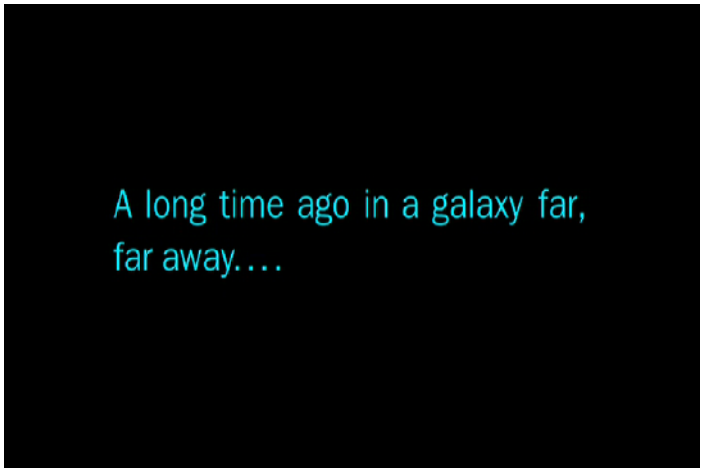
The Digital StudyHall

Randy Wang

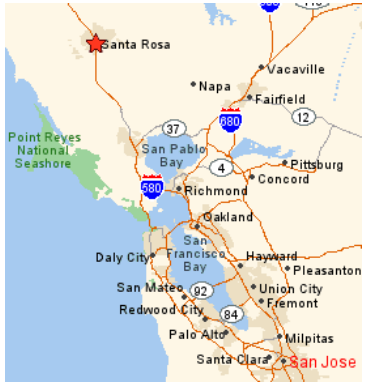
Urvashi Sahni, Nitin Garg, Sumeet Sobti, Anindita Dasgupta, Tom Anderson, ...

April, 2006

1977

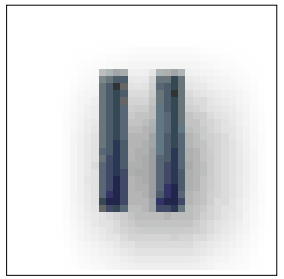


"Tutored Video Instruction"



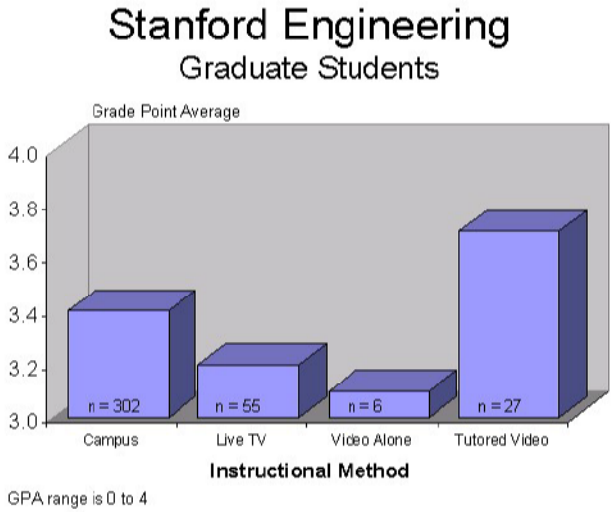
- Stanford -> Santa Rosa plant of HP
- Minimally edited videos of unrehearsed lectures
  - Easy to make

"Tutored Video Instruction"



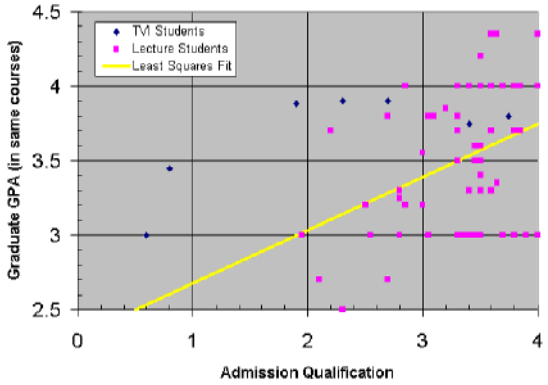
- "Tutor" job:
  - Initiate and encourage stopping the videotape for discussions
  - Rely on dynamic interaction to stimulate intrinsic interest
  - Interfacing with on-campus instructor

TVI results



- Caveat: data does net yet permit a rigorous statistical test

TVI results



- TVI students start with worse qualifications
- They come out ahead regular students

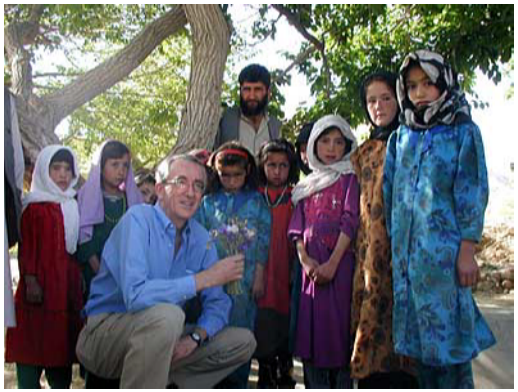
Lessons

- Although not sufficient by themselves, captured lectures are a good foundation
- Instigating interaction can significantly enhance effectiveness
- Successful instigation can be effected with relatively simple means
- Group learning can play a key role

Outline

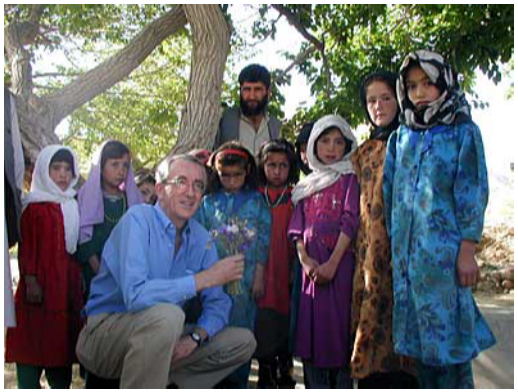
- The "TVI prelude"
- India education background
- Introduction to the Digital StudyHall
- Connectivity: Postmanet and beyond
- Content production
- EdTV
- Experience and pedagogy
- Conclusions

What to focus on?



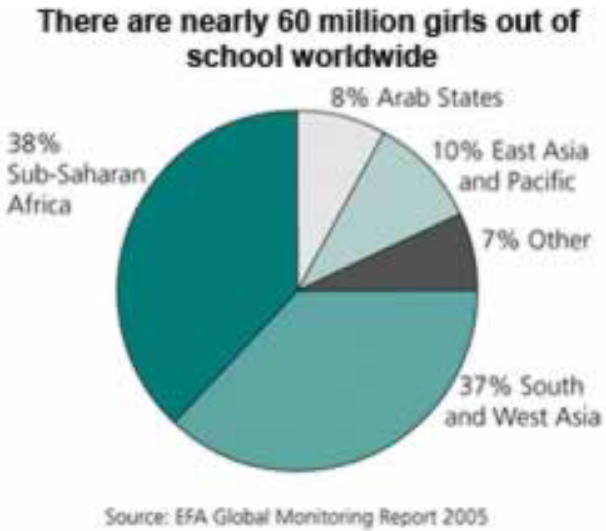
- Peter Bell (president of CARE):
  - Three top priorities of combating extreme poverty…

What to focus on?



- Peter Bell (president of CARE):
  - Three top priorities of combating extreme poverty…
  - Basic education, clean water, fighting AIDs

India



India

- Adult literacy rate: 61%
- 34% of adult illiterates in 9 most populous countries
- An average Indian spends about 2 years in school

Source: Unesco, 2004, *Frontline*, volume 21, issue 16, July-August, 2003

Poor state of public/private education

- “Free” public schools of extremely poor quality
- Serious teacher shortage
- Exponential growth of unregulated private “teaching shops,” especially in rural areas

StudyHall

- Urban private school in Lucknow
- Catering to middle-class students
- 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 Village Schools

Madantoosi, near Lucknow

- About 250 students per school
- 2-6 teachers
- Little training
- Difficult subjects: English, math, science

The Village Schools

Run by Swanirvar, near Calcutta

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The Village Schools

Chinai, UP

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Chinai, UP

An Urban School

Run by SEWA, in Lucknow

The Villages

Madantoosi 1/8

The Villages

Madantoosi 2/8

The Villages

Madantoosi 3/8

The Villages

Madantoosi 4/8

The Villages

Madantoosi 5/8

The Villages

Madantoosi 6/8

The Villages

Kannar 7/8

The Villages

Kannar 8/8

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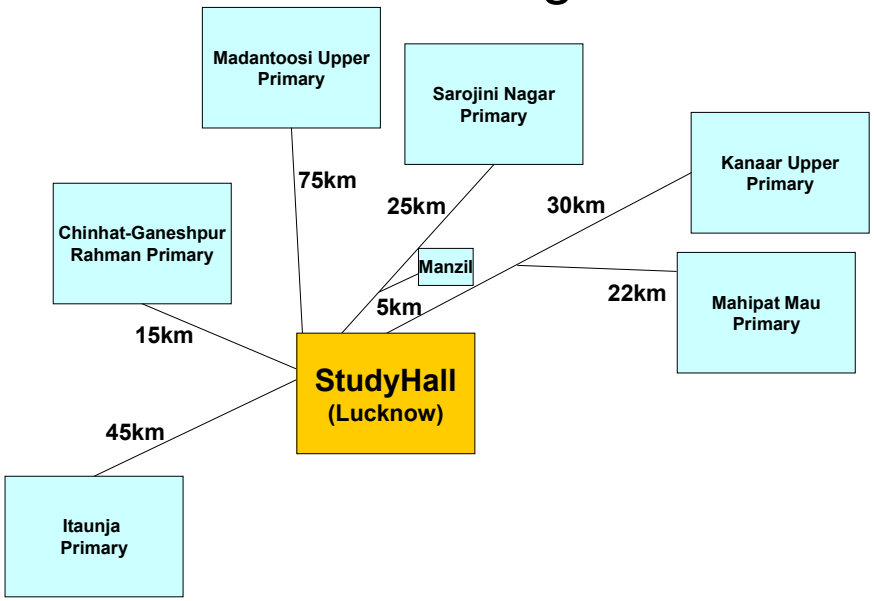
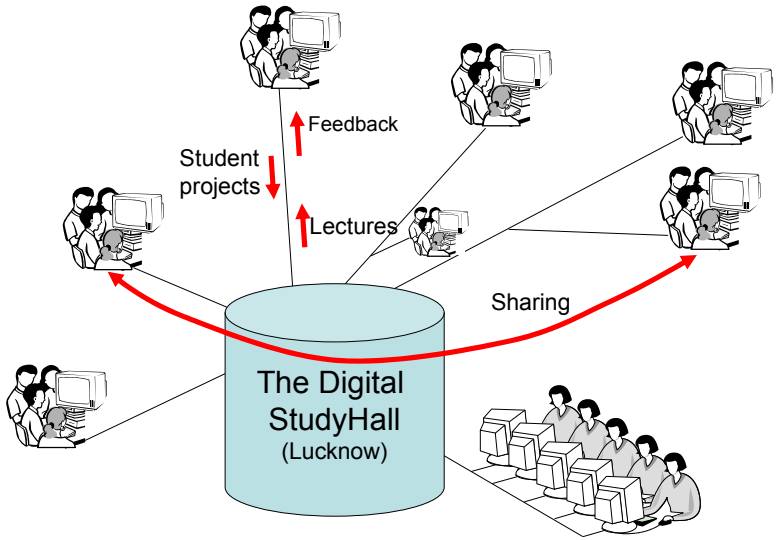
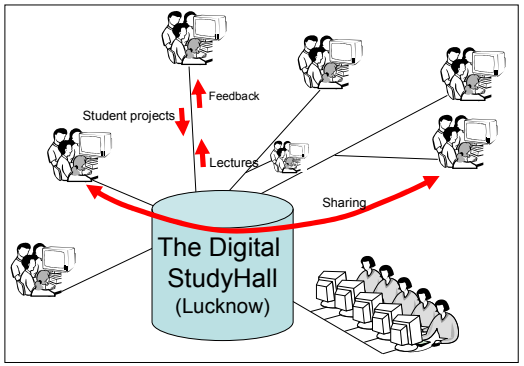
The Affiliated Village Schools



