MILLEE:
Mobile and Immersive Learning for Literacy in Emerging Economies




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Design for Development
UC San Diego, March 12, 2008

tier
technology and infrastructure for emerging regions

BiD
BERKELEY INSTITUTE OF DESIGN

Academic Background

Ph.D., Computer Science, UC Berkeley, 2008 (expected)

Prior degrees from UC Berkeley

- B.A., Economics
- B.S., Electrical Engineering & Computer Sciences

Coursework at UC Berkeley's Graduate School of Education

- Literacy theory (2-semester sequence)
- Psychology of reading
- Second language acquisition

Diploma, Teaching English as a Foreign Language, 2008 (expected)

Previous Projects

Location-Based Services for US immigrants

- Goal: identify LBS applications for low-income, Spanish-speaking agricultural workers
- Qualitative interviews with community volunteers

Universal Passbooks (collaboration w/ Ricoh Innovations and Stanford Digital Vision Fellows program)

- Goal: identify social computing solutions for low-income US communities
- Qualitative interviews at homeless shelter and job placement center

Needs finding → Systems design & implementation → Evaluation

Previous Projects

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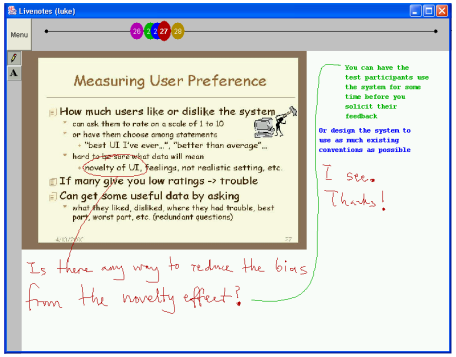
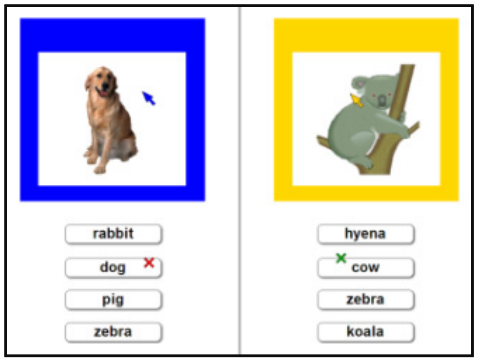
Livenotes [in ACM CHI 2005, ISLS CSCL 2002]



- Goal: recreate small-group learning experience in large lectures
- Developed multi-threaded application for synchronous discussions via wirelessly-connected Tablet PCs

Shared computer with multiple mice

(collaboration w/ Microsoft Research India)



- Goal: split-screen game for collaborative learning
- Mentored Master's project by Andrea Moed & Owen Otto

(James R. Chen award for outstanding Master's project at Berkeley's iSchool)

Needs finding → ***Systems design & implementation*** → Evaluation

Previous Projects

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Microfinance in Uganda [in ACM CHI 2007a]

(collaboration w/ Hewlett-Packard consortium)

- Goal: field evaluation of handheld solution for tracking low-collateral loans
- International research fellowship from United Nations and UC Berkeley

Needs finding → Systems design & implementation → ***Evaluation***

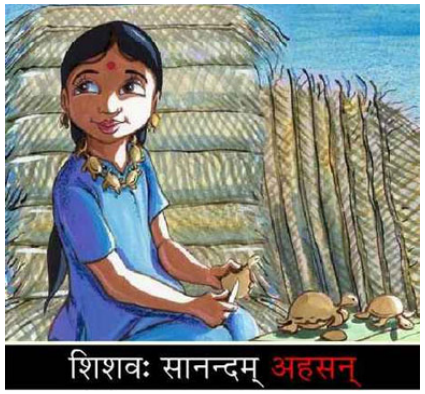
Dissertation Research

How can we harness “new media” to make literacy and language learning more accessible to low-income children in developing regions?

