

Evaluating Facilitated Video Instruction for Primary Schools in Rural India

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ABSTRACT

The educational system, especially in developing regions, remains one of the most challenging systems for intervention and implementation of change. The objectives of this paper are to present findings of the first year of an evaluation study of Digital StudyHall (DSH), a Facilitated Video Instruction system being used in rural primary schools in India. Our analysis shows that the DSH system supports classrooms by providing teachers with instructional resources, access to expertise, and in-practice professional development.

In the paper, we will a) describe the DSH system b) detail the evaluation design and c) present an analysis to demonstrate how some of the teachers using the DSH system change their teaching based on their experiences.

Keywords

Developing regions, Educational Technology, Evaluation, Teaching.

1. INTRODUCTION

The importance of improving primary education is universally recognized. In the past four decades, the ICT community has committed towards developing regions, especially for educational change [1]. These interventions have evolved from earliest versions of “computers in classrooms” to community-based initiatives to mobile technologies [2], [3], [4], [5], [6]. It is also widely understood that there are enduring systemic challenges that face the deployment of technology in developing regions.

The focus of this paper is to understand the efficacy of Facilitated Video Instruction used by teachers to mediate video to the students [7]. We will present first year results from an evaluation of the Digital StudyHall (DSH) system [8] being carried out in rural primary schools in India. While the DSH system has been in use since 2005, we are conducting an evaluation in a group of 11 schools that have not previously used the intervention. This

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moderate scale deployment exceeds the size of previous deployments of DSH. The study seeks to understand impact of DSH system on student learning as well as change in teacher practice. The evaluation follows a mixed methods protocol of experiment with qualitative case studies.

India, with its vast potential and enduring problems faces a persistent challenge of weak rural school system [9]. There is shortage of physical as well as human infrastructure. A primary school often has only two teachers who can be summarily reassigned for jobs such as census duty and elections, reducing the instructional time. The students, majority being first generation learners, do not always attend, often called away for farming or household duties. These challenges are ironic considering that India is branded as the frontier of ‘flat world’.

The DSH project seeks to improve the classroom experience for students by helping rural teachers connect to more experienced teachers and rich content materials. By facilitating access to teaching expertise, the project strives to affect generational changes in both teaching and learning. The organization records live video lessons from good classroom teachers, trains struggling teachers in video mediation, and supports their instruction. This is enabled by digital technology, which is now affordably recorded, archived, and distributed. The underlying premise is that if low resource schools can be connected to centers of educational excellence, there can be improvement in teaching leading to increased student learning. In our evaluation, we seek empirical accounts of this transfer and the conditions for deployment.

We begin our paper by giving background on the theoretical accounts of Facilitated Video and educational research on expertise. We follow by detailing the overall deployment, settings, mixed methods design, data analysis, and the challenges that we have faced in the deployment. Then we present our findings from the first year. Finally, we will present implications for ICT work in educational change and future work.

2. BACKGROUND

2.1 Facilitated Video Instruction

The Facilitated Video methodology is adapted from the Tutored Video Instruction [7]. The researchers demonstrated the potential of using “unrehearsed, unedited videos of regular classroom courses”[7] with a tutor that mediated them to the students in remote sites. The method proved to be cost effective, used

existing resources, and bridged the need for quality education to off-campus students [10], [11].

Facilitated Video instruction has been adapted by several projects to provide access for low resource and remote areas in education and agricultural information.

First, the DSH project started in 2005 connects rural schools in India to centers of educational excellence [11]. Operating from the city of Lucknow in the state of Uttar Pradesh in India, the organization has recorded over 1500 videos of expert teachers teaching state curriculum lessons. It distributes them on a large video database. The local education experts train teachers in rural and slum schools in mediating these videos to their students. In addition, the organization supports these teachers with different community participation strategies.

Second, the Digital Green project started in 2006 uses “concepts and experiences borrowed from the DSH project” to popularize sustainable farming techniques among farmers in Karnataka and Tamil Nadu in India [12], [13]. The organization video records local farmers explaining their practices and uses them towards agricultural extension in wider communities.

Both of these projects use digital video, concept of facilitator mediating locally produced video content, and connects the users to broader disciplinary resources.

2.2 Deliberate practice and nature of teacher expertise

The research on expertise shows that experts make connections between specific situations and the principles that they represent [14]. The same can be said for expert teachers also [15]. The ability to develop expertise through deliberate practice consisting of practicing of routines, noticing details, and situating the practice in practice has been well documented [16]. In this manner, the link between learning, practice, and teacher expertise has been well established.

3. EVALUATION OF DSH-FIRST YEAR

3.1 Overall Deployment

The DSH evaluation was planned as a two-year mixed methods study in recruited schools of Chinhat District in the state of Uttar Pradesh. We have focused on the state of Uttar Pradesh as the DSH had its main office in Lucknow, the state capital. It had existing contacts with the state Department of Education and an established history of working in this region. We started the work in June 2009 and finish our first year in May 2010. The second year will be from July 2010 to May 2011.