The Digital StudyHall

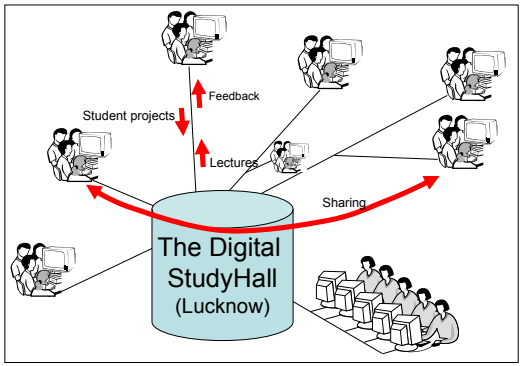


The Digital StudyHall



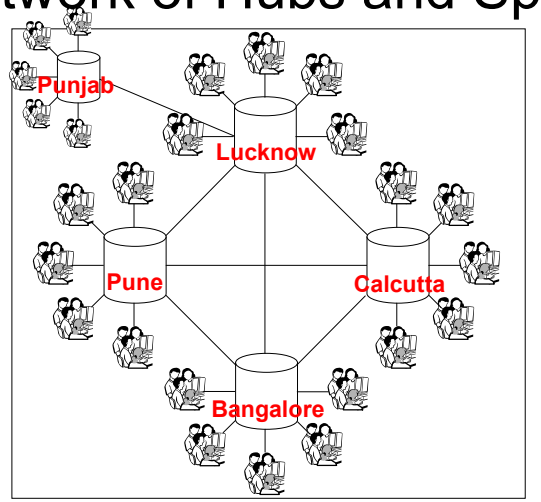
- Narrow the gaps between:
  - Urban and rural
  - Private and public schools
  - The rich and the poor

The Digital StudyHall



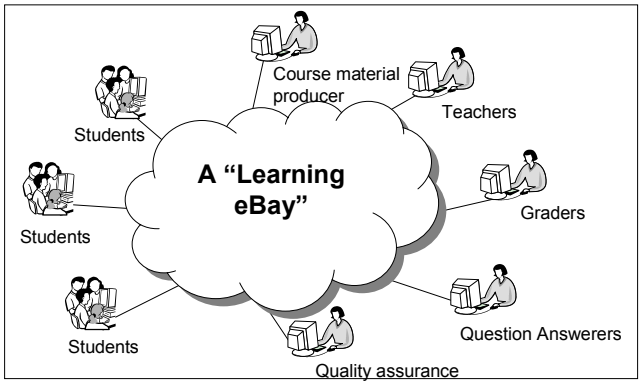
- "Out-sourcing" model
  - Make shared resources available to those who can't afford piecemeal instances of their own
  - Economy of scale: encourages specialization, fosters efficiency
  - Uniform standards and quality

A Network of Hubs and Spokes



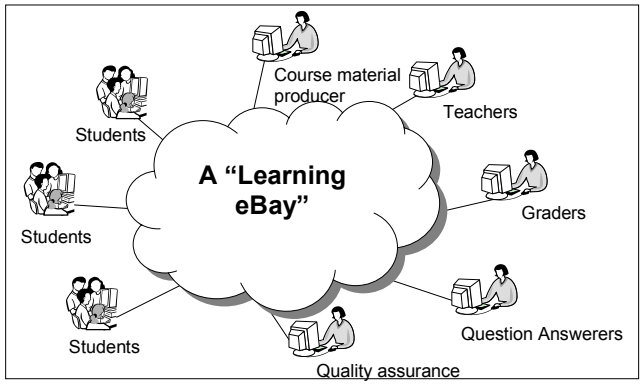
- Networked centers of excellence
- "Radiating" content and methodology into neighboring slums and villages

In the longer run…



- 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

- Schools in Bihar, Madhya Pradesh, Uttar Pradesh, and Rajasthan:
  - 63% leaking roofs
  - 58% no drinking water
  - 89% no functioning toilet
  - 27% no blackboard
  - 8% none of the above
- Weigh the cost of ICT against the above
- Cost realism crucial for scalability

Source: The decline of public education, Frontline, 21(16), July 2004.

Principle 1: cost realism

- Cost of “wiring” a village school: $400 - 1500
- Cost of “wiring” a child: $2 - 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

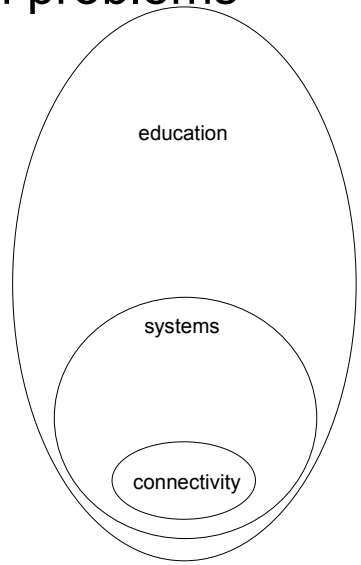
- Cost of “wiring” a village school: $400 - 1500
- Cost of “wiring” a child: $2 - 6
- (Not included: operational cost)
- Compare this against:
  - A GSM base station
  - Erecting a tower for a directional 802.11 antenna
  - Launching EDUSAT
  - Adding an extra telephone line to a house in the US
  - Wiring a household in the Salt Lake Area with fiber

Principle 1: cost realism

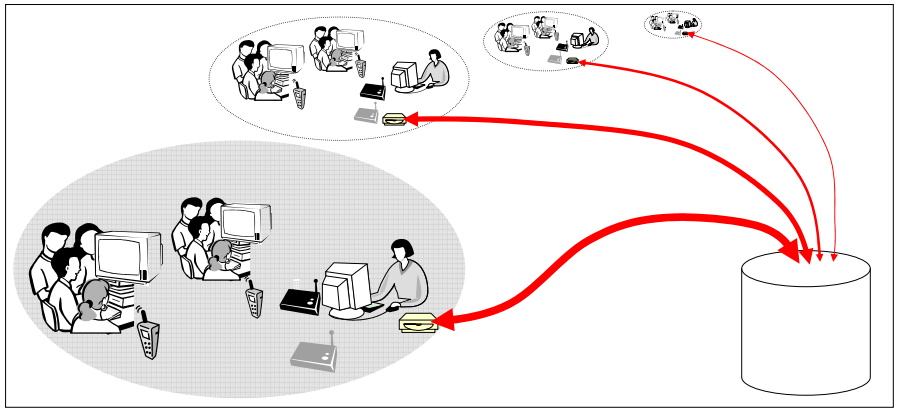
- Cost of “wiring” a village school: $400 - 1500
- Cost of “wiring” a child: $2 - 6
- (Not included: operational cost)
- Slides convention:

Principle 2: build “whole systems” that solve education problems

- It’s about getting kids taught!
- Education
  - The hub-and-spoke model
  - Content
  - Pedagogy
  - Working with people
- Systems
  - Content production
  - Networking
  - Village displays
  - Distributed database
  - .....



Recurring themes

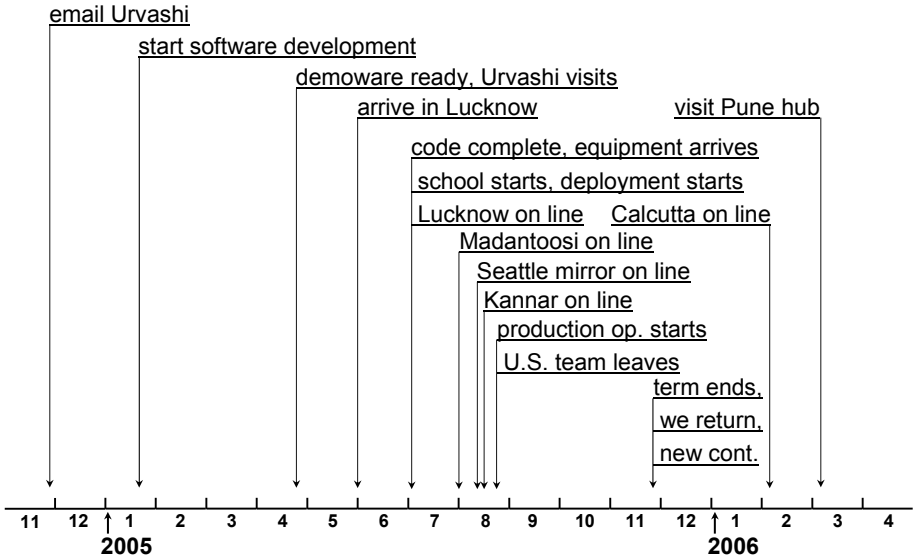


- Any-to-any communication, customization, sharing, high bandwidth, cheap, solve education problems
- Enable collaborative learning among kids

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 teach effectively with such a system?