Some related projects:

One Laptop Per Child (Negroponte)

Shared computers with multiple mice (Microsoft-Berkeley)



Same Language Subtitling (Kothari)

Historical Precedent

Sesame Street (Fisch and Truglio 2001)

- Since 1968
- Combined education and entertainment
- Impacted children in >120 countries

Streaming Sesame videos on cellphones (Horowitz et al. 2006)

- Most benefits to households below or at poverty line

Explorations with Sesame-themed computer games, Internet-based games (Revelle et al. 2001)

- Lacked resources for summative learning assessments

English in India

English is a global language: 1.2 to 1.5 billion people in >170 countries (Crystal 1997)

ESL is taught in almost all schools in India

Mastery of English is the "single most influential factor that determines access to … important avenues of economic and social advancement" (Kishwar 2005)

90% of indigenous web content in India is in English

"World Language" Fluency

Low-income populations in Africa, Asia and Latin America desire to improve command of an appropriate "world language"
(Clegg, Ogange & Rodseth 2003; Faust & Nagar 2001; Kapadia 2005)

Widely spoken language, e.g. English, Mandarin, Spanish, etc.

Regional dialect is not necessarily native language for low-income groups

"World language" fluency opens the door to further education, "New Economy" jobs, higher incomes, social prestige, etc.

Schools Fail at "World Languages"

Schools in developing countries have limited impact

For example, in India:

- Rural ESL teachers communicated with us through interpreters
- 43% to 61% of school-going-age children do not attend school regularly (Azim Premji Foundation 2004)

Our Envisioned Solution

Mobile games that target learning anytime, anywhere

- Make ESL learning resources more accessible

Run on cellphones

- Fastest growing technology platform in developing world
- Battery powered
- Physically portable

Existing cellphone applications for literacy mostly leverage SMS

Case for E-Learning Games

Enhance motivation and learning (Jenkins 2005)

Incorporate good learning principles (Gee 2003)

Prior randomized experiment (Banerjee et al. 2005)

- 2 years, >10,000 urban slums students in India
- Math-learning computer games twice per week
- Significant gains in math test scores

Project Lifecycle (2004-08)

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Human-centered design process

- 7 rounds of field studies, totaling 7 months in India

Summer 2004: needs assessment (rural + urban)
Winter 2004: exploratory study (urban slums)
Summer 2005: exploratory study (village school)

Summer 2006: feasibility study (urban slums)
Winter 2006: feasibility study (village school)
Summer 2007: further iterative design + testing

Winter 2007: commence longitudinal pilot

Exploratory Studies (2004-05)
[in IEEE TEDC 2005, ACM IDC 2006, ACM CHI 2007a]

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Dissertation Outline

Human-centered, fieldwork-based approach

Pedagogical design patterns

- Pimsleur Generator
- E-Learning games on cellphones

Traditional village games

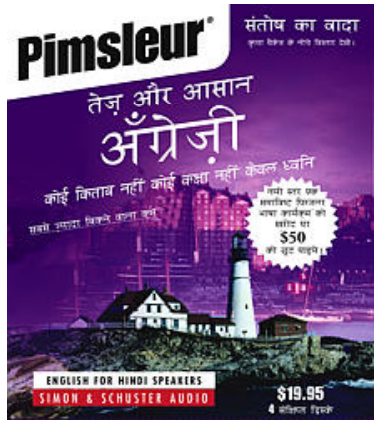
Future directions

Pimsleur Audio CDs

Among most effective commercial products for conversational skills

- Based on Paul Pimsleur's work (1967)
- Targets functional contexts, e.g. greetings, travel

Supported by subsequent research on human memory, retention and learning (Nation 2001)



How Pimsleur Works

Example from Hindi-learning unit

Learning principles

- Organic learning
- Anticipation
- Graduated interval recall

Drawbacks

Drawbacks with existing Pimsleur units

- Prohibitive price
- Not localized for developing regions needs

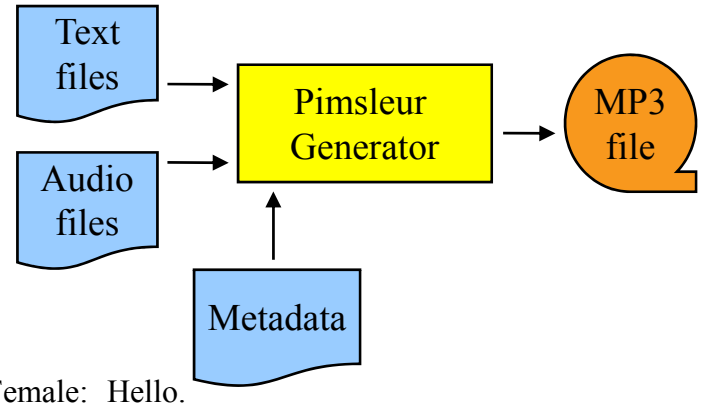
Observations

- Localization can take place at content level, reuse pedagogical principles
- Pimsleur principles are repetitive, can be expressed in computational form

Pimsleur Generator

Authoring tool for generating custom Pimsleur-like audio units

- Input: custom conversational script from local curriculum developer (XML-based declarative language)
- Output: audio track which embodies language learning principles used in commercial Pimsleur units



Female: Hello.
Male: Hello Ma'am.
Female: Are you from India.
Male: Yes I'm from India.
Male: Do you understand Hindi?
Female: No, I don't understand.
Oh you understand English.
Male: Yes I understand English.
Female: You understand very well.