While the DSH has been in operation since 2005, for the evaluation we decided to start a new and bigger deployment. This was done to ensure potentially statistically valid results and to get a broader diversity of school situations. In addition, as we work with new sets of schools, we have avoided evaluating existing relationships.

The evaluation focuses the effect and change in teachers’ practice and student outcomes from the use of the DSH system. We are also interested in understanding the effort for deployment. In the first year, the researchers setup the DVD player and TV in each school, monitored, and conducted data collection and analysis.

The deployment and systematic support mechanism was integral to the evaluation. We understand community building, teacher focused professional development, and systematic monitoring and support as the three main components of the DSH system. To facilitate this system, we conducted a teacher-training workshop, follow-up review, and regular schools visits.

In the following sections, we will describe in detail the settings for the evaluation, design of the experiment, design of the qualitative case studies, data analysis techniques, and the challenges in deployment.

3.2 Settings

An initial set of schools was identified from a previous 2005 survey of 20 government schools in Chinhat district.

Chinhat is a peri-urban district in Lucknow. The Chinhat District Educational Board gave us the official permission in November 2008. Then researchers visited the schools, talked to principals and teachers, gave information about the DSH organization, observed lessons, and documented the building facilities. The schools were chosen based on factors such as: built classrooms, available or possible electrical connection; willingness of participants; and access to the students and teachers. Due to these factors, there is a selection bias for the schools. One of the schools was identified as being inappropriate for the study, and it was dropped. The final list of 11 schools (all the names are pseudonyms) was as follows:

1. Brickwall
2. Flower Nagar
3. Ponside
4. Treeganj
5. West Village
6. Eastgaon
7. FirstOnepur
8. Northdhauna 1
9. Northdhauna 2
10. Longwall
11. Lightabad

In March 2009, we met with principals to detail the responsibilities and expectations to take part in evaluation and the informed consent procedures. All the principals consented for their schools to participate.

After their permission, the team conducted preliminary fieldwork in the schools till May 2009. This included classroom observations to understand students’ level of engagement with English and Math and teaching. The schools were organized in top, middle, and bottom ranking order as per the above indicators.

We started the evaluation with the school reopening in July and conducted teacher recruitment and interviews. While the teacher-training workshop was scheduled for June, it was postponed towards end of July as the teachers were reassigned the teachers for census work. In the workshop, the teachers received training in video mediation and building respectful school climate.

The power connection was installed in September followed by setting up of the DSH equipment. The use of DSH started between Sept 14th -23rd in all the schools.

3.3 Experiment Design

The quantitative study is a pair-wise group comparison of the English and Math test scores. Each school was assigned one

control and one treatment (DSH) class. The Grade 3rd was the English group while the Grade 5th was the Math group. We chose to have each school contribute a DSH class and a control class, so that we would be treating all schools uniformly. Due to factors such as only one section in each grade, teacher access, and turnover rates in schools, we chose the experimental design as an inter-school rather than an intra-school setup. We chose to work with 3rd and 5th grade was so that there wouldn't be any overlap of students over the two years of the study. We ensured that the "most engaged" school was not experimentally paired with "least engaged" school even if they were demographically balanced.

To summarize, half the schools used 3rd grade English as treatment and 5th grade math as control, and the other half of the schools used 3rd grade English as the control and 5th grade Math as the treatment.

3.4 Qualitative case studies

The qualitative component of the evaluation seeks to understand how the teachers use the DSH system to teach. This is ethnographic in nature and focuses on questions about the interaction among teacher-DSH-students and the teachers' sense of self as a teacher. Our data collection has included interviews, ethnographic fieldwork, and video recordings. Using this data, we have generated case studies in our analysis. The use of descriptive case studies is well established in educational research [17]. In our work, case studies allows us to investigate the group's change in practice at the levels of individual teacher experience, professional development, and the organizational support for instruction in the classroom. In that regard, the cases presented in the paper are representative of the larger data corpus. In writing these accounts, we have continually focused on the interactions of teachers with the Facilitated Video instruction as situated in their classrooms.

We selected six schools from the larger recruited group. The selection was made to a) ensure a diverse representation of participants and b) likelihood of continued access to teachers for interviews and video recordings. The small number ensures rigorous and systematic data collection across the six DSH classrooms. This strategy was influenced by a tradition of educational research drawn from sociolinguistics, education, anthropology, and computer supported collaborative work [18]. These schools were Pondside, West Village, FirstOnepur, Treeganj, and Brickwall. We conducted baseline video recordings of teaching without the use of the DSH. Then we made periodic recordings of the teachers as they taught with the DSH setup.

