MILLEE: Mobile and Immersive Learning for Literacy in Emerging Economies

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April 12, 2010
The World Bank

Educational Technology in the Developing World

The Hole in the Wall
One Laptop Per Child
Mobile Learning: Hope or Hype?

“There are only few widespread examples of the use of [mobile] phones for education purposes inside or outside of classrooms in developing countries that have been well documented, and fewer still that have been evaluated with any sort of rigor” (World Bank, 2009)

Mobile Learning: Out-of-School

- Cellphones can make education more accessible through out-of-school environments
  - User can learn anytime, anywhere without disrupting work

- 101 million children worldwide do not attend school
  - 36 million in South-Asia
  - 39 million in Sub-Saharan Africa
Solution Overview

- Fluency in “power language” e.g. English
- Public schools in developing regions (e.g. India) are not succeeding
- Leverage mobility of cellphones to make literacy more accessible
- Game-like exercises for enjoyable learning experience

Case for E-Learning Games

- Can incorporate good learning principles (Gee 2003)
- Demonstrated learning benefits with urban slums children (Banerjee et al. 2005)
  - 2 years, >10,000 children
  - Math learning computer games twice per week
  - Significant gains on math test scores
- ... and rural children (Kam et al. 2009, Azim Premji Foundation 2004)
  - Significant improvements on spelling skills
Selected Media Appearances


• Angrezi, the Phoney Way. In Times of India, December 5, 2009.


International Collaborators

Sesame Workshop
Chinese Academy of Sciences

University of Nairobi

ASSET India Foundation
Byrraju Foundation
Dhirubhai Ambani Institute of ICT
IIIT Hyderabad
Suraksha

Current and previous funders:
• MacArthur Foundation
• Microsoft
• National Science Foundation
• Nokia
• Qualcomm
• Verizon
Multidisciplinary Collaborators at CMU

- Local project management – Shabnam Aggarwal
- School of Design – Jodi Forlizzi, Stephanie Meier
  - Visual design
- Entertainment Technology Center – Hanika Khakhanis
  - Videogame design
- Language Technologies Institute – Maxine Eskenazi
  - Speech recognition on cellphones (conversational skills)
- Dept. of Modern Languages – Pooja Reddy, Sue-mei Wu
  - Second Language Acquisition and Reading Science

Project Timeline

- 10 rounds of fieldwork, >12 months total in India
- Human-centered design process with 100 children
Classroom Study [in IEEE/ACM ICTD 2009]

- Deployment throughout Spring 2008
  - Three times per week
  - After-school program at private village school
- Quantitative study with 27 participants (grades 2-9)
- Demonstrated significant post-test improvements on spelling skills ($p = 0.007, \sigma = 3.3$)
- Learning gains correlated with grade levels ($r = 0.61$)


- First study on rural children’s voluntary use of cellphones in their daily lives over extended time
  - Opportunities for mobile learning in everyday rural settings?
  - Social contexts behind such naturalistic settings, including adoption challenges?
Study Context

• Mango growing district in rural India

• Economic baseline
  – $500 to $2,500 annual household income
  – Upper-caste households own land on which lower-castes work as laborers
  – All 20 households we visited owned at least one cellphone

Scenarios: Learning in the Fields

• An upper-caste boy learns from a cellphone-based game when “working” in the fields
Scenarios: Learning at Home

- Male and female siblings learn from cellphones games at home between dinner and bed-time

With cellphone

Participants

- 26-week pilot with 18 children
  - 9 boys, 9 girls
  - 10 to 14 years old (mean=12 years)

- Loaned out cellphones
  - 14 out of 18 participating households had at least 1 cellphone
  - 7 out of 18 households had programmable cellphones
Curriculum Design

- English is widely viewed as a “world language”
  - English fluency opens doors to economic advancement
- Curriculum developed by local teacher
  - Targeted 180 word families for 16 weeks

Task-Based Language Teaching

Instructional sequence around tasks (Cameron 2001, Nunan 2004, Prabhu 1987)

1. **Schema-building** exercises that introduce vocabulary, linguistic forms and context for the task
2. Communicative exercises to provide **controlled practice**
3. **Listening** to how above linguistic units are used in **authentic settings**
4. **Language development** exercises for above units
5. Freer practice in groups, e.g. information gap activities
6. Pedagogic task proper
Best Practices in 2nd Language Teaching [in ACM CHI 2007]

- Avoid reinventing the wheel
- Reviewed sample of >35 applications
- Sample has a balance b/w listening, reading, speaking and writing skills
- Distilled >50 design patterns (Alexander 1977)

Traditional Village Games
[in ACM CHI 2009 – Best Paper Honorable Mention]

- How are traditional Indian village games different from existing Western videogames?
- Compared game elements against 296 game design patterns documented in Bjork and Holopainen 2005
Analysis: Differences in Games

- Identified 37 non-trivial differences
  - Difficulty based on sub-goals
  - Resource management
  - Skill acquisition
  - Score keeping
  - Rituals associated with space
  - Inter-team interactions

Prototypes: Videogame Design

- Designed videogames based on traditional village games (Kam et al. 2009)
Electricity Access

- Power outlets in homes of 16 out of 18 children
  - But irregular electricity

- Despite irregular electricity, did not leave phones plugged into wall outlets due to security concerns
  - Recharged cellphones only when electricity was present and participant was home
  - Recharged cellphones from workplaces that had generators (3 households)