In future, can be extended to interactive version, e.g. conversational agent

Data Structures

Based on transcription of 4 Pimsleur units (30-min each)

- Devised uniform logic based on second language acquisition principles

Patterns for formulaic, oral language

- E.g. “This is a ___.”
- Curriculum developer declares syntax tree to specify phrasal structure

Algorithms

- Organic learning
- Anticipation
- Graduated interval recall

```
teach (node) {
   if (node is a leaf) {
      if (learner has not been taught meaning of
         node's phrase) {
         say node's meaning in native language;
         say node's phrase in target language,
            and asks learner to repeat aloud;
         pause;
         teach_pronunciation (node);
         anticipation (node);
         insert node into priority queue;
      }
   }
   else {
      if (learner has not been taught meaning of
         phrase's meaning or linguistic structure
         pertaining to node) {
         if (first child of node is a leaf)
            say node's meaning in native language;
            for each child of node {
            teach (child);
            graduated_interval_recall ();
         }
         if (learner has not encountered linguistic
            structure pertaining to node & node has
            explanation for this structure)
            say node's explanation in native language;
         anticipation (node);
         insert node into priority queue;
      }
   }
}
```

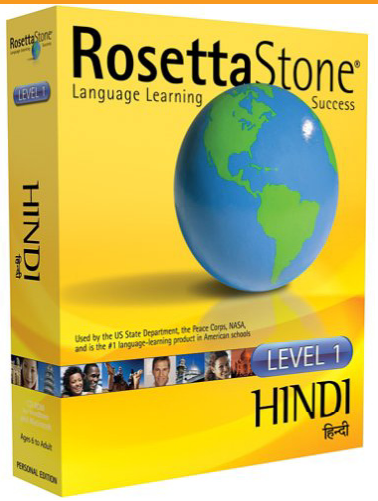
Best-selling Foreign Language Packages

Avoid reinventing the wheel entirely

Reuse best practices from most successful commercial language learning packages

Reviewed sample of >35 applications

Sample has a balance b/w listening, reading speaking and writing skills



Design Pattern

“Template” solution to previous problem

- Have been used in urban planning and architecture (Alexander 1977), software engineering (Gamma et al. 1995), computer science education (Bergin) and games (Björk and Holopainen 2005)

Benefits

- Represent solutions to frequent problems in skeletal form
- Encourages reuse, avoids reinventing the wheel

Distilled >50 patterns

- Shortlisted 11 patterns for language beginners

Pimsleur Generator: Results

Evaluated with 3 conversational scripts developed for grades 1 and 8 by India partners

- Declarative language for user input was sufficiently expressive

Evaluated with 47 rural school children (grades 1-5) over two weeks

- No post-test gains on short-term vocabulary retention
- Did not pay attention or respond to anticipation prompts

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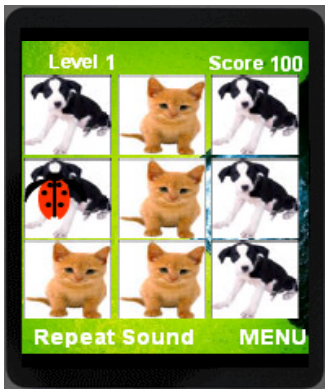
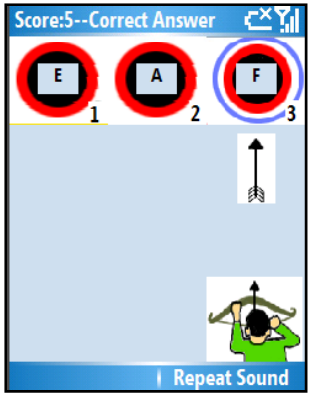
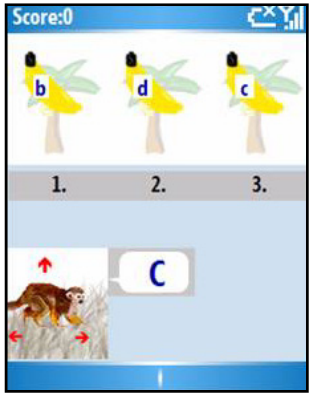
E-Learning Games [in ACM CHI 2007b]

