The Digital StudyHall

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Outline

- The “TVI prelude”
- India education background
- Introduction to the Digital StudyHall
- Connectivity: Postmanet and phttp
- Content capture
- EdTV
- Homework
- Pedagogy
- Other applications
- Conclusions

StudyHall

- Urban private school in Lucknow
- Founder and principal: Dr. Urvashi Sahni

StudyHall

- Well-staffed
- Well-furnished
- Lots of facilities: sports facilities, science labs, music rooms, computer labs
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**The Affiliated Village Schools**
- About 250 students per school
- 2-6 teachers
- Little training
- Difficult subjects: English, math, science
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StudyHall (Lucknow)

- Itaunja Primary
- Chinhut-Ganeshpur
  - Rahman Primary
- Madantoosi Upper Primary
- Sarojini Nagar Primary
- Kanaar Upper Primary
- Mahipat Mau Primary

Distances:
- 75km
- 25km
- 30km
- 22km
- 15km
- 45km
- 5km
Narrow the gaps between:
- Urban and rural
- Private and public schools
- The rich and the poor

"Out-sourcing" model
- Make shared resources available to those who can’t afford piecemeal instances of their own
- Economy of scale: encourages specialization, fosters efficiency
- Uniform standards and quality

Scale up
- More villages
- More students
- Start schools where there’s none today
- More staff/volunteers
- Including volunteers overseas (mirror at UW-Seattle running)
In the longer run...

- Allows distributed participants to “plug themselves in”
- Matches supply and demand
- Service offerers: both volunteers and professionals
- Flexible time and location commitments by participants
- “Open source” model

Principle 1: cost realism

- Cost of “wiring” a village school < $1500
- Cost of “wiring” a child < $6
- (Not included: operational cost)
- Compare this against:
  - Average daily income per person: $1 - $2
  - Not uncommon: a rural family spends 1/5 of income sending one kid to school
  - A village teacher’s daily income: $1 - $4
  - A text book in the village: $0.3

Principle 1: cost realism

- Cost of “wiring” a village school < $1500
- Cost of “wiring” a child < $6
- (Not included: operational cost)
- Slides convention:

Principle 2: build “systems” that solve education problems

- A lot more than connectivity
- “workflows” and pedagogy
- Work with people:
  - Headquarters staff
  - Village teachers
  - Students as students
  - Students as teachers

Recurring themes

- Any-to-any communication, customization, sharing, high bandwidth, cheap, solve education problems
- Enable collaborative learning among kids

Some hard questions

- How do you provide connectivity?
- How do you quickly populate your database with good teaching content?
- How do you address the “display problem”?
- How do you collect homework and provide feedback
- How do you teach effectively with such a system?
Work in Progress: Icons

- Deployed as planned
- Modified during deployment
- Tried in lab, or ongoing work
- Future work (not tried yet)

The Affiliated Village Schools

- Madantoosi Upper Primary
- Sarojini Nagar Primary
- Kanaar Upper Primary
- Chinth-Ganeshpur Rahman Primary
- Itanja Primary
- Mahipat Mau Primary
- Manzil
- 45km
- 15km
- 75km
- 25km
- 30km
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- 5km
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Components: repository, phttp, EdTV

"Workflows:" content capture, homework feedback

Pedagogy research

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What Is A Postmanet Router?

- Start with a conventional router
- Users oblivious of “routers”
- Routers are *general* and *transparent*

- At the end of the day, it spits out a DVD

- Picked up by a postman
What Is A Postmanet Router?