We also conducted ethnographic observations of the classrooms. One of the main purposes of these observations has been to document the everyday routines of teachers. This has helped us to understand the place of the DSH system in their daily professional routines. We documented the logs of DSH use, carefully noted all our contacts with schools, copied attendance, and any relevant details of school life. Our questions from this data include; how does the teaching time of a DSH lesson compare to the same lesson taught without DSH? How do external events such as election and holidays affect the classrooms? This has helped us understand the level of effort required to deploy and support DSH.

To summarize, from June 2009- March 2010, we have collected 33 videos of the six teachers using DSH, conducted about 70 field visits, and collected 22 teacher interviews from all the teachers.

3.5 Data analysis techniques

3.5.1 Student learning

The tests were paper-pencil tests for English and Math. The tests were designed to test the development of student learning. The English tests were comprised of pictograph-English word identification as well as simple sentence formations. The pre-test was more basic in nature since English is introduced in the third grade and the post-test was more advanced along the same theme. They had written as well as oral components. The oral test had questions such as "what is your father's name? how many brothers and sisters do you have?, and what color is your bag?". Both the parts were graded numerically.

The math tests were comprised of a combination of vocabulary, simple multiple choice, and simple written responses. The pre-test was based on the exit exams of Grade 4th since they were given to 5th graders. The post-test was based on the state curriculum covered till that time by the teachers using the DSH video lessons.

The test were designed on the state curriculum textbooks and based on a) interviews with the teachers about the syllabus coverage in their use of DSH video lessons and b) observations to understand the instructional level of students.

3.5.2 Change in teacher practice

One of the primary ways of looking at learning is to identify the ways that the participants constitute learning as they interact with each other. Interaction analysis is an interdisciplinary method that builds on existing traditions in ethnomethodology and Conversation Analysis to better understand the coordination of multimodal resources of talk, gesture, action, and use of technologies [19]. Researchers from varied fields such as psychology, sociology, anthropology, education, communication studies, and linguistics use this method to situate micro-level interactions in the broader ecological context.

The analysis is framed by the concept of "professional vision" in teaching [20], [21] which focuses on how teachers notice and interpret classroom interactions, especially in the use of video. Our analysis is also supported by the idea of "deliberate practice" that seeks to understand the relation between learning and becoming an expert. To understand organizational change, we draw upon research in Science & Technology studies [22] and educational change [23].

We approached the video interaction analysis in two steps. First, we content logged the DSH video lessons to understand how those teachers taught. In these logs, we found that the teachers made their professional vision visible into broadly five categories of teacher- student talk, noticing, explanations, reformulations, and managing students. Two of the three categories, teacher – student talk and noticing, relate to those used by analysts of classroom discourse [24], [25], teacher educators studying teacher expertise [26], and used by teachers themselves. We identified the other three categories in the data based on the work that they do for the teachers. For example, one DSH video teacher's apparent account of how a proper fraction works constitutes an explanation.

Second, we content logged the Chinhat teacher videos of DSH use to understand the interactions between teachers with the video lessons as well as students. In these logs, we used the following

heuristics grounded in ethnographic research on teacher learning and expertise:

- a. Identify the teaching practices in DSH video lessons
- b. Analyze their use by the Chinhat teachers

For example, when a Chinhat teacher reviews that particular DSH lesson on proper fractions, she can mediate through following the explanation, reformulation, or watching. Triangulating this data with the ethnographic accounts, we compiled case studies of the DSH mediation.

3.6 Challenges in deployment

Difficulties with electricity were a significant source of disruption for the project. Out of the 11 schools, eight did not have electrical connections when we approached them in March 2009. The DSH staff worked with different government agencies to get the power started in the schools. As a result, all the schools got the electricity started in late August to mid September. We installed the equipment in September and the teachers started using the setup between Sept 14th- 23rd.

However, the power went off in Brickwall, FlowerNagar, and Pondside from late October to December. In the first two schools, passing trucks snagged the electrical cable hanging low amidst the mango trees and it broke. At the Pondside School, there was an alleged cable theft. Since it was government property, the local electricians refused to fix it.

From Oct 20th to Nov 6th, the West Village School lost power in the DSH classroom due to combination of general power outage and localized electrical plug failure. Around the third week of November, Eastgaon had reported power outage and a non-working DVD player.

In November, we decided to hire an electrician for periodic upkeep and then these schools got their power restored in the first week of December. The power again got disconnected in February in FlowerNagar, Brickwall, FirstOnepur, and Eastgaon. The DSH electrician was able to restore it later that month.

To summarize, FlowerNagar and Brickwall were without power for about two and half months in total. FirstOnepur, Eastgaon, Pondside, and the West Village schools lost their power for about a month. Due to the power failures, the use of the DSH in these schools keeps getting disrupted.