Designed and piloted 10 mobile games by applying pedagogical design patterns and game design principles (Crawford 2003, Malone 1981, Rouse 2001)

- Letter-sound correspondences
- Listening comprehension
- Word recognition
- Linguistic structures







Iterative Design and Testing
[in ACM CHI 2007b, ACM DIS 2008, IEEE/ACM ICTD 2007]

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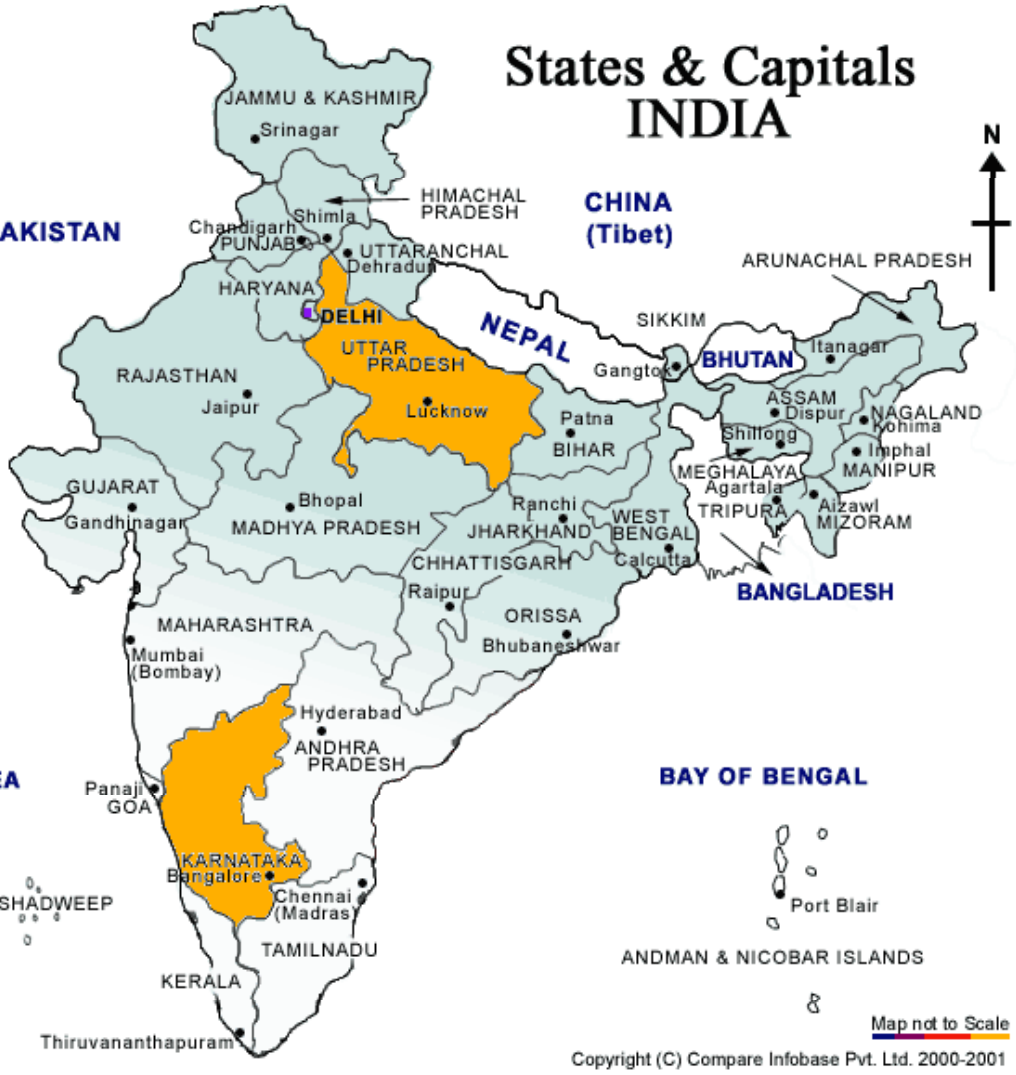
Field-tested prototypes w/ three communities in North and South India

- Urban slums school
- Private village school
- Government village school



Results: Learning Outcomes [in ACM DIS 2008]