• The postman may also drop off an incoming DVD

A Postmanet Router

• Basic idea of using DVDs not new
• What is new: general and transparent
• General:
  – Support for multiple applications
  – Generic infrastructure (public transit system)
  – 2-way communication
  – Multiplexing/demultiplexing onto/from minimum disks
• Transparent:
  – No manual inspection of DVD content
  – No manual staging, copying
  – No manual handling of acks, losses, duplicates, ..... 
  – Just insert/remove DVDs from the box

Advantages

• Wide reach: a truly global “network”
• Great bandwidth potential, technology trends:
  – “Sneaker nets” becoming more powerful
  – Storage density growth > Moore’s Law
  – Wide area bandwidth growth bound by digging ditches, launching satellites, erecting WiMax towers...
• Low cost
• Incremental deployment:
  – Classic chicken & egg problem: infrastructure, applications, users
• Good scalability

DVD Capacity

• HD-DVD: 15-20GB per layer, maximum of 40GB dual-layer discs
• Blu-Ray: 27GB per layer, 54GB dual-layer discs
• Sony plans to commercialize 4-layer 100GB Blu-Ray discs in 2007
• Sony has demonstrated 8-layer 200GB Blu-Ray discs in October of 2004
• Torok of Imperial College London
  – Asymmetric pits encode more than one bit per pit
  – Expects 4-layer 1TB discs 2010-2015

Scientific American, February 2005.
phttp: Postmanet-enabled http

- Network packets carried by DVDs in the postal system
- Transparency:
  - Minimum manual involvement beyond postal workers' leg work
  - Crucial for scale-up

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Difference from offline browser

- Offline browsers
  - Eventual connection
  - No support for server scripts
- Phttp
  - May never be connected
  - Explicit migration of server script fragments

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DVD Robot

- Why DVDs? Capacity, cost, weight, …
- Robot automation

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The key is transparency

- Transparency and efficiency needed for:
  - Scale up
  - Handling “exceptions:” lost or damaged DVDs
  - Splitting server scripts for asynchronous interactions
Complement with low-latency network

- Catalog of metadata
- Small requests, acks, NAKs, retransmission requests, etc.
- A UI for the cell phone?

Complementing low-latency low-bandwidth link

- Our current choice: packet radio (ham radio)
- Pro: range, cost; Con: low bandwidth
- (India cell phone tele-density: 2.5% as of 2003)

Recurring theme:
any-to-any communication

- Customized content, customized schedule
- High-bandwidth
- Cheap

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Main content sources and their mixture

1. Recording of live lectures

2. Authoring by remote volunteers

3. Redistribute existing content

Lecture capture

- Replaying captured lectures, by itself, will not suffice, but
- It can be an important part of a bigger solution
- (We will talk about other parts of the solution)
Real-time MPEG4 encoders

- 720x480 (DVD quality), DivX codec
- 30fps generates 1GB/hour
- 10fps generates 0.3GB/hour

Screen Capture Movie

- 1024x768, DivX codec
- 5fps, 100kbps, 50MB/hour
Recurring Theme:
any-to-any communication

- Customized content, customized schedule
- High bandwidth
- Build "systems," not just providing connectivity
- Cheap

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The display problem

- Additional computer displays?
- Projectors?
- Expense and power consumption

EdTV

- Multiple TVs serve as displays
- Cheap and low power
- Plus cheap “input” devices
EdTV components ("output")

- Graphics card with RCA/S-Video output
- Small TV signal transmitter
- A 12-inch TV set burns 20W

EdTV

- Multiple TVs serve as displays
- Cheap and low power
- Plus cheap "input" devices

EdTV components ("output")

- Scan converter (VGA to RCA/AV)
- AV-to-RF converter
- A 12-inch TV set burns 20W

EdTV

- Multiple TVs serve as displays
- Cheap and low power
- Plus cheap "input" devices
EdTV ("output")

- Extra graphics cards, sound cards, and transmitters for extra channels
EdTV ("output")

EdTV leaving the classroom

EdTV: more profound potential

- Kids work during the day
- (50% attendance during mango-picking season)
- Customize EdTV schedule: catch up at nights

EdTV leaving the classroom

EdTV is not regular TV:
- Personal media vs. mass media
- E.g.: "village idol", same-language-subtitling

EdTV is not WebTV:
- Shared infrastructure, shared backend connectivity, cheap

EdTVs are not kiosks
- Brings a face into each household
- Shared (multi-user) experience
EdTV “input” devices