Officially, the schools have been in session since July 5th 2009. However, in July, there was no instruction since the school staff was busy with new student registration and scholarship distribution. The students trickled in from their summer vacation and the attendance picked up in late July to reach about 50%. In August, at least one teacher from each school was reassigned for working in the census counting by the government. Since these are mostly two-teacher schools, it meant that one teacher and an instructional aide taught all the five grades.

The teacher and student attendance picked up in September but then declined in October because of the three-week religious celebration of the Hindu festivals of Dusshera and Diwali. In December, the schools conducted mid year exams for a week so there classes for only two weeks before winter break. The schools were closed in January till mid February by the District Magistrate orders due to severe cold weather. Later that month and in the first week of March, the attendance dipped to about 30-40% due to potato harvesting and religious holidays. To summarize, there

have been only about three months of instruction in eight school months.

4. WHAT WE LEARNED

In the previous section, we described the study design of the evaluation of the DSH system and the data collection and analysis. In this section, we will describe our findings from the first year of this evaluation. In Section 4.1, we will give an overview of the 11 schools to present the change in teacher practice and the student learning outcomes. In Section 4.2, we will present detailed analysis to demonstrate how the Chinhat teachers used the DSH system to resolve two key problems of practice a) overcoming isolation by getting advice and assistance from other teaching professionals and b) developing performance through skill acquisition. In Section 4.3, we will present analysis of the conditions organized by the DSH to support teaching and learning.

4.1 Overview of change in teacher practice and student learning

4.1.1 Change in teacher practice

At the start of the evaluation in 2009, we ranked the schools in top-middle-bottom order on their potential of use. In March 2010, we revised this order based on our findings. The analysis demonstrates that the middle ranking schools such as Pondside, Longwall, FirstOnepur, West Village, and Treeganj have clearly benefited from DSH. In that regard, they have moved to the top of the list. While the top ranking schools from the initial list such as Flower Nagar and Brickwall continue to be excellent, it is the teachers in the middle ranking schools that have shown the most effective change in practice, which can be attributed to the use of DSH.

From the interviews and field notes, we gained critical information about the ways that teachers talk about teaching. In the first round of teachers interviews, in response to the questions of “How do you teach a lesson? How do you plan for your lessons?” most of the teachers had difficulty in identifying and articulating the components of their teaching and the routine of planning a lesson. Over time, the interview data shows that the teachers have got more specific in their descriptions of teaching.

The research on teacher expertise shows that noticing details, proposing interpretations, and forming heuristics is part of what experienced teachers are able to do [26]. In this manner, the ability to describe teaching in talk and demonstrate in practice gives us strong indicator of a teacher’s practice. Using the teacher talk indicator from interviews, we triangulated with classroom observations and the DSH classroom video recordings to conduct comparative analysis with the baseline data. We present two brief descriptions of this change from the Pondside and Longwall schools. These cases are drawn from the larger data corpus and are representative of the change in teacher practice.

4.1.1.1 Pondside (DSH English)

In July 2009, Ritu had expressed her inability to teach in English and did not appear confident in her outlook as a teacher. During the November visit, she was assertive and gave detailed descriptions of her teaching English with DSH. Ritu was positive in her evaluation of the system and was more confident as a teacher. While there was no power for three weeks from October

to November, she continued to teach with the DSH methodology adapted from her previous use.

When we visited on Nov 4th, there were only three third graders present in the school. The student attendance is a constantly changing variable in our study and the numbers usually hover around 40-50% on good days. Ritu suggested that we could observe her teaching the first and second graders since they were also beginning English language learners. There was no power in the school and the DSH setup could not be used.

As we sat in the back, Ritu cleared the blackboard and set up a table with Teacher Learning Materials (TLM). She taught the students English alphabets from A to G and tested students for their previous knowledge of alphabets. Ritu wrote the letters on the board and conducted IRE sessions with the class.

Ritu initiated the questions in both Hindi as well as English. For example, for the letter E, she asked, "How big is haathi? Elephant?" She drew pictures under each letter and questioned students regarding the letter-word-picture correspondence. The students were actively engaged with Ritu's teaching and responded with answers to her questions.

4.1.1.2 Longwall (DSH Math)

There were distinct differences in Neetu's practice between the baseline and the later data. First, there was change in Neetu's perception of "such projects that come and go". Having access to other teachers' expertise and the support for the usage had changed Neetu's views. That was evident in her continuing and sustained mediation of the DSH video lessons. Second, the level of participation by the girl students had increased as a result of the feedback by the DSH staff. Third, the level of participation by the class in general had increased. Fourth, Neetu had added various DSH class management strategies to her teaching repertoire including public applause, calling students to board work, and encouraging students to support their peers.

During a monitoring visit in November, Neetu asked us to observe the girl students in her class as she taught them fractions. Earlier in October, the DSH staff had visited Longwall and commented on the lack of participation by the girl students. Neetu had worked on those suggestions and wanted to show us the class participation in particular, and her teaching with DSH in general. She informed us that she had planned to administer a DSH test in her class to show us that the "girl students participation has improved".