Work in Progress: timeline



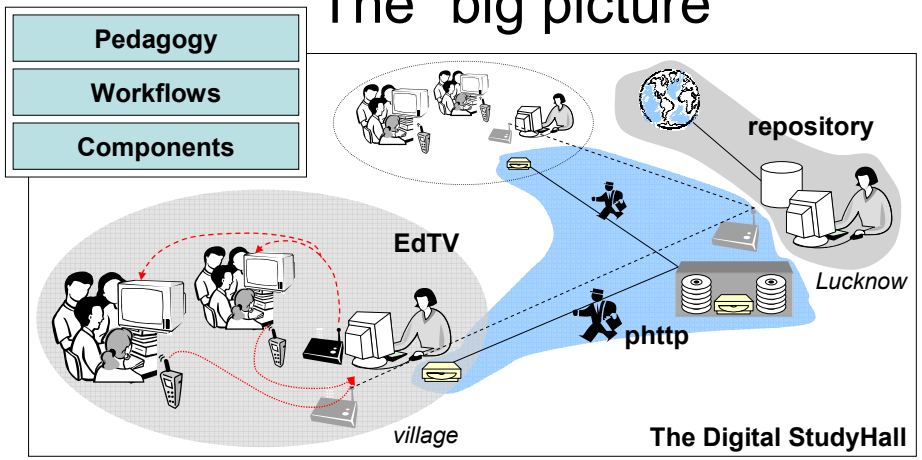
Work in Progress: Icons

Deployed as planned

Tried in lab, or ongoing work

Future work (not tried yet)

The “big picture”



- Components: repository, phttp, EdTV
- “Workflows:” content capture, remote monitoring, ...
- Pedagogy research

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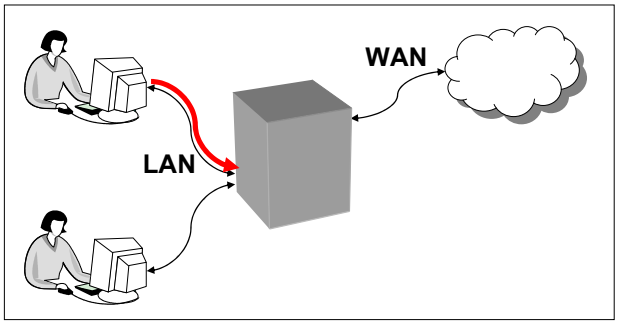
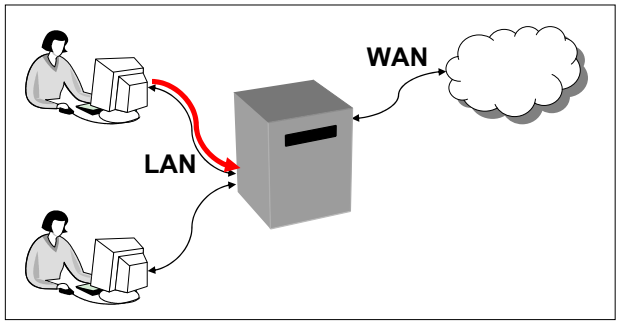
What Is A Postmanet Router?



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

What Is A Postmanet Router?



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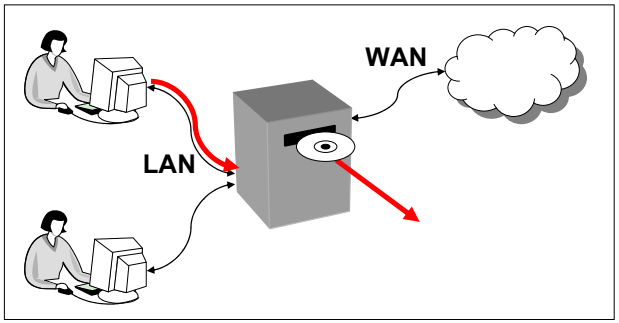
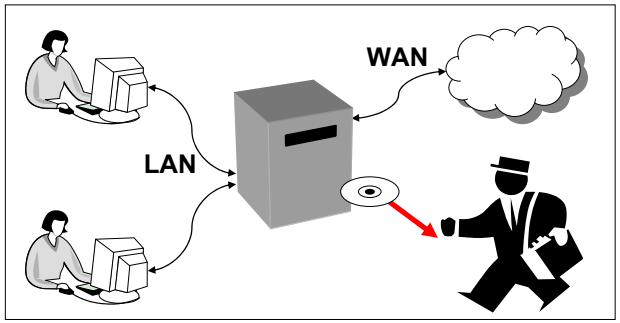


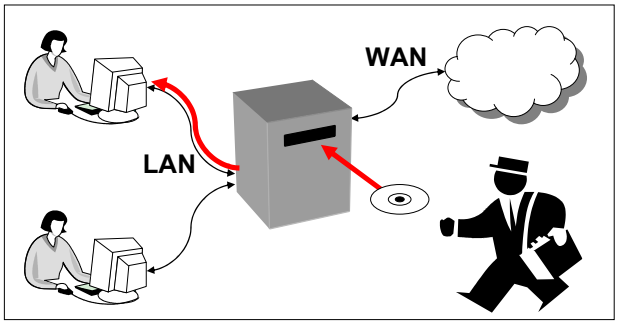
- At the end of the day, it spits out a DVD

What Is A Postmanet Router?



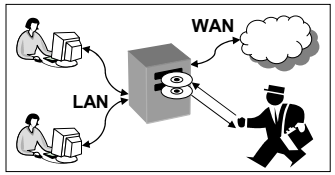
- Picked up by a postman

What Is A Postmanet Router?



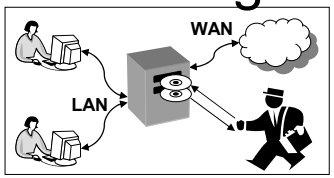
- The postman may also drop off an incoming DVD

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



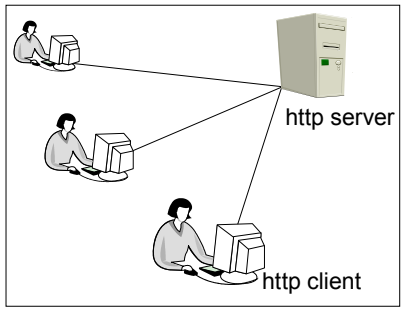
- Wide reach: a truly global "network"
- Great bandwidth potential, technology trends:
  - "Sneaker nets" becoming more powerful
  - Storage density growth > Moore's Law
  - Wide area bandwidth growth bound by digging ditches, launching satellites, erecting WiMax towers…
- Low cost
- Incremental deployment: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

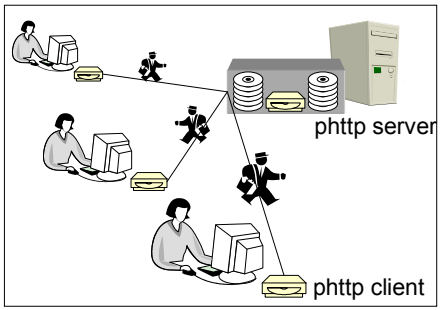
DVD Capacity

- 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

Sources: http://www.macworld.com/news/2004/09/21/sony/
Scientific American, February 2005.

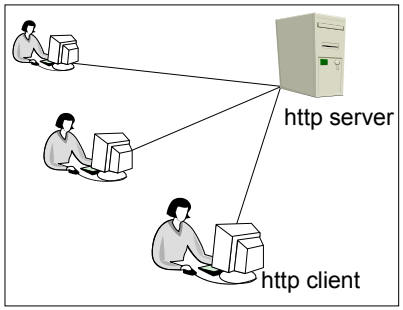
phttp: Postmanet-enabled http

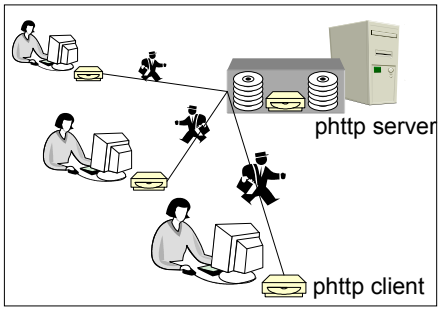




- Network packets carried by DVDs in the postal system
- Transparency:
  - Minimum manual involvement beyond postal workers' leg work
  - Crucial for scale-up
- Village-side cache that absorbs most of the requests

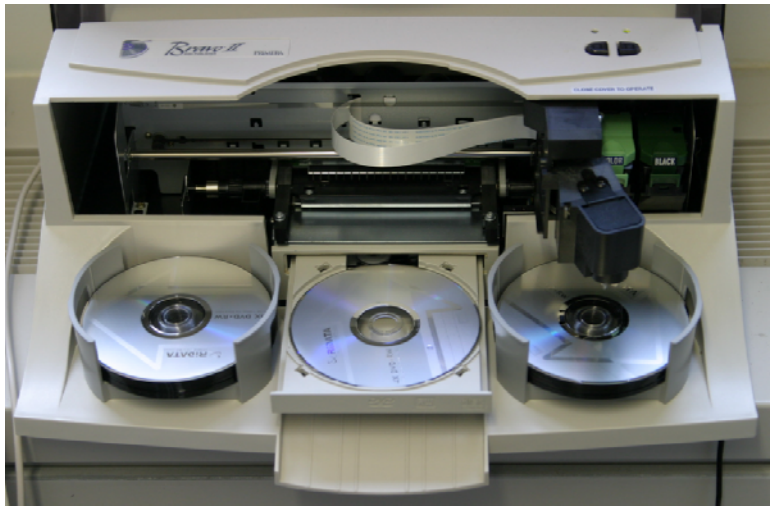
Difference from offline browser





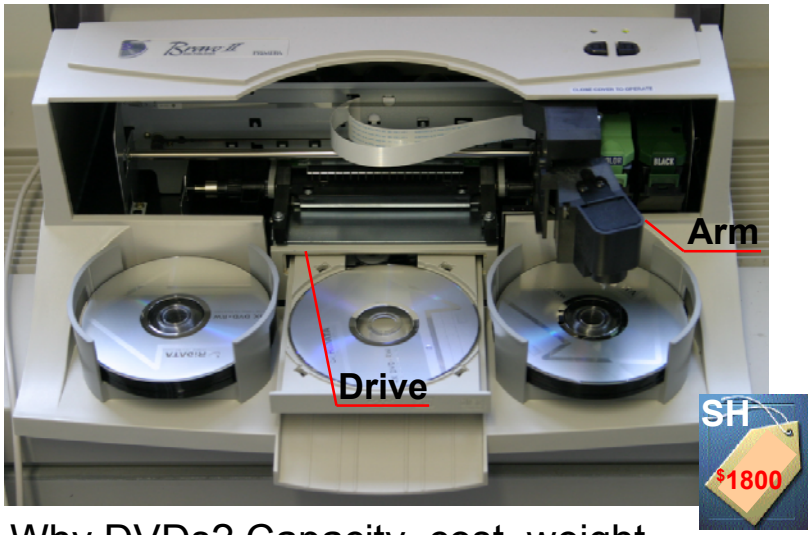
- Offline browsers
  - Eventual connection
  - no support for server scripts
- Phttp
  - May never be connected
  - Explicit migration of server script fragments

DVD Robot



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

DVD Robot



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DVD Robot

- Why DVDs? Capacity, cost, weight, …
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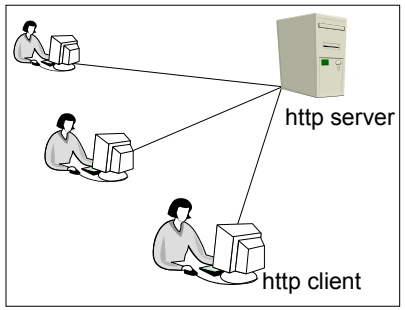
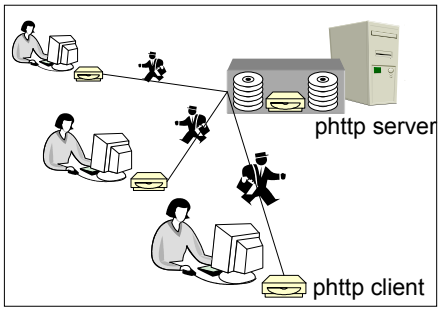
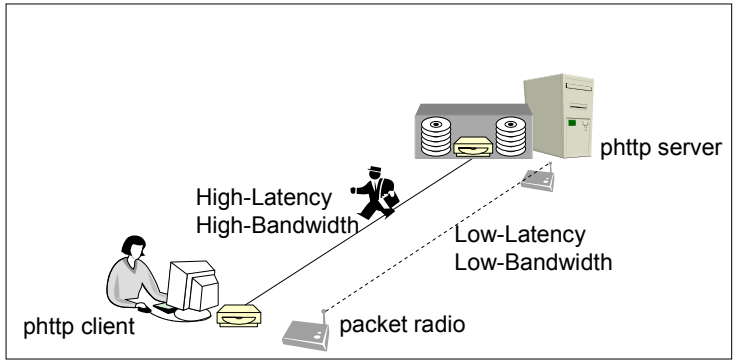
The key is transparency





