids to read the</p>	

word written by the VT> C: Monkey, Elephant (Unison)	
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Thus, we see Mr. Mohitlal using the model lesson to scaffold his teaching. He also mediates the digital lesson for the children, in effect pointing out to them what to notice and extending, to an extent, the content of the video. For example, he relies on the video teacher's cues about pedagogy and lesson content, but he also relates the lesson to the children's local context by reminding them of where monkeys can be seen locally ("roadside and village outside"). In addition, he has begun to rely on the subtitles from the model lesson video to provide additional reading practice and exposure to new vocabulary. Although his conversational interaction with the children is on the whole repetitive and limited compared to the video teacher's, he does interact with the children, keeping them engaged in the lesson. Later in the lesson, following the video teacher's lead, he eventually introduced dramatization, asking a child to "roar like a lion," although he did not divide the children into groups and ask them to act out the parts of being monkeys, lion, and elephants, as did the video teacher. In summary, this analysis made clear that Mr. Mohitlal had learned to make use of the full use of methods demonstrated on the video lesson, apart from small group work, and to a lesser extent for dramatic enactments. He adopted the video teacher's vocabulary, and he engaged the children with subtitles as additional reading materials. His interaction with the children was continuous, and they responded continuously as well.

Conclusion

Kanta, a teacher in an informal rural learning center, stood in the tiny alcove of her two-room house. A dozen or so adolescent girls sat crowded at her feet, having put aside their "chikan" embroidery, the vocational training their parents had sent them to receive, while a bevy of younger children peered in and pushed for a prime spot at the door. All awaited the start of the video lesson, a digital story called "The Lion and the Tiger," which they listened to and then read in English with Kanta's mediation, translating the unfamiliar words into Hindi and back again. A simple scene, to be sure, but also a remarkable one, many variations of which we recorded over a period of almost a year. The use of inexpensive and readily available digital video technologies, combined with an expansive notion of teaching, texts, and literacy, linked to network of like-minded teachers, trainers, and ICT professionals, can indeed enable an under-educated teacher in a remote Indian village both to learn and teach a group of children that the world has forgotten. Appadurai (1996) writes persuasively of the migration of people and the movement of texts and images around the world, a joint phenomenon that he considers the quintessential feature of our digital and global age. Teachers like Kanta, Mr. Mohitlal, and the youth they instructs have thus far been shut out of these movements, confined and constrained geographically, socially, and educationally. We believe that our research, or more properly the project on which it is based, demonstrates how bands of geospatial opportunity can be created, and how flows of information, tools, and people can be reconfigured to allow for

individual advancement and a greater social good, even in the most challenging of circumstances.

This research is an initial demonstration of how model lessons can be deployed through digital video to improve teaching and learning in government and private rural Indian schools and non-formal educational settings. Although our study examined only 4 sites—3 schools and one non-formal setting that served approximately 100 children—we believe that that we have demonstrated the potential power of the approach. Specifically, the data show remarkable gains in test scores of subject matter knowledge; children in classes that were part of the intervention scored almost 400% higher in English and almost 300% higher in math than did children in a comparison school. There were changes as well in classroom interactional patterns, suggesting that teachers did alter their customary recitation-centered styles to become more student-centered and activity-oriented in their approaches. The qualitative data illustrate how one teacher used and learned from the model lessons over time—for example, acquiring pedagogical strategies for interacting with the children and learning to connect classroom topics to the children’s local social worlds.

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Appendix A: Coding Scheme for Classroom Interactions and Activities

Teacher asks whole class a question
 Teacher asks individual student a question
 New individual student is called on
 Whole class responds in unison to a question
 Teacher uses the blackboard/writes
 Student goes up to the blackboard to write or draw
 Teacher involves student physically in a learning demonstration
 Teacher says/does something that causes laughter
 Teacher gives some form of praise ("good!", clapping, etc.)
 Teacher takes some form of disciplinary action
 Student says/does something that causes laughter

Teacher presses "pause" and begins to mediate

Teacher repeats a question in the video.
 Teacher asks a variation of a question in the video.
 Teacher (and students) re-enacts activity in video.
 Teacher initiates a variation in an activity in video
 Teacher rewinds and replays portion of video.
 Teacher fast forwards and skips portion of video.

Time Video Played

Time Mediated

Teacher mediates without pausing

Teacher asks a question about what's happening in the video.
 Teacher repeats a question in the video.
 Teacher asks a variation of a question in the video.
 Teacher (and students) re-enacts activity in video.
 Teacher initiates a variation in an activity in video.
 Teacher rewinds and replays portion of video.
 Teacher fast forwards and skips portion of video.
 Students respond to a question the "digital" teacher is asking
 Students repeat after the "digital" teacher
 Students read from the video
 Students read from blackboard

Teacher asks a question in English
 Teacher asks a question in Hindi
 Class speaks in English
 Class speaks in Hindi

Individual student speaks in English
Individual student speaks in Hindi

Appendix B: Examples of Test Questions from Subject Matter Tests**Madantoosi (February)** M.M. - 25**English**

Q.1,a) Name the animal which has a very long neck? (6)

b) Name two animals which have stripes on their body?

Ans-

c) Which animal is the king of the jungle?

Ans-

d) Which animal is the ship of the desert?

Ans-

e) Which animal always copies us?

Ans-

Q.2 Fill in the blanks with using has/ Have. (5)

a) Ram _____ a ball.

b) They _____ kites.

c) You _____ a pen.

d) Sheela _____ a red cycle.

e) We _____ mangoes.

Q.3 Fill in the blanks using the following words. (5)

taller, stronger, younger, faster, bigger

a) Cat is _____ than rat.

b) Car is _____ than cycle.

c) The sun is _____ than the wind.

d) Giraffe is _____ than Zebra.

e) Ram is _____ than his uncle.

Q.4 Fill in the blanks- (4)

a) _____ comes after Sunday.

b) _____ comes between Tuesday and Thursday.

c) _____ comes before Saturday.