We sat in the back of her fifth grade classroom. Neetu inserted the DVD, turned the TV on, and accessed the DVD menu to click on the fractions test. She wrote the problems on the board. Then she asked the girl students to solve the problems. Neetu got the students to take turns coming up to the board as well as questioned them as a group. The students solved problems individually as well as worked with each other. She complimented them as they finished their work.

The class had good participation in the test and the students were comfortable answering Neetu's questions. They also used mathematical terms in English and had demonstrated proficiency in approaching fractions problems. As I talked to the students about DSH videos and teaching, one student said, "it was exciting and helpful since there were two teachers in the room- Neetu Ma'am and the video teacher".

4.1.2 Evidence of student learning

We conducted pre-tests in all schools in July 2009 and post-tests in March 2010. The pre-test design was based on the exit exams for Grade 4th in Math and administered to the Grade 5th students. The English pre-test was based on very basic competency in starting English language learners such as alphabet-picture correspondence and identifying everyday objects and people using English. The post-test design was based on review of the state curriculum covered by the Chinhat teachers in their use of the DSH video lessons. This information was documented from interviews with the teachers and the DSH use logs compiled by the teachers themselves.

We also monitored student progress by informally talking to the students and getting their feedback on learning with DSH. The students as well as teachers reported benefits such as- helping with English especially in Math, having more understanding of the topic, and enjoying the watching of another teacher.

Currently the student results are inconclusive as the tests were confounded by factors such as lack of student attendance leading to small sample size, lack of sustained instructional period, planting and harvesting season, and lack of sustained instructional period due to power outages and teacher reassignments. In our research meetings, we had to decide to not administer the weekly and monthly tests due to lack of student and teacher attendance. And for the same reasons, in 2009 we also had to postpone the planned November post-test to March 2010. In this regard, we do not have statistical evidence of change in student learning outcomes.

We are using these results to design future assessments that are more appropriate for the unique challenges in this deployment.

4.2 DSH provides teacher with access to expertise, teaching resources, and in-practice professional development

In this analysis we will show that the DSH system provided resources for the Chinhat teachers to assist their teaching in the classroom. The analysis demonstrates that the participants used the system to access the expertise of other teachers and mediated these resources to their students. In this manner, the Chinhat teachers developed teaching through deliberate practice over several months.

On November 6th, Sudha started her English lesson with Grade 3rd by putting in a DSH DVD of alphabets from P-Q in the DVD player. She turned towards the students sitting on the floor and asked them to pay attention. When the students settled down, Sudha turned on the TV and hit play.

On the DSH video lesson, Shalini the video teacher, taught the students using participatory techniques such as group activities, front-of-classroom display by students, and different props used as learning materials.

Our data shows that Sudha paused five times in the 30-minute lesson and mediated Shalini's instruction by reformulating her explanations (see Figure 1).

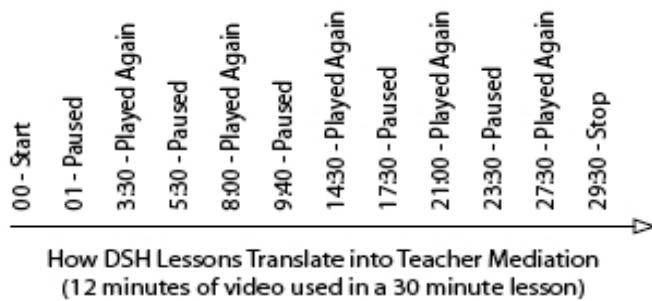


Figure 1. Image showing the pattern of DSH mediation by Sudha

She adapted the activities and used the existing resources to replicate the DSH artifacts.

4.2.1 Contextualizing language learning- “I am the king, I am the queen”

Sudha and the students worked in the classroom with the DSH video lesson. They started from the letter P and got to Q. Sudha paused the video twice to mediate and the whole class participated in the learning activities structured around the letters. For example, for P, Sudha asked the students to get up and sing with her as she followed Shalini’s teaching on the video. This activity was repeated twice in the group and was complemented with boardwork on spelling and pronunciation. Each mediated activity took about five to seven minutes and then the video was played again.

About 20 minutes in the playback, the video teacher Shalini started teaching the letter Q. She brought two students up to the blackboard and gave them two pre-made golden paper crowns. She told the first student that she was the king and that the second student was the queen. Then she guided the students in learning Q through a song activity focused on the use of this letter. The song had the following verses:

“Roses are red, Grass is green
I am the king, I am the queen”

Shalini sang these verses accompanied with explaining gestures, which were then picked up by her students as they repeated after her. For example, for “the grass is green”, Shalini made a sweeping gesture to enact the expanse and the location.