More Social Rituals Around Electricity

- Highly fluctuating voltages (4 households)
  - Damage to battery chargers

- Hesitant to take advantage of neighbors’ generosity
  - Recharged cellphones by relying on neighbors with generators
  - Recharged cellphones from neighbors who had stable power outlets

- Excessive use of multimedia-rich applications drained batteries quicker
Everyday Use of Multimedia

- Listened to music clips
  - Bought at point-of-sales outlets in town
  - Shared with friends via Bluetooth
- Took videos and photographs of important events

Duration of Mobile Learning

- Despite electricity challenges, participants were able to keep cellphones charged for mobile learning
  - Average usage of 2 hours, 23 min per week
Locations of Cellphone Use

- Unexpectedly, most learning via cellphones occurred at home (vs. outdoors)
  - Home is cooler than outdoors due to summer heat
  - Participants self-reported taking cellphones outdoor prior to summer
  - Concern about loss of phone

* % of total time spent at a particular location

Community of Gamers

- Strengthened existing ties (13 pair-wise relationships)
- Games facilitated new ties across gender, caste and village boundaries (10 pair-wise relationships)
- New social relationships transferred to real-world, non-gaming settings
Learning Benefits

- Average participant covered 46 new words over 16 weeks of unsupervised usage of cellphones
  - At this rate, each participant is expected to learn 150 new words in a calendar year

Other Challenges

- 6 swollen batteries

- Why did this happen?
Other Challenges – Gender Equity

• 6 swollen batteries

• Why did this happen?
  - Extreme heat from kitchen stoves
  - The 6 participants (5 of them were girls) tried to hide phones from brothers

Scaling Up in India and Beyond

• Controlled experiment with 800 rural children in 40 villages (with Nokia grant and 450 cellphones donation)
  - Official 5th-grade English curriculum in India
  - Benchmark against standardized English test in India

• Partnership development with
  - Cellphone manufacturers
  - Wireless carriers
  - Third-party content developers
  - Education service providers
Curriculum Roadmap

- Local curriculum developer (20+ years experience)
  - 10 daily lesson plans x 10 textbook units = 100 daily lesson plans for one academic year
- Vocabulary – predictor of success on comprehension
  - Word families + word parts (content vs. function words)
  - Complexity + accuracy + fluency
  - Generative use of language
- Grammar - phrasal structures
- Phonological awareness

Adoption Ecology

- “One size fits all” approach does not scale

Diagram: Ministry of Human Resource Development (Ministry) → Department of Education →

National:
  SCERT (National Council of Educational Research and Training)
  NCERT (National Council of Educational Research and Training)
  NCBE (National Board of Educational Research and Training)
  NCIE (National Council for Vocational Education and Research)

State:
  SIMEAT (State Institute of Management and Education)

District:
  DEET (District Institute of Educational Training)

Block:
  SRC (School Resource Centre)

Cluster:
  CRC (Cluster Resource Centre)

Village:
  VEC (Village Education Committee)

School:
  PTA (Parent Teacher Association)
  MTA (Middle Teacher Association)
**PACE Framework** [in ACM CHI 2007]

- Four components of PACE framework
  - **Pattern** – best practices for learning and engagement
  - **Activity** – design of learner interaction
  - **Curriculum** – targeted syllabus + audio-visual content
  - **Exercise** – basic unit realizing Activity + Curriculum

- Facilitates division of labor and local adaptation

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**Building Local Capacity**

[in ACM interactions 2008]

- Worked with 15+ undergrad researchers from India
  - Alumni are pursuing graduate school in North America

- Winter school with 130 undergrads across India, hosted by IIIT Hyderabad (December 2009)

- Develop local pool of talented manpower
  - Human-computer interaction
  - Low-end cellphones programming
Acknowledgements

- Carnegie Mellon University (USA) - Rafae Aziz, Ryan Baker, Rachita Chandra, Manoj Dayaram, Maxine Eskenazi, Ayan Kishore, Alex Kowalski, Anuj Kumar, Derek Lomas, Gino Mancuso, Andrew Ngan, Pooja Reddy, Daniel Rhim, Geeta Shroff, Kyle Sondrock, Raja Sooriamurthi, Le Wei, Sue-mei Wu
- Chinese Academy of Sciences (China) - Lv Fei, Tian Feng
- Dhirubhai Ambani-Institute of Information and Communication Technology and Indian Institute of Technology (India) - Aishwarya Agarwal, Anshul Chaurasia, Denny George, Chetan Gupta, Amol Jain, Ashwin Jain, Rachit Jain, Siddhartha Lal, Manish Lohani, Mohit Maheshwari, Nikhil Marathe, Akhil Mathur, Kishan Patel, Dhruv Shah, Surendra Survi, Satyajit Swain, Vivek Tripathi, Pallav Vyas
- University of Nairobi (Kenya) - Tonny Omwansa
- University of Pittsburgh (USA) - Leonora Kivuva
- Pilot team (India) - Mehnaaz Abidi, Shabnam Aggarwal, Aman Anand, Siddharth Bhagwani, Jatin Chaudhary, Sonal Gupta, Shirley Jain, Alok Prakash, Neelima Purwar, Rolly Seth, Gautam Singh, Kartikey Singh, Kavish Sinha

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