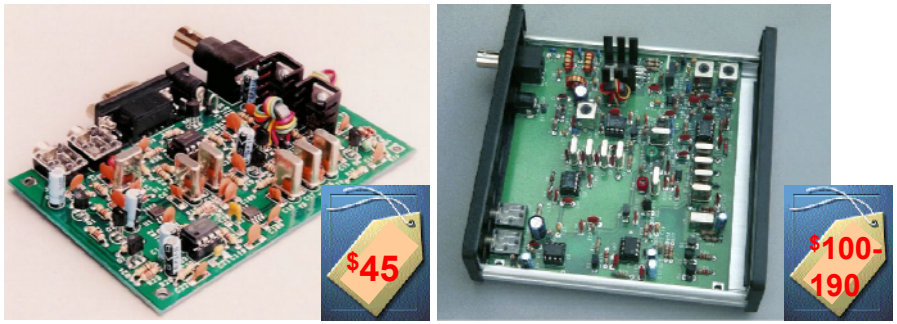
- Transparency and efficiency needed for:
  - Scale up
  - Handling “exceptions:” lost or damaged DVDs
  - Splitting server scripts for asynchronous interactions

Complement with low-latency network



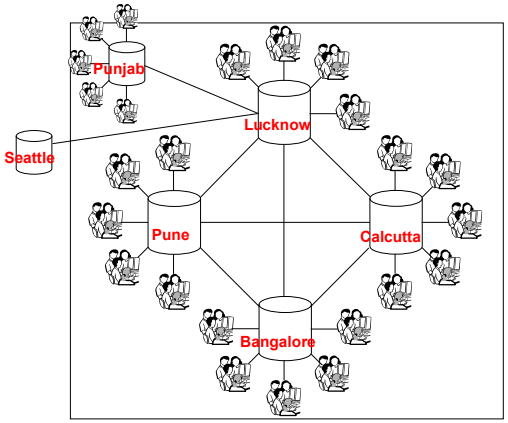
- Catalog of metadata
- Small requests, acks, NAKs, retransmission requests, etc.
- A UI for the cell phone?

Complementing low-latency low-bandwidth link



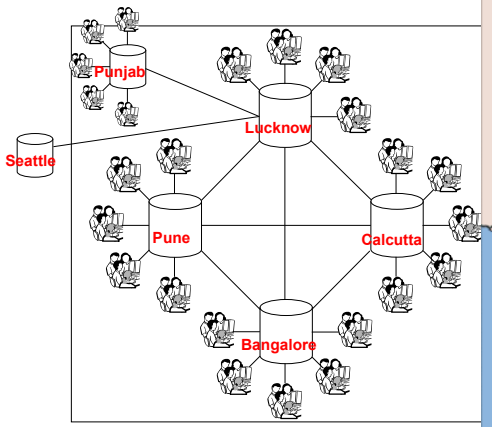
- Our current choice: packet radio (ham radio)
- Pro: range, cost; Con: low bandwidth
- (India cell phone tele-density: 2.5% as of 2003)

A network of hubs and spokes



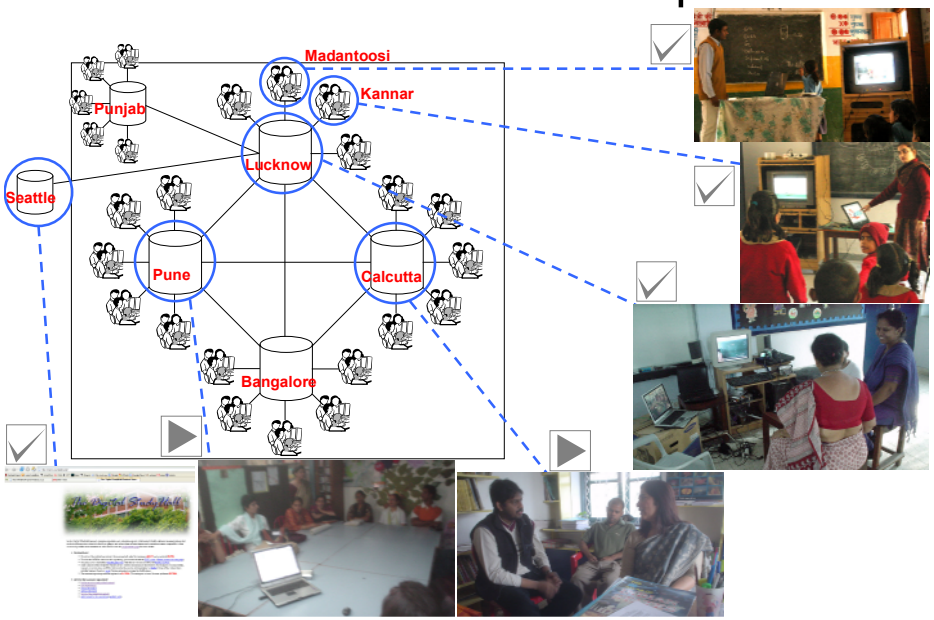
- Partnering with NGOs
- "Hub-heavy" exploratory expansion for parallel efforts
- Parallel content creation and pedagogy experiments

A network of hubs and spokes

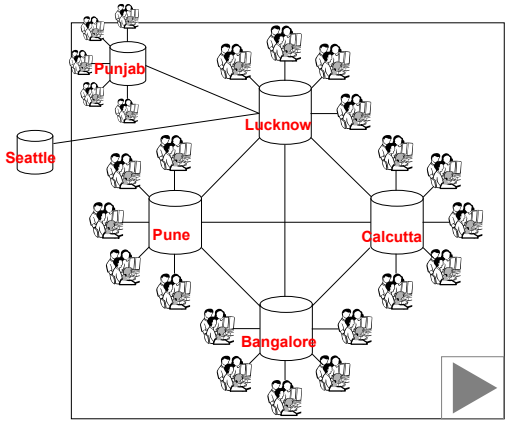


- Partnering with NGOs: a key strategy

A network of hubs and spokes



An "Education Napster"



- A distributed system built on two networks
- Asynchronously connecting the hubs
- With a layer on top of Postmanet and gmail

- Issues: end-to-end addressing, routing, keeping track of who has what, ...

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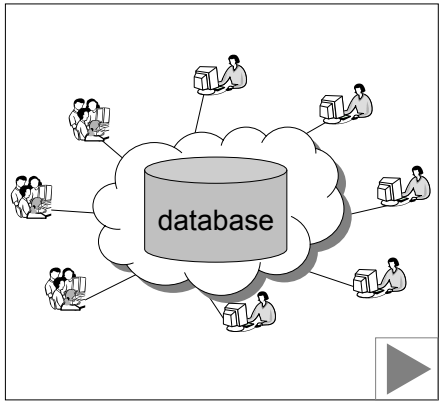

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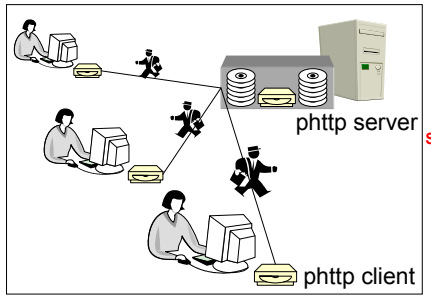
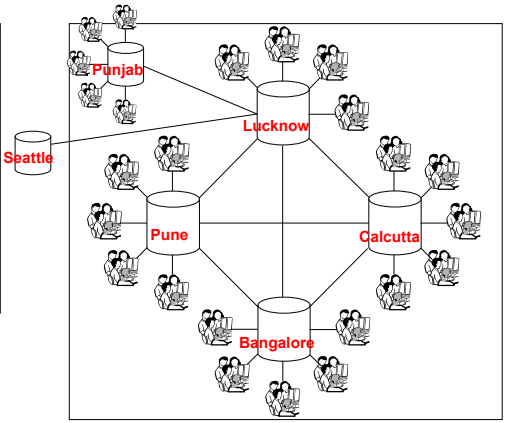
Recurring Themes





- Cheap, easy to build, effective
- Support for point-to-point communication (for peer-to-peer learning)
- High bandwidth
- Build whole systems

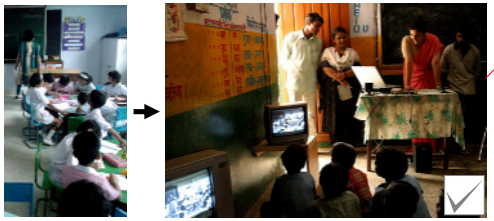
Outline

- The “TVI prelude”
- India education background
- Introduction to the Digital StudyHall
- Connectivity: Postmanet and beyond
- Content production
- EdTV
- Experience and pedagogy
- Conclusions

Subjects

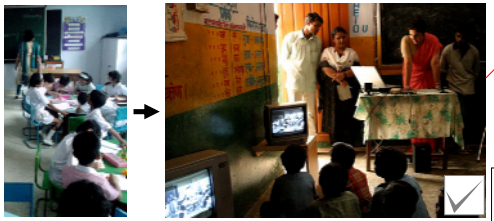
- English: a critical skill in India
- Math
- Science

Main content sources and their mixture



1. Recording of live lectures

Main content sources and their mixture



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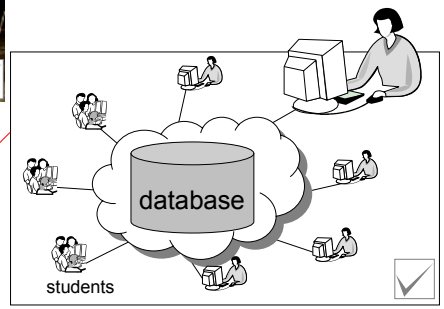
2. Off-line authoring



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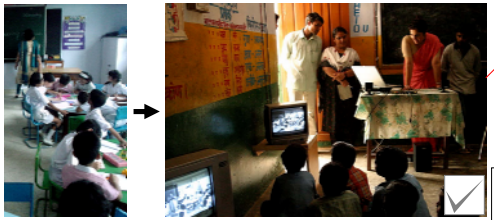