First major quantitative study in summer 2007, with 47 rural school children (grades 2-5)

Demonstrated short-term vocabulary retention

- 1.96 out of 5 on pre-test, and
- 3.85 out of 5 on post-test
  (p-value < 0.001, std. dev. = 1.42)

Results: Gameplay Enjoyment [in ACM DIS 2008]

Players enjoyed showing off game achievements

- Winner screens
- Repeated over and over again



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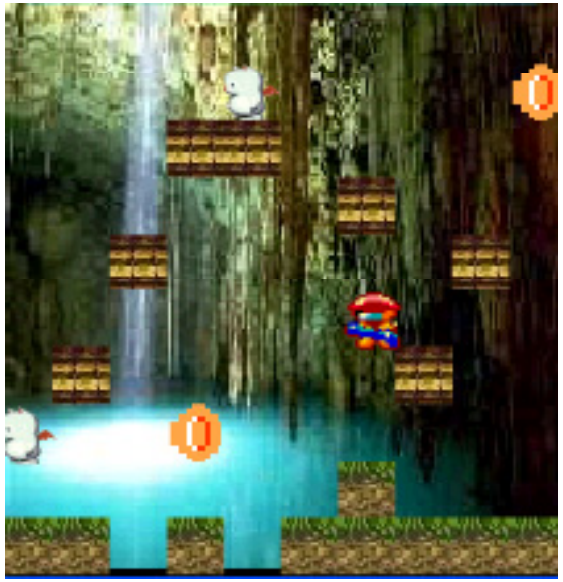
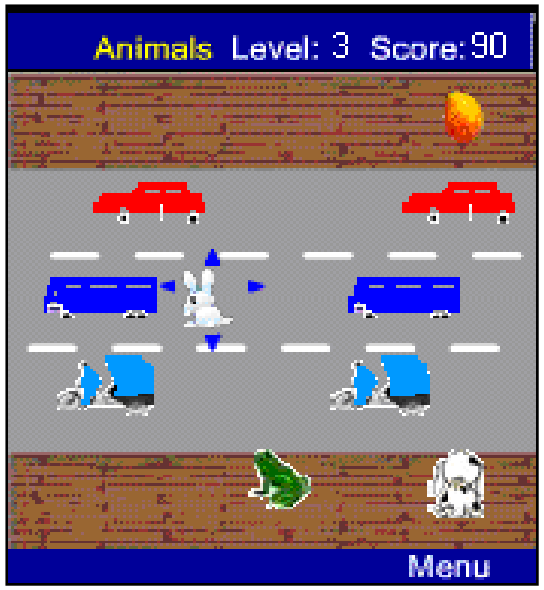
Cultural Relevance [in DiGRA 2007]

But most games fail to match the understanding or expectations that rural children have about games

- What are characteristics of traditional village games?
- How do traditional games differ from videogames?





Traditional Village Games

Example: Tree-Tree

Toward a Design Grammar

Analyzed 28 traditional village games

Synthesized key rules into design grammar

Analogy to a design grammar

- Nouns, e.g. entities and objects in the game world
- Adjectives, e.g. attributes of players and objects
- Verbs, e.g. actions that change game state

State Variables

Game state

- # of players, teams and opposing sides
- # of objects, e.g. ball, stone, stick, marble, pen

Player state

- Position, i.e. x, y coordinates
- Active, at rest, imprisoned, invulnerable, out of game

Object state

- Position, i.e. x, y coordinates
- Owner

Actions and Goals

Player actions

- Catch, evade, protect, guard, rescue, move, rest

Actions on objects

- Throw, deflect, pick up, discard, strike, arrange, guess

Goals and end conditions

Differences in Games

How are traditional Indian village games different from existing Western videogames?

Compared design grammar against 296 game design patterns documented in Bjork and Holopainen 2005

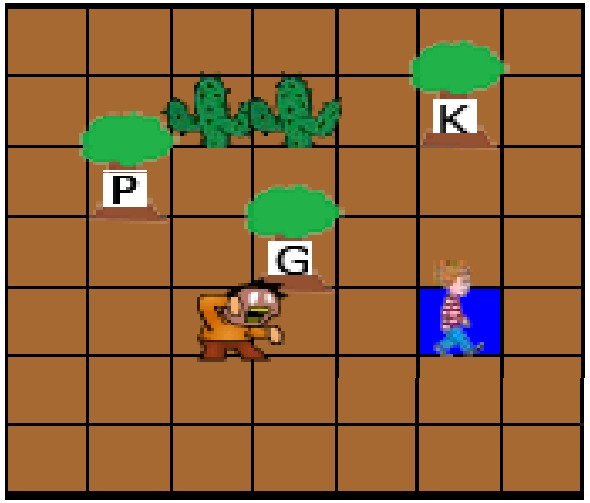
Identified absences or differences

- Difficulty level based on subgoals
- Resource management
- Score-keeping
- No skill-acquisition for player characters
- Lack of system-generated game events
- Rituals associated with physical space