- A ham “remote”: a simple transmitter that emits several command signals:
- Same ham receiver at base-station that handles both:
  - Input from ham remote, and
  - Input from long-distance communication with headquarters
- TV and radio control signals: ways of bridging the last mile

EdTV “input” devices

- Walkie talkies, microphone, voice recognition
- Use Hindi
- Paid $10 apiece but can do much better

EdRadio

- Radios even more pervasive
- Customized local content: songs sung in schools, teaching English, recordings of “town hall meetings,” kids being “DJs for the day,” text-to-voice of content relevant to locals, …
Recurring theme:
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Electricity

- Intermittent power
- Battery/inverter unit
- Laptop battery: no UPS required

- Low-power TVs and laptops
- 10-20 hours operating time? (haven’t tested draining battery)

Electricity

- Operator training

- Training for village and headquarters operators
- Capture the training sessions and use the system to propagate training videos
- Village operator training videos done in Hindi
Operator training

- Training for village and headquarters operators
- Capture the training sessions and use the system to propagate training videos
- Village operator training videos done in Hindi

Village computer monitoring and administration

- Village computer log collection: distance monitoring and diagnosis
- Various levels of system restore in case of trouble
- Quick replacement with spares
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- Village computer log collection: distance monitoring and diagnosis
- Various levels of system restore in case of trouble
- Quick replacement with spares

The homework workflow (1): digitizing

- Camera instead of scanner: speed, versatility, portability, simple power requirements
- Microphone: digitize voice questions
- Webcam: video for a personal touch, not strictly necessary

The homework workflow (3): grading

- Step 3B: Batch image editing software + tablet pen

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The homework workflow (3): grading

Step 3B: Batch image editing software + tablet pen

Step 3C: produce a feedback video with screen capture

The homework workflow (4): feedback

- Collective feedback played to all students on EdTV in classroom
- Use it to instigate group learning
- Individualized feedback “scheduled” at convenient times on EdTV
  - In-classroom, or even during evenings
  - Pause, rewind, zoom, etc.
  - Review graded raw images if necessary
- Showcases customized content/control of EdTV

Implications (1): better experience

- Not only comparable to what urban kids receive,
- But also better than existing homework feedback experience: more personal, rich media
- Same workflow useful for less structured question/answer sessions
Recurring theme: any-to-any communication

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- Build “systems,” not just providing connectivity
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Two different questions

- Given a reasonably competent teacher, can any technology better a blackboard?
- Where there’s no teacher at all, how do you make the most out of what you have?
- Our focus is the second question

A Tale of three schools

- StudyHall morning sessions
- StudyHall after-school program for slum girls (Prerna)
- Madantoosi (village) school
- Prerna as an “in-house testbed” of village schools
A Tale of three schools

- Morning lessons → villages?
- Afternoon lessons → villages?
- Morning lessons → afternoon classes?

A Tale of three schools

- Teacher qualification difference
- Language difference
- Student background (environment) difference
- Different text books
- Systemic difficulty of bridging the education gaps
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Try 1: Morning → Afternoon

- Teacher qualification difference
- Language difference
- Student background (environment) difference
- Different text books
- Systemic difficulty of bridging the education gaps

Try 1: Morning → Afternoon

- Recorded material provides a framework
- Teacher “facilitates:” instigate interaction
- Training for less experienced teachers
- (Model lessons stored in database for future training)
- Mediation:
  - Questions by teacher
  - Dialogue between teacher and students
  - Student exercises
  - Student-to-student interaction
  - Role plays
  - Songs, poems, stories, drawings
  - Tests
Teachers Learn to Mediate

- Learn communication/interaction skills
- Study recorded material ahead of time
  - Familiarize with material
  - Plan
- Flexibility:
  - How much to depend on recorded material
  - How much to improvise
Try 2: Replicate experience in villages

- Model lesson in front of village teacher
- Followed by village teacher's running the class
Replicate in villages
Try 3: Staged model lessons in afternoon school