As Sudha’s class watched this video, Sudha turned to her desk and tore two pages from her notebook. She wrote “King” on one and “Queen” on other. After she finished, Sudha paused the video. She turned and said in Hindi “two students are going to come up and tell us that the king wears a crown and the queen also wears a crown”. The instruction was mainly conducted in Hindi and Sudha talked in English when mediating the DSH lessons. In this manner, the mediation provided Sudha with resources to practice her spoken English with the students. In our analysis, we have tried to maintain faithful transcription of the classroom discourse in data as well as the English translation.

As she talked, Sudha raised her hands over head to form a crown shape. In doing so, she adapted Shalini’s strategy to demonstrate a word meaning through multimodal gestures. When two students got up from the front row and walked over to her, she positioned them to face the class and picked up the two paper crowns that she had made earlier. Sudha placed the crowns on their heads. She pointed at the first student wearing the king crown and said, “I am

the king” and then pointed at the second student and said, “I am the queen” (see Figure 3). The students nodded to demonstrate their understanding.



Figure 2. Sudha pointing to the two students as she mediates the song activity

Sudha turned to face the class and sang the song for the letter Q. The students repeated after her in words and using gestures such as cupping their hands to indicate rose and swaying in their places to imitate the movement of the grass. After they sang about the grass, Sudha turned to the first student and said, “I am the king”. The student shyly repeated in a soft voice, “I am the king”. Sudha repeated in a louder, more emphatic tone “I am the king” and the student responded more confidently “I am the king”. She leaned forward, touched the other student and said, “I am the queen”. The student repeated, “I am the queen”. This activity was repeated and then Sudha asked for the next pair to demonstrate.

Sudha used the DSH system to access the teaching expertise, mediate instruction, and conduct deliberate practice for her professional development. The asynchronous system allows teachers to develop their practice in-practice [27]. Consider an excerpt from Sudha’s baseline video (Figure 3).



Figure 3. Sudha teaching the class before the DSH deployment

Sudha stood at the front of the classroom behind her desk. The students sat on the floor in ordered lines. As she read from an open textbook, the students repeated after her.

“rain rain go away
come another day
(.)
ok
it is jolly warm today
rain rain go away”

There is marked difference in teaching between the two excerpts. While both the teaching episodes still demonstrate the classical classroom discourse of Initiate-Response-Evaluate (IRE) sequences, there is an increased interactivity by Sudha as well as the students. Her explanations are not mere reading of the text but

use contextual cues to demonstrate the word meanings. The students in turn pick up those cues as they participate in the classroom. For example, in the main analysis we saw that the students used both talk and gestures to demonstrate their understanding. That was absent in the baseline video. The research in teaching and learning demonstrate the importance of context and effectiveness of increased participation by the students, especially in language learning [28]. In addition, there is also ample evidence that complex explanations given and received by people are constructed in communicative modalities of talk, gaze, and embodied gestures [18].

Over course of several months, Sudha was able to develop her performance through skill acquisition from the use of the DSH system. The research shows the link between expertise and practice [16], [29]. There is a general consensus in these accounts that experts in different fields put in a minimum of 10,000 hours of practice to reach their current levels.

To better understand the nature of Sudha's deliberate practice, consider the following timescales of this performance development. Shalini, in the DSH lesson, explained the letter Q with the song activity in a two-minute episode during a 13 minute recorded session. In her review of the video, Sudha identified that activity as relevant and mediated it for over four minutes with her students. In both cases, Sudha and Shalini took three turns with three student pairs leading the song but Sudha's activity took double the time. This evidence points to the practiced nature of Shalini's expertise as well as Sudha's practice for skill acquisition with the use of the DSH system.

4.3 DSH organizes conditions to support the learning and teaching in the classrooms

In the previous analysis, we illustrated the use of the DSH system by the teachers in the classroom. The purpose of this analysis is to trace the different ways that the teachers were supported in their efforts to mediate the DSH instruction and to answer as much as possible the question: How did the DSH system organize conditions to support teaching and learning in the 11 schools?

The analysis draws from the concept of "socio-technical network" from the area of Science & Technology studies [22]. The studies of socio-technical practice are concerned with the ways that technologies feature in our daily working lives and our interaction with them [30]. In using this notion, we will use the Actor-Network Theory (ANT) [31] to present ethnographic accounts of how the DSH system organized the conditions in the 11 schools. To do this work, we will use two technical terms from the ANT literature- actants and mediators. An actant is a detailed account of an action that makes a difference, transforms something, and makes things happen. A mediator is an actant whose specific actions show translation, transformation, and modification.

The purpose of using ANT is to make the different actants visible in order to make explicit their specific actions that organized the implementation at the eleven schools. In this manner, this is a relevant approach to study organizational changes.

4.3.1 Translation of proposed use to actual use

The DSH project proposes to connect low resource schools to centers of educational excellence. This is done by teacher training, access to expert teachers, and support at the infrastructure level [8].