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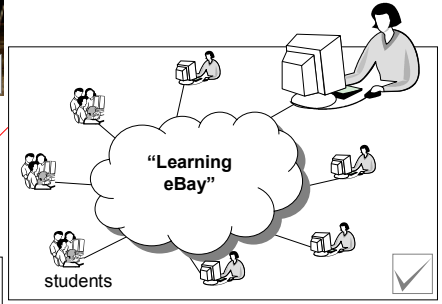
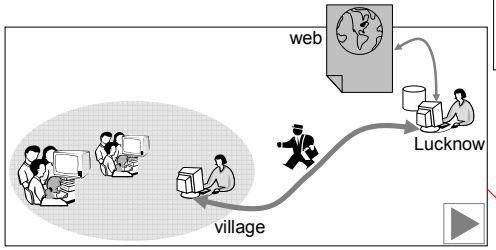




3. Redistribute existing content

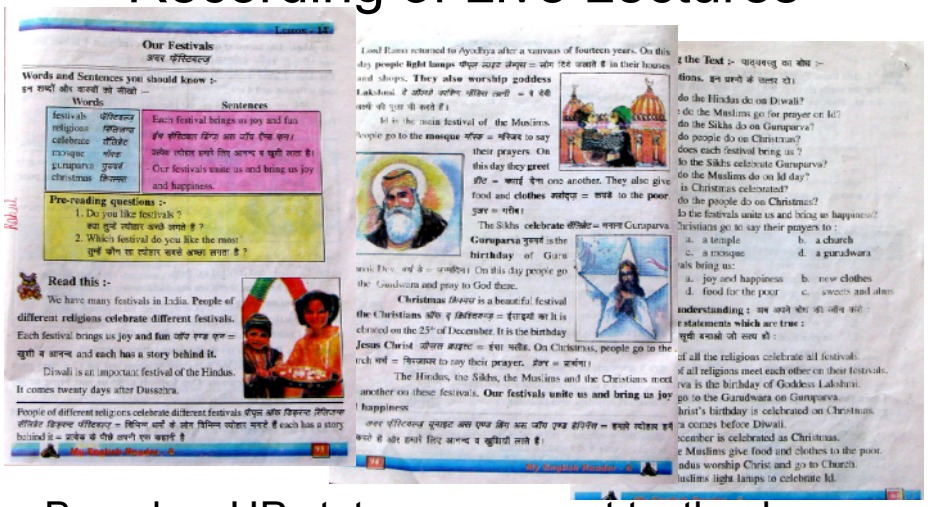
Issues discussed later

- Replaying captured lectures, by itself, will not suffice, but
- An important part of a bigger solution
- Target audience
- Pedagogy in general...

Recording of Live Lectures

- Based on UP state government textbooks
- Carefully planned coherent sequences

Recording of Live Lectures



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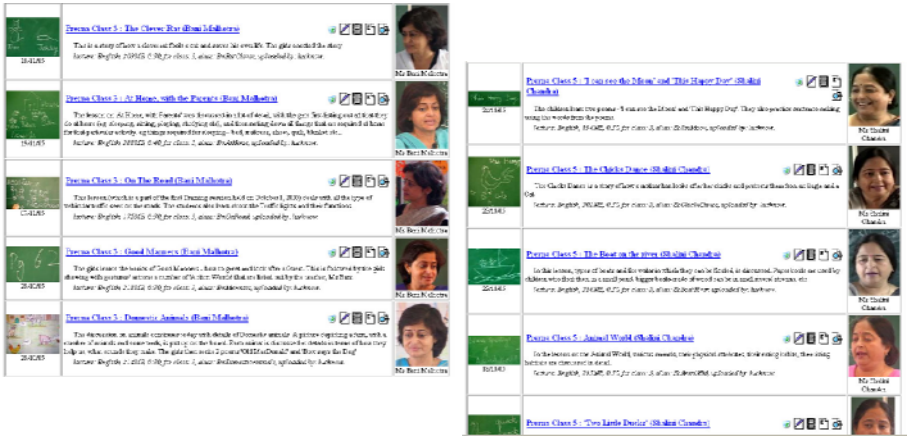

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Recording of Live Lectures

- Highly interactive, with lots of:
  - Questions and answers
  - Role plays
  - Activities

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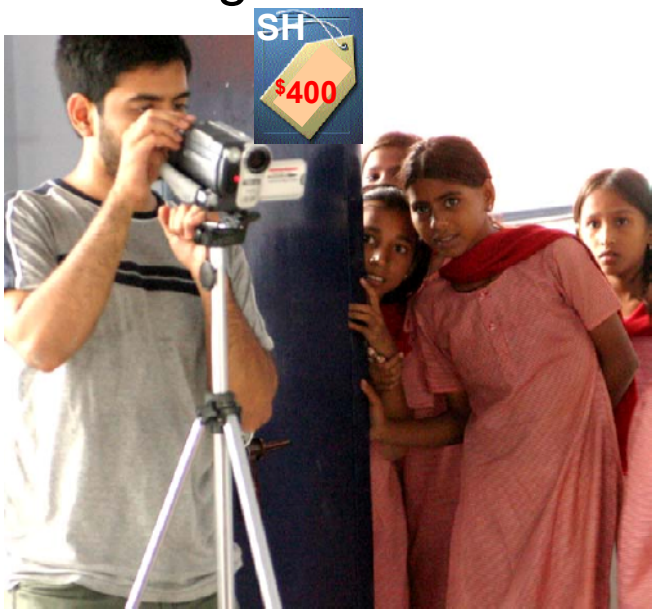

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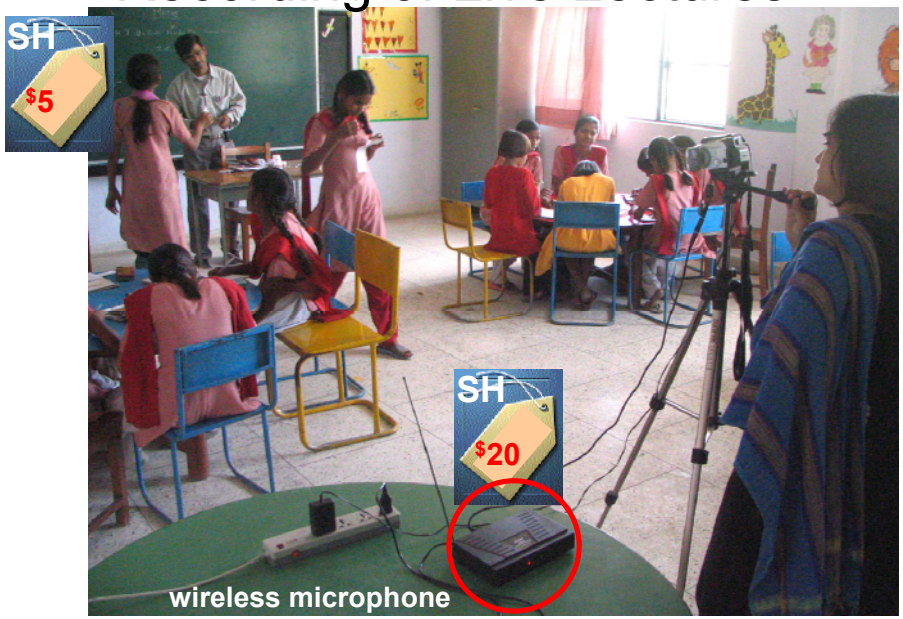

Recording of Live Lectures

- 720x480 (DVD quality), XviD codec
- 30fps generates 1GB/hour
- 10fps generates 0.4GB/hour

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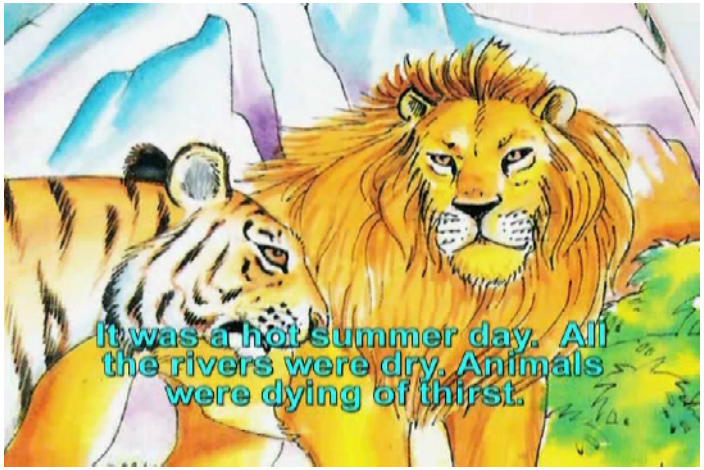
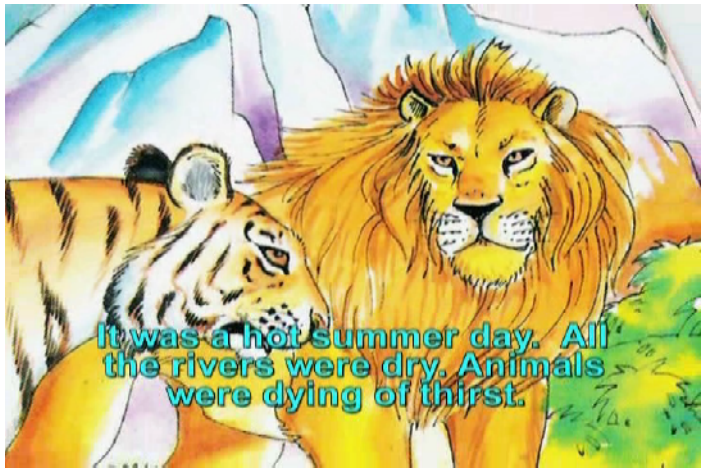
Digital Stories



- For training listening, speaking, reading, writing skills

Digital Stories



- Gather existing images, write scripts, record voice, put them together (with “Ken Burns” effect)
- Easy and cheap to make

Digital Stories (teachers)

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Digital Stories (ourselves)

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Digital Stories (partners at other hubs)

- Gather existing images, write scripts, record voice, put them together (with “Ken Burns” effect)
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Enlisting middle-class students

- Gather existing images, write scripts, record voice, put them together (with “Ken Burns” effect)
- Easy and cheap to make

Student Projects

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Student Projects

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Student Projects

Benefits for students

- Reading/writing/communi -cation skills
- Practical computer skills
- Team work
- Work for a cause
- Have lots of fun

Drama Rehearsals and Performances

- Short plays
- Scripts developed by teachers
- A good tool for teaching English dialogue
- Rehearsals and performances captured

Drama Rehearsals and Performances

Drama Rehearsals and Performances

Drama Rehearsals and Performances

All stored in the database

Recurring Themes

- Cheap, easy to make, effective
- Highly relevant and coherent sequences of local content
- Peer-to-peer learning
- High bandwidth
- Build whole systems

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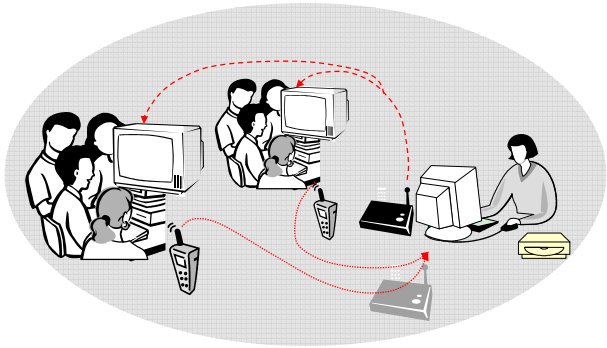
The display problem