- Stage sequences of model lessons
- By best teachers from morning school
- Conducted in front of after-school girls
- Recorded for reuse by both:
  - Village schools, and
  - Future afternoon classes
Try 3: Staged model lessons in afternoon school
- Entire English curriculums for classes 3-5
- Based on government text books
- 90% English, 10% Hindi
- “Bonus:” for the 1st time, the best teachers teach in the afternoon!
- The girls seem to be doing very well

Receiving ends: promising so far
- Village 1 (private)
  - 5 hours of daily use
  - English lessons for all grades
  - Science lessons for grades 5-8
  - Want a lot more (math lessons)
- Village 2 (public)
  - Working well but less well
  - Worse power outages
  - Software bugs
  - Elections/festivals
  - Sufficient teacher motivation?

Evaluation
- Design rigorous tests for evaluation
- Turn the Digital StudyHall into a learning science testbed

Build a participatory and immersive environment
- Role-plays
- Distributed development of digital plays: involving both urban kids and rural kids
- After-hour cartoon shows
  - Consciously cultivate an English-speaking environment
  - Edited, with extra voice over
Preparations for scale-up

- Involve various levels of government
- Design teacher training sessions for scale-up
- Devise cheaper village hardware “classes:”
  - a spectrum that starts with DivX players + TVs
- Methodic scale-up that builds a network of excellence

A model for urban slums: “Prerna 2”

- Use existing school premises after regular hours: low cost
- Hire a small dedicated staff:
  - Trained in mediation
  - Armed with a high-quality digital content feed
- About $10K per year for 200 children
- Cost-effective way of reaching dense urban slum populations
- Reach out to existing urban schools and special ed kids

A model for rural areas: “Prerna 3”

- Use existing school premises after regular hours: low cost
- Hire a small dedicated staff:
  - Trained in mediation
  - Armed with a high-quality digital content feed
- Higher grade classes: target high dropout rates of girls

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The “big picture”

- Components: repository, phttp, EdTV
- “Workflows:” content capture, homework feedback
- Pedagogy research

Synergy: phttp + repository

- A simple distributed file system analogy
- Generic abstraction that can support all manners of shared applications (without a conventional network)

Synergy: phttp + repository

- A simple distributed file system analogy
- Generic abstraction that can support all manners of shared applications (without a conventional network)
- A network analogy: a “network with memory”
- Why not direct peer-to-peer transfer between villages?
Synergy: phttp + repository

- A simple distributed file system analogy
- A network analogy: a "network with memory"
- Why not direct peer-to-peer transfer between villages?

Synergy: phttp + EdTV

- A natural two-hop "network"
- The phttp "hop:" pervasive, high-bandwidth, cheap, asynchronous
- The EdTV "hop:" cheap end devices, bridging last mile

Synergy: repository + EdTV

- The repository abstraction makes it easy to build shared EdTV applications, like voice mail
Synergy: repository + EdTV

The repository abstraction makes it easy to build shared EdTV applications, like voice mail.

Recurring themes

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Message in a bottle

- How is this fundamentally different from a cassette in the mail?
- Sending a message to the database == sending a message to the world
- It’s about interconnecting to the world

Implications

- Implications for StudyHall: raise bar of excellence for all teachers
- Implications on breaking down class barriers
Implications

- Implications for StudyHall: raise bar of excellence for **all** teachers
- Implications on breaking down class barriers

Implications on breaking down class barriers

High-level things I learned

- Be a generalist, not a "computer scientist"
- Work with and respect locals
- Importance of long-term commitment
  - Expect delays
- The most fun and rewarding work ever!!
High-level things I learned

- The most fun and rewarding work ever!!

Interested in helping?

- $  
- Smuggle equipment to India  
- Non-technical help: e.g., “teach” virtually  
- Technical help  
- Data? Software? Time?  
- You get to determine the agenda!

Thank you!

- Google for: digital studyhall  
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