Consider the following use by the actants at the West Elementary School in the Chinchhat district. The lesson was mediated by Sudha, an experienced teacher who teaches Grade 3rd. We see her using Shalini's techniques, mediating instruction to her students, and contributing to her professional development. This use shows that the translation from initial framing to its actual use happened without massive deformation. In this section, we will show how the actants started from the proposed use and arrived to this actual use. We will do so by describing the effort of translation and the workarounds.

4.3.2 Effort of translation

Sudha had been teaching since 1997 and spent most of that time at the West Village. Earlier in 2005, the DSH organization had covered the West Village in a district wide survey for another project. We approached her in July 2009 to discuss being part of our evaluation. The principal, Ram, and Sudha remembered one of the researchers from that project. When we were talking with Sudha about her experience as a public schoolteacher, she said, "I love the atmosphere at this school and love working with the students". She consented to be in the DSH group and explained, "I have to adapt many methods to teach in the classroom and I am a teacher that wants to learn new things." As we interviewed her regarding teacher perceptions, Sudha informed that she has seen the "teacher practice change from less student questions and more physical discipline to encouraging more of teacher student questions, use of activities, and more talking to the students". We enrolled Sudha as an actant in the evaluation and invited her for the teacher-training workshop. Sudha received the first DSH DVD at the workshop.

Ram decided to setup the equipment in Grade 5th room since it had a lockable door and secure windows. So the Class 3rd was moved into that room when Sudha mediated the videos. On one of our visits, she informed us that sometimes she taught the 5th graders also using the setup. In that regard, the technology was considered stable enough to be used in different situations.

After Oct 20th, there was no power for ten days so the inverter died and Sudha could not use the setup. The power came back to the village in the first week of November but the school equipment did not work. The researchers would call the school every week to get update of the power situation. During these six weeks, the DSH researchers conducted four school visits and several phone calls.

4.3.3 Workarounds: Actants as fixers

The DSH uses a common and stable technological setup of TV, DVD player, and an inverter. However, the use of this simple system is affected by systemic challenges such as grid level power outage, localized electrical failure, district mandated curricular interventions, temporary reassignment of teachers, and student attendance. On November 6th, when the researchers visited the West Village Elementary, the school was in full session with classes happening in the front yard as well as in the rooms. While the power had been restored to the village and the school, the Grade 5th room did not have any power. The TV was covered with a plastic sheet to keep dust out. After the power came back in the village, Sudha had tried to use the setup but could not turn it on. She requested the village chief to send an electrician but no action was taken. Since the principal Ram was away on a government reassignment, there was no recourse to the higher officials. As we started looking around the room to try and find

the cause, we soon realized that there was only one power outlet that was being used by our equipment (see Figure 4).



Figure 4. Image showing the problematic electrical setup at West Village

Ajay, one of the researchers, soon located the fault as the heavy plug of the inverter causing the cheap electrical wall outlet to pull away from the wall and in turn causing a break in the connection. He fixed the problem by using a workaround of plugging the TV and DVD player directly in the outlet. While that solved the immediate problem, the inverter was taken back to the office to be charged and a sturdier model later replaced the outlet. The whole process of identifying and solving the problem took about an hour of the site visit. While it was a relatively simple issue, the broader aspect is of robust monitoring and support for ICTD projects. As a result of this and many such workarounds, the DSH organization decided to contract an electrician for periodic maintenance and upkeep.

In the analysis, we illustrated how the moments of efforts by varied actants translated to actual instructional hours for the students and teachers in the classrooms. Consider the following workflow for the above analysis (see Figure 5).

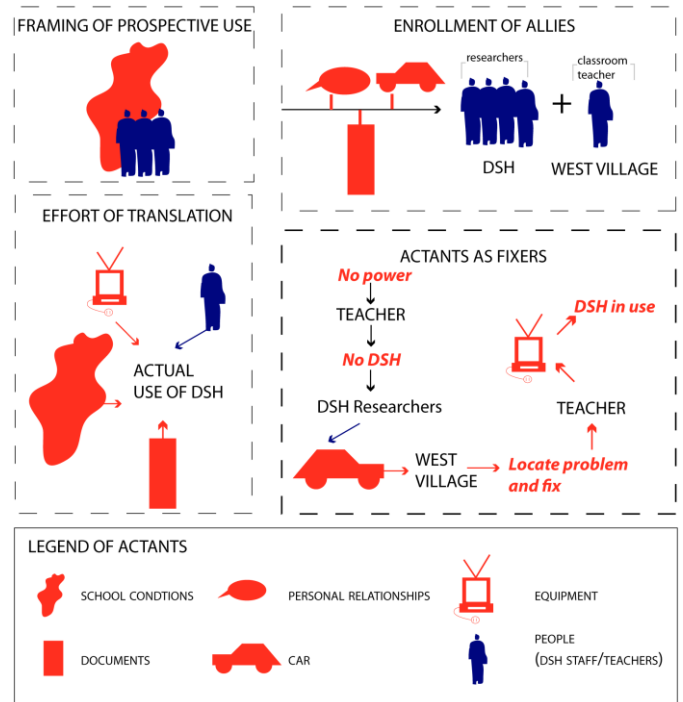


Figure 5. Image showing the workflow for translating the prospective use into actual use in a Chinhat classroom