- 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 components (“output”)

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

EdTV

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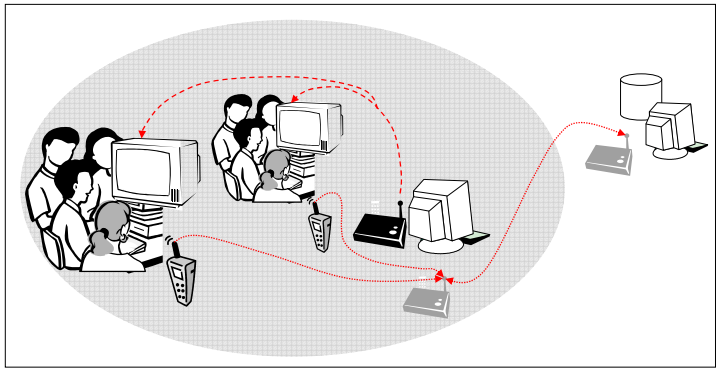
EdTV leaving the classroom

- Kids work during the day
- (50% attendance during mango-picking season)
- “Capturing” kids after (or outside) class

EdTV: more profound potential

- 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

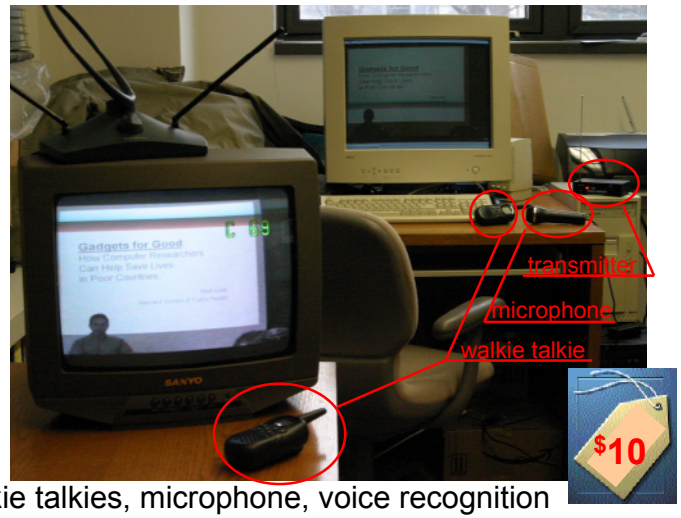


- A radio “remote:” a simple keypad transmitter that emits several command signals.
- TV and radio control signals: ways of bridging the last mile

EdTV “input” devices

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

EdTV “input” devices



- Walkie talkies, microphone, voice recognition
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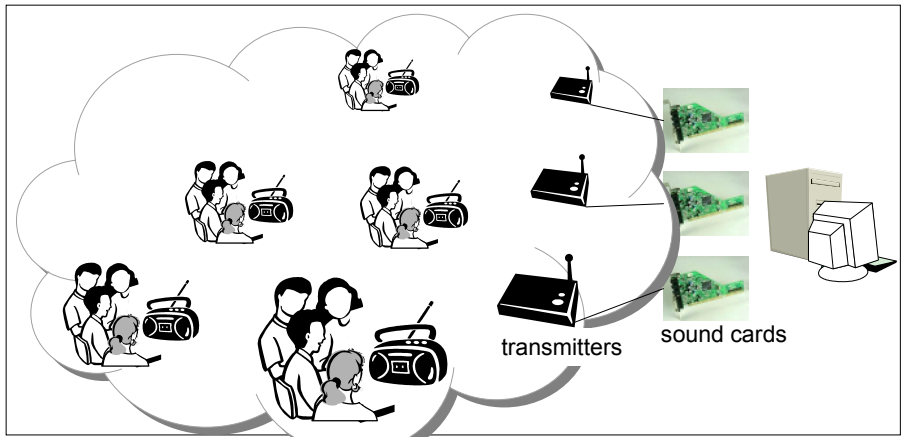
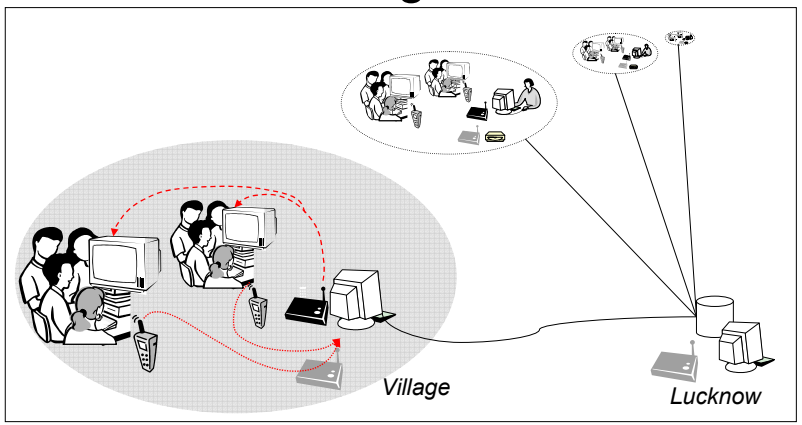
EdRadio



- 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 themes



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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)

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- Training for village and headquarters operators
- Capture the training sessions and use the system to propagate training videos
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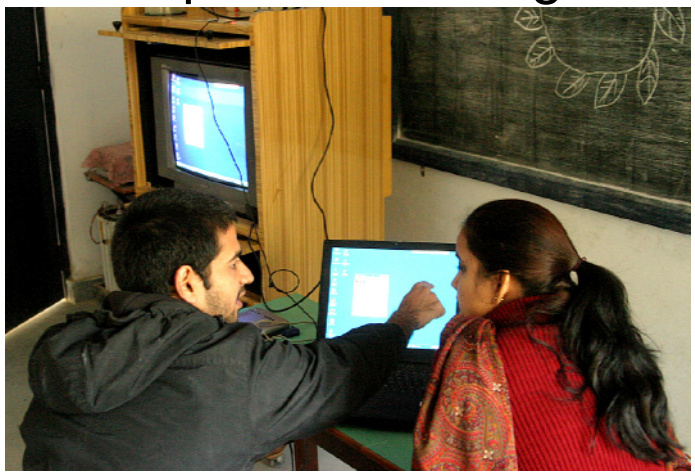

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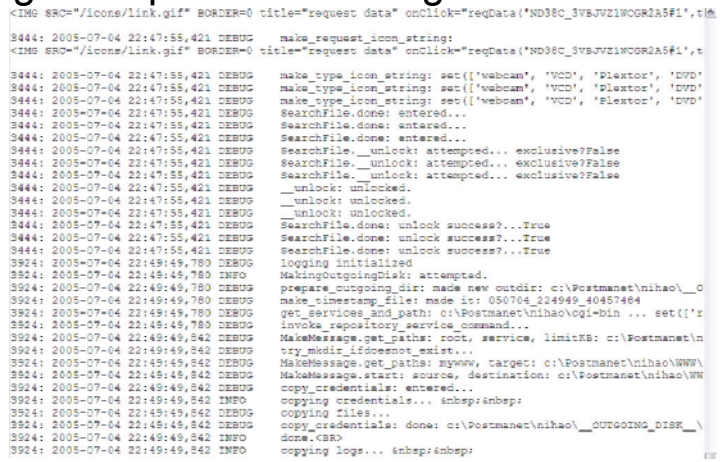
Village computer monitoring and administration

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

Village computer monitoring and administration



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Two different questions

- Given a reasonably competent teacher, can any technology better a blackboard?
- Where there's no reasonable 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 (public)

- 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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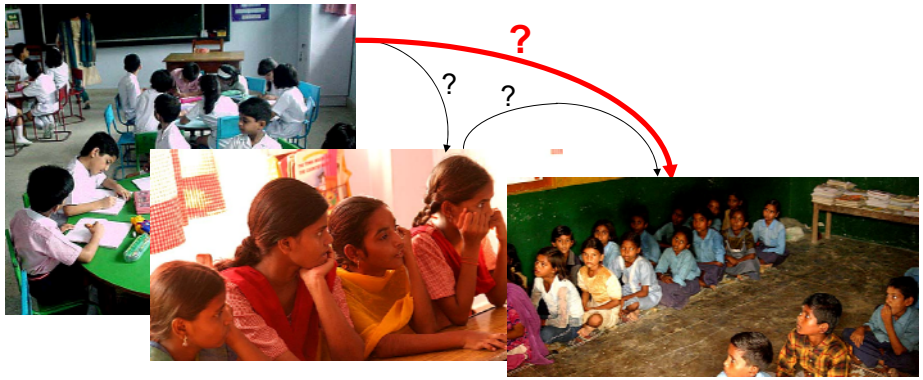

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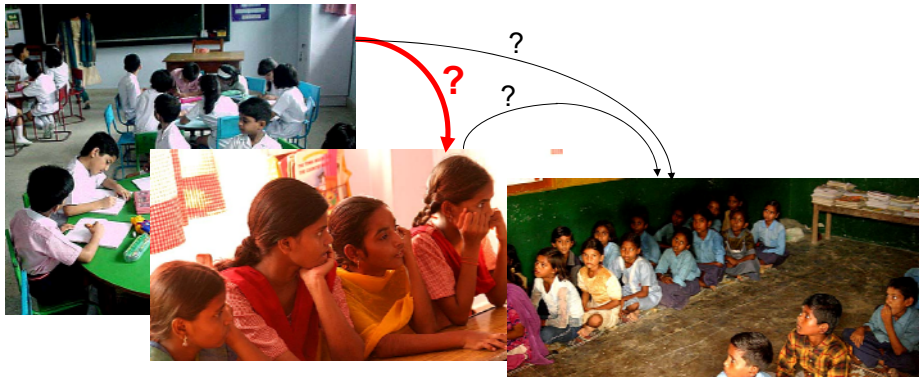

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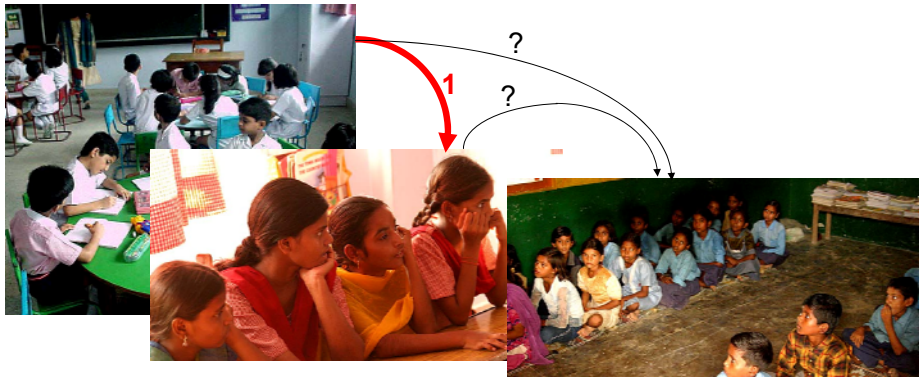
Try 1: Morning -> Afternoon