Applying Grammar

Applied game design grammar

Tree-Tree
(playground version)



Tree-Tree
(digital version)

Result: more intuitive game design

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Ongoing Work

Longitudinal pilot deployment

- From January 2008 to January 2009 (at the minimum)
- Three times per week for rural children from poor families
- After-school program at private village school

Developing 1-year curriculum with experienced English teacher in India

Targeted Syllabus

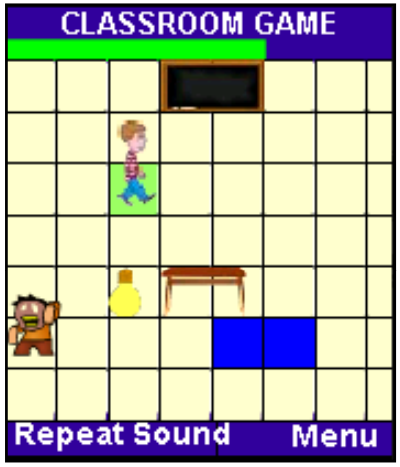
Expected syllabus (both oral and written)

- Nouns related to: classroom items, fruits & vegetables, body parts, clothes, etc.
- Basic grammar: singular vs. plural, gender forms, etc.
- Question and answer: the 5 W's and 1 H

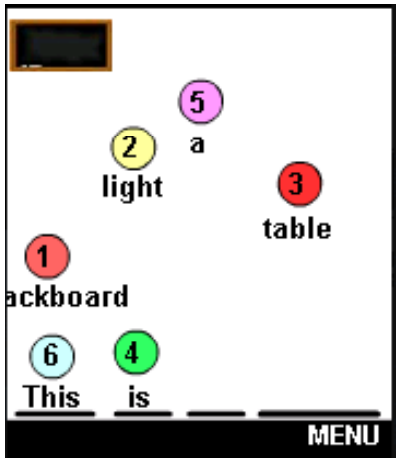
Latest Designs

Game design grammar, Sesame Street India characters

Giti Phod game



Marbles game



Hypothesized Results

Pre-tests, post-tests and delayed post-tests

Benchmark against standardized English exam

- 30 hours of instruction in English as a Second Language

Expect participants to learn more compared to their lessons in government rural schools

Future Work (Summer 2008 and onwards)

Scenarios for informal learning

- Other out-of-school settings, e.g. home, work, play



Partnership w/ Sesame Workshop India

- Locally produced content for local learning needs

Funded by recent grant from MacArthur Foundation (Digital Media and Learning award)

Future Work (Summer 2008 and onwards)

Target Hispanic children and adults in migrant farming communities

- Traditionally underserved by mainstream ESL commercial learning products

Funded by recent grant from Verizon

Adult Language Learning

Goal: target lowly-educated adults in developing regions and industrialized countries

- Functional literacies for adults in service industries (e.g. call centers, taxi drivers, etc.)
- Continuing education for female home-makers

Leverage convenience of mobile learning

Acknowledgements

Thesis committee

- Computer Science – Eric Brewer, John Canny
- Education – Glynda Hull

Team members

- Berkeley – Ruth Alexander, Jane Chiu, Varun Devanathan, Asya Grigorieva, Dimas Guardado, Christopher Hom, Anjali Koppal, Maksim Lirov, Aaron McKee, David Nguyen, Anand Raghavan, Divya Ramachandran, Priyanka Reddy, Vijay Rudraraju, Monish Subherwal, Jingtao Wang
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Advocates

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- Qualcomm - Wireless Reach award
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For More Details

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Dissertation work featured in TV documentary on novel cellphone applications in the developing world

Cellphone: The Ring Heard Around the World.
Produced by Canadian Broadcasting Corporation's Documentary Production Unit, to be aired on public TV in Canada on April 3, 2008

Viewable online after April 3: http://www.cbc.ca/documentaries