In organizing support for teaching and learning in DSH classrooms, the translation of use was an account of actants seeking workarounds to overcome obstacles. The DSH staff, researchers, teachers, teacher training workshops, and video equipment acted as mediators to move the teaching from expert teachers to teachers developing their performance. In that regard, the analysis of the organizational conditions of the DSH system serves as a focal point to understand implementation as a socio-technical system where varied actants come together to effect organizational change. This has relevance for the ICTD community since it points to the difficulties in building such communities.

The analysis of the organizational conditions is a more complex story than the mere attribution of success or failure of an implementation. The translation was an effort by actants who had different material qualities depending on the site and their role. For example, while Ajay was a DSH researcher, at the West Village he wore the uniform of an electrician. The support setup leads to the question if the DSH system could have organized these conditions if actants did not mediate. And what does that say about the DSH system itself? As learning and technology research analysts, we argue that we need to recognize the effort of different actants in organizing these complex workflows. In that sense, it is not a simple matter of “what if it was otherwise” as posited in deterministic accounts of ideal software operating in pristine environments. It becomes a matter to empirically account for the social activity. Looking only at the overall translation of framing and the overall end states of interactions represented as instruction, all the eleven schools may seem similar. However, tracking the movement of actants busy with workarounds revealed that there were residues of faraway people and places that intervened in this process.

Although this analysis has not managed to fully trace all connections that could have better revealed the figurative accounts at all the sites, the findings are situated in the broad context of the difficulties in educational reform and implementation [32], [33]. Using this argument, we believe that facilitating implementation requires paying close attention to local social processes and the navigation skills to access resources and expertise.

5. IMPLICATIONS

In the final section of the paper, we draw upon the previous analysis to present implications after the first year of from this evaluation. Our three implications are regarding a) Strengthening connections between teacher education and ICT research b) Developing systematic evaluation of ICT interventions for educational change and c) Designing student learning measures in response to the deployment challenges.

5.1 Strengthening connections between teacher education and ICT research

Our first implication is regarding the potential of the DSH system towards teacher preparation. The analysis demonstrates the value of the DSH system towards change in teacher practice. The teacher educators have urged for opportunities for student teachers “to practice and reflect on teaching while enrolled in their preparation programs” [26]. In addition, the researchers have described the challenges of making representations of teaching available for pre-service teacher education or research [34].

The analysis of the DSH use by teachers shows that having access to other teachers in their classrooms allowed them to develop their own practice. In this manner, the DSH system can provide opportunities for the student teachers to convey their own interpretations of teaching as they mediate the expertise of other teachers. We believe that providing pre-service teacher programs with a conceptually sound DSH framework would effect generational change in teacher practice and in turn student learning outcomes.

5.2 Developing systematic evaluation of ICT interventions for educational change

Our second implication is regarding evaluation methodology for ICT projects in educational change. The evaluation is organized around a mixed methods protocol that has allowed us to pay close attention to the interactions and use of this system. While the qualitative data allows us to gain insights in the situated nature of the teacher mediations and their practice, the quantitative data gives us statistical information about student learning. However, the analysis does not satisfactorily answer the question of how student learning happens. Hall [35] calls this the problem of “conversational fragments”. When we combine the ethnographic data of teacher practice to student test scores, it does not tell us how and when learning happened. We are not able to see and hear the total classroom interaction. Since the test scores are severely confounded by external variables such as attendance and farming, we would like to develop ways to pay close attention to the sequential nature of teacher-student interactions as facilitated by the DSH.

However, as a method of investigating practical accomplishment of teachers using technology, we are confident that the analytical

accounts are accurate and systematic representations of this community. In this manner, the strategy of mixed methods protocols is successful towards analyzing the use of DSH to effect educational change.

5.3 Designing student learning measures in response to the deployment challenges

Our third implication is regarding the design of learning measures in face of existing challenges in developing regions. Our analysis shows that the deployment in government schools in India faces significant challenges and currently we do not have results for the student learning. Due to various factors, the sample sizes as well as average means in both English and Math have been low. As a response to these results, we are discussing ways to measure student achievement that are continuous and can fit in the classrooms with minimal disruption of instruction. Another strategy that we are considering is to develop a participatory framework with Chinhat teachers for designing tests that are more nuanced towards student growth.

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