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Try 1: Morning –> Afternoon

1

Mediation

- Recorded material provides a framework
- Teacher “facilitates:” instigate interaction
- Training for less experienced teachers
- Mediation:
  - Questions by teacher
  - Dialogue between teacher and students
  - Student exercises
  - Student-to-student interaction
  - Role plays
  - Songs, poems, stories, drawings, other activities
  - Tests

Mediation

1/6

Mediation

2/6

Mediation

3/6

Mediation

4/6

Mediation

5/6

Mediation

6/6

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

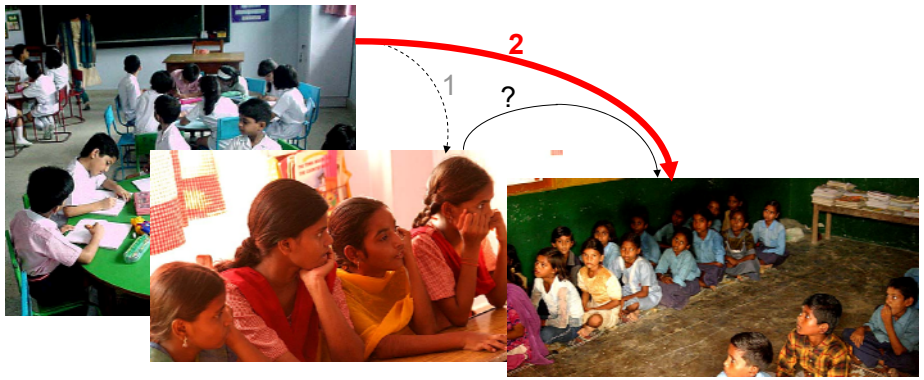
Learn to mediate

4/5

Learn to mediate

5/5

Try 2: Replicate experience in villages



- Model lesson in front of village teacher
- Followed by village teacher's running the class

Replicate in villages

1/7

Replicate in villages

2/7

Replicate in villages

3/7

Replicate in villages

4/7

Replicate in villages

5/7

Replicate in villages

6/7

Replicate in villages

7/7

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

Afternoon kids

Morning school teacher

Afternoon kids

Morning school teacher

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Distribute to villages

1/7

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2/7

Distribute to villages

3/7

Distribute to villages

4/7

Distribute to villages

5/7

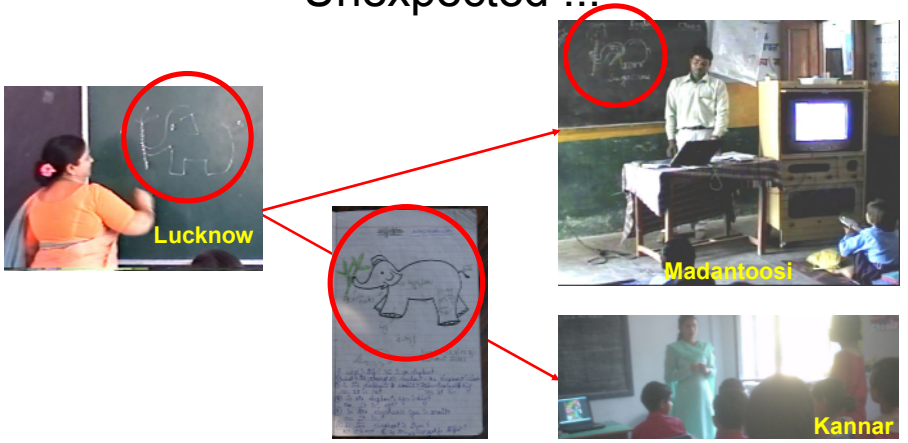
Distribute to villages

6/7

Distribute to villages

7/7

Unexpected ...



- Motivated teacher took own initiative
- Uses the system to train/teach self
- Abandons crutch during live lessons
- “Graduating” teachers: the ultimate success

Materials in the database

Peer learning (digital stories)

Morning school kids

Madantoosi village

Afternoon school (Prerna)

Kannar village

Peer learning (drama)

Afternoon school

Madantoosi village

Peer learning (drama)

Afternoon school

Madantoosi village

Daily village school lessons

- Village 1 (Kannar, private)
  - 5 hours of daily use
  - English lessons for grades 3, 4, 5, 6, 8
  - Math lessons for grade 5
  - Science lessons for grades 5, 6, 7, 8
  - Want a lot more

- Village 2 (Madantoosi, public)
  - Works well under pressure
  - Slacks off without pressure
  - Elections/festivals
  - Zero accountability in public schools

Unscientific results (Kannar)

- After being in “the system” for 7 months
- Can carry out an English conversation with a visitor without aid
- Teachers can “carbon copy” both content and methodology from headquarters faithfully

Unscientific results (Prerna)

- Can understand spoken English mostly without aid
- Struggling to form their own sentences
- A reason: 2.5-3 hours of school per day
- Much improved teaching too

Unscientific results (Madantoosi)

- Students: unsatisfactory progress
  - Lack of accountability in public schools
- What is impressive (promising) to a visitor:
  - Effective lesson given by teacher who has no English

Peer-teaching

- Importance of influencing public schools
- Public schools: kids eager, most teachers lazy
- Enlist good students to be class “leaders”
- Potential promise of solving teacher absenteeism
- Potential of scaling skilled and motivated mediator

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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

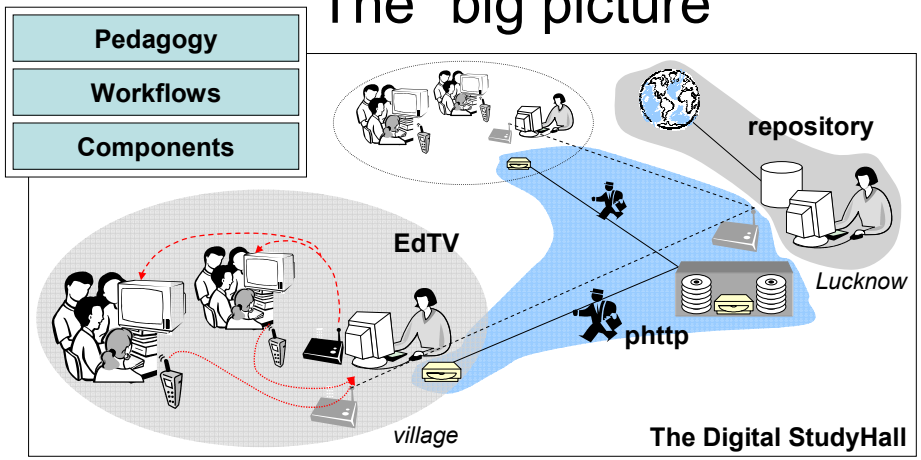
A model for rural areas: “Prerna 3”

- 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

Outline

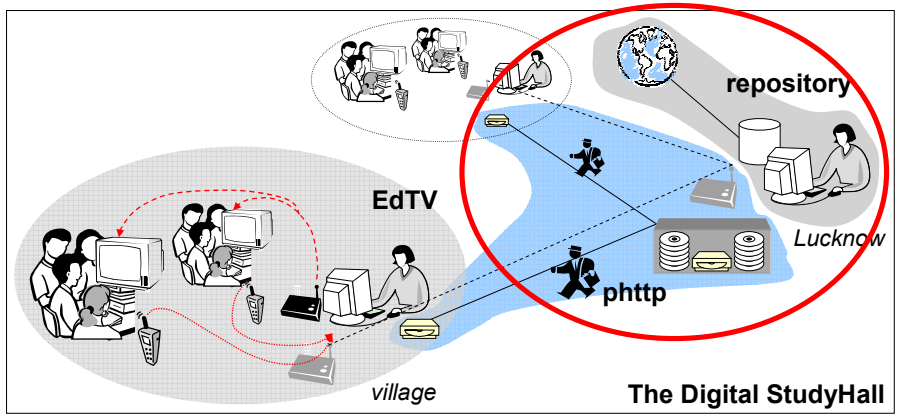
- The “TVI prelude”
- India education background
- Introduction to the Digital StudyHall
- Connectivity: Postmanet and beyond
- Content production
- EdTV
- Experience and pedagogy
- Conclusions

The “big picture”



- Components: repository, phttp, EdTV
- “Workflows:” content capture, remote monitoring, ...
- Pedagogy research

Synergy: phttp + repository



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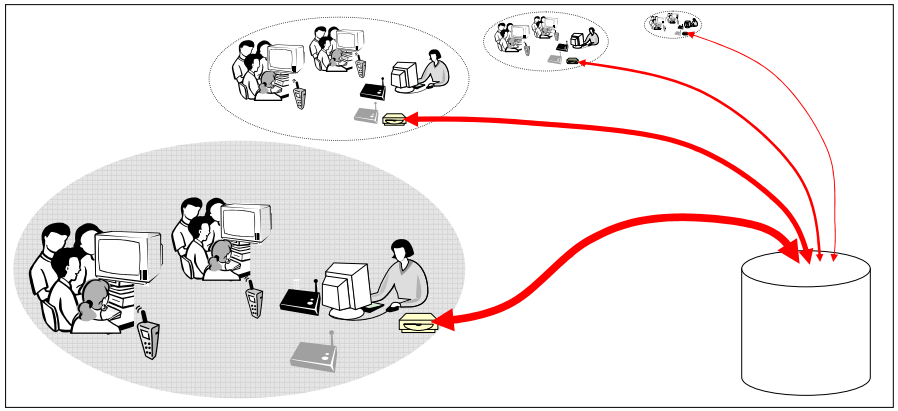
- Generic abstraction that can support all manners of shared applications (without a conventional network)

Synergy: phttp + repository



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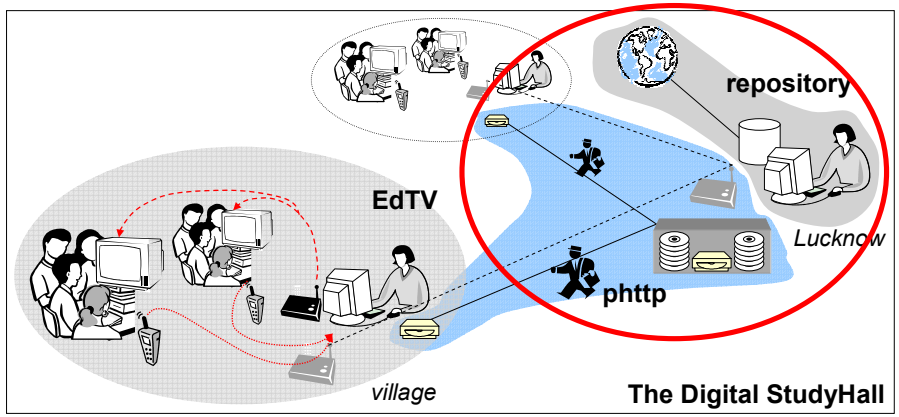
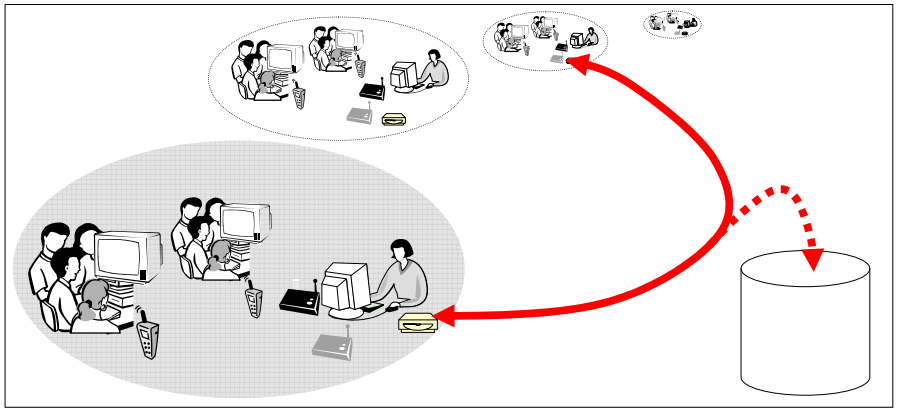


- A simple distributed file system analogy
- A network analogy: a “network with memory”
- Why not direct peer-to-peer transfer between villages?

Synergy: phttp + repository



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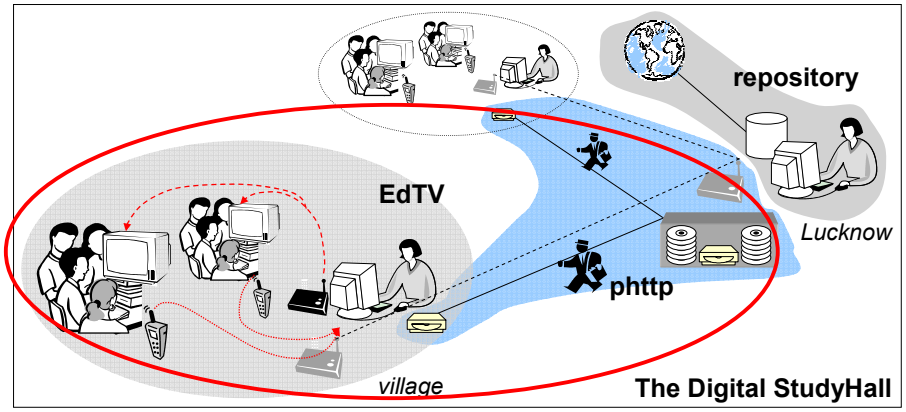
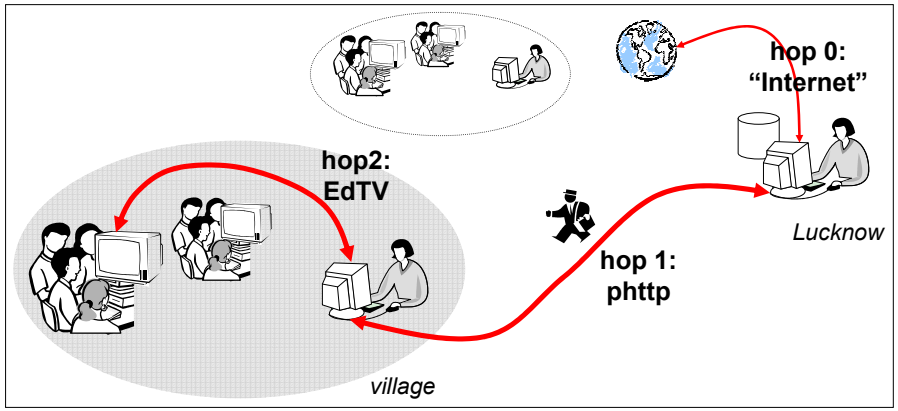


- A natural two-hop “network”
- The phttp “hop:” pervasive, high-bandwidth, cheap, asynchronous
- The EdTV “hop:” cheap end devices, bridging last mile

Synergy: phttp + EdTV



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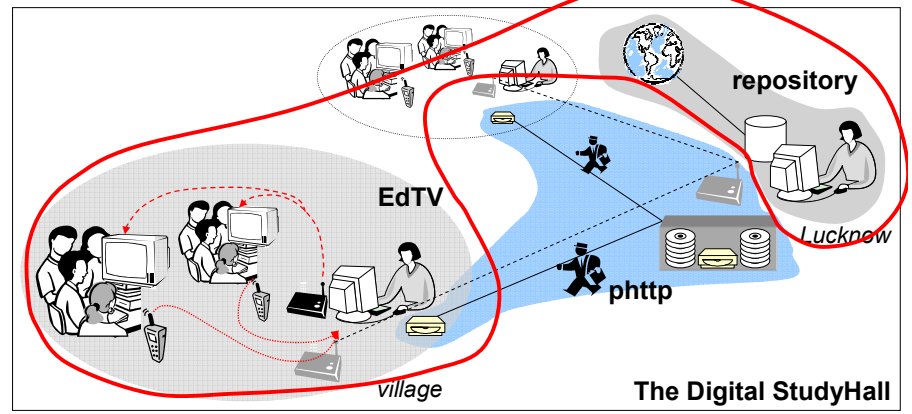
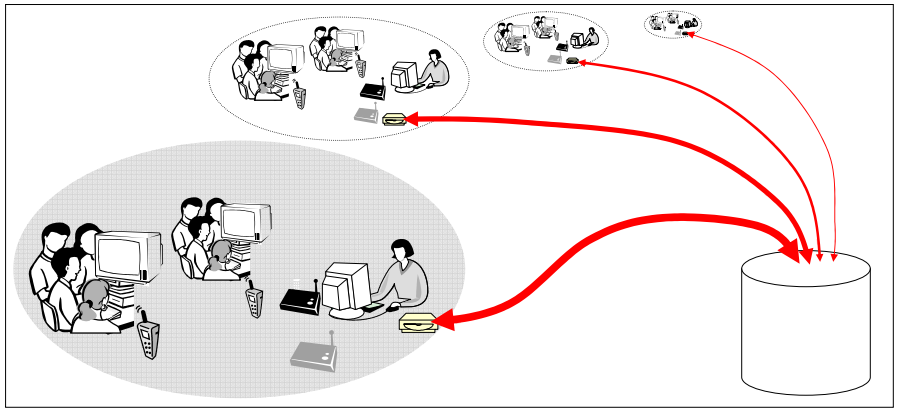


- The repository abstraction makes it easy to build shared EdTV applications, like voice mail

Synergy: repository + EdTV



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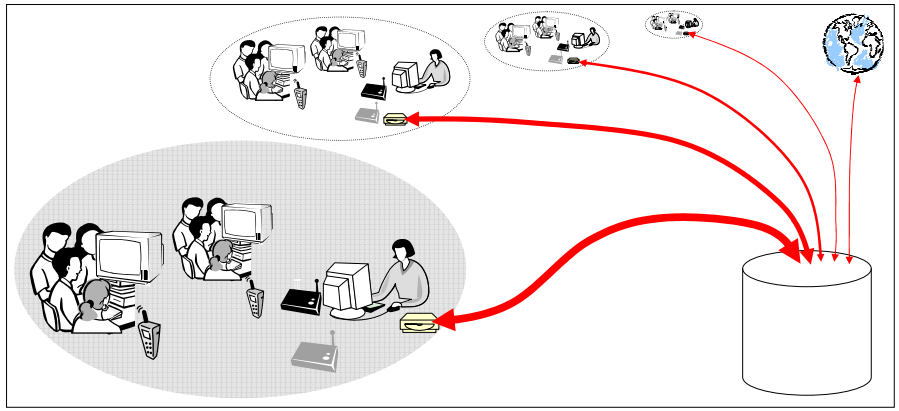
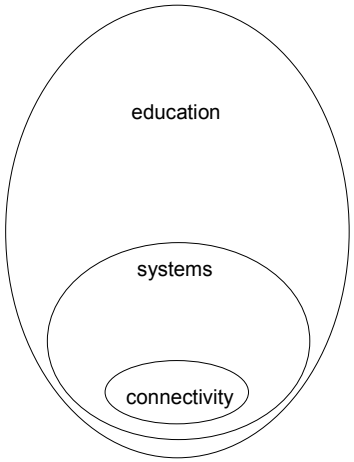
Recurring themes



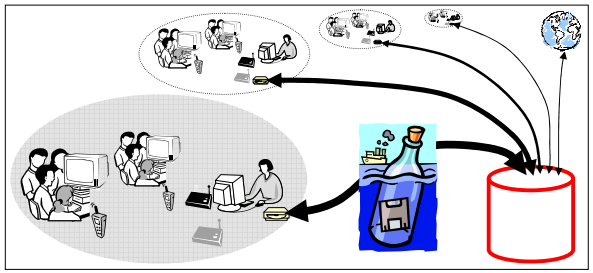
- Any-to-any communication, customization, sharing, high bandwidth, cheap, solve education problems
- Enable collaborative learning among kids

What is the Digital StudyHall?

- Not about any one particular piece
- It's about building an "eco-system" of symbiotic pieces
  - Systems
    - Content production
    - Networking
    - Display
    - Distributed database
  - Education
    - The network of hub-and-spoke model
    - Content production
    - Mediation-based pedagogy
      - Unskilled but motivated teachers
      - Digital feed
      - Training in mediation and communication

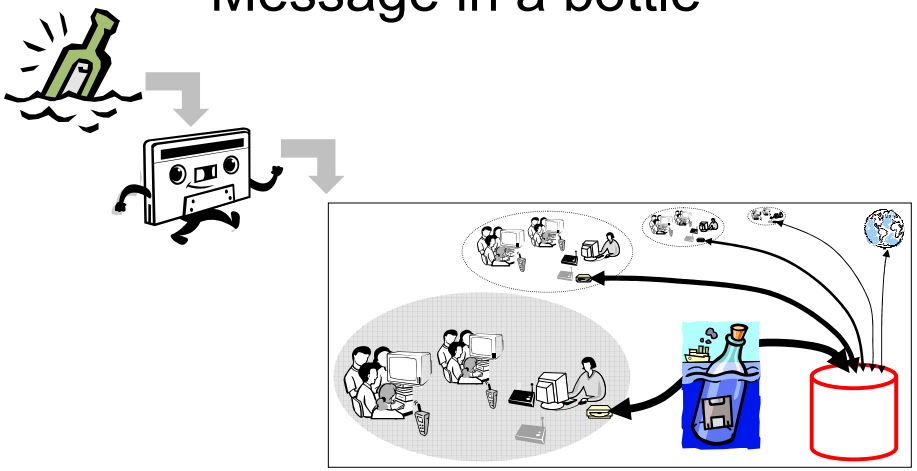


An example of symbiotic relationships



- Postmanet: less interesting by itself
- Postmanet: much greater impact when connected to a distributed database

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 the world

Implications

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

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High-level things I learned

- Have clear and “correct” goals
- Be a generalist, not a “computer scientist”
- Work with and respect locals
- Importance of long-term commitment
- The most fun and rewarding work ever!!

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Thank you!

- Google for: digital studyhall
- http://dsh.cs.washington.edu
- http://pnet.cs.washington.edu
- rywang@cs.washington.edu

Thank you!

- Donate to: the Digital StudyHall
- http://dsh.cs.washington.edu
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