Digital Innovation & Empowerment For All

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With Gloria Lim, Helen Chen, Aditi Goyal, & Theresa Johnson
• World population: 6.7B
• 5.4B world population live in developing countries
• 1B living on less than $1 a day
• 4.1B mobile users world-wide
• 2.6B mobile users in developing countries
POMI 2020

Programmable Open Mobile Internet

The Stanford Clean Slate Project
http://cleanslate.stanford.edu
Stanford Research Team

Dan Boneh
Monica Lam
David Mazieres
Phil Levis
Mendel Rosenblum
Christos Kozyrakis
Ramesh Johari
Guru Parulkar
Nick McKeown
Fouad Tobagi
Andrea Goldsmith
Arogyaswami Paulraj

Applications
HCI
Security
Languages
Distributed Systems
OS
Architecture Economics
Networking
Radio

Education
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The Big Research Agenda

Handheld
- UI
- Secure mobile browser
- Energy efficient
- Secure OS
- HW Platform

Data Substrate
- PRPL Virtual Data System

Computation Substrate
- Network of VMs, Mobile VMs

Network Substrate
- OpenFlow

Applications
- PocketSchool, Virtual Worlds, Augmented Reality

Radio technology
- Multi-Gb/s, 99% coverage

Economics
POMI in EDUCATION

- **PocketSchool**
  - Responding to Digital Divide, Education Divide, & Economic Divide

- **Mobile Wireless Sensor-Simulation Lab**
  - Innovating STEM education

- **PRPL ePortfolio**
  - Innovating Learning, Assessment, & Employment Processes
Investigate the effectiveness of the mobile learning device as a multimodal interactive means, the portability and personalization factors, usability design innovations, informal learning opportunities, etc.

- Usability research
  - Adoption and implementation & Learning activities and interactions

- Mobile Learning effect study
  - Literacy, Numeracy, empowerment, health (Behavioral, Cognitive, Social dimension)

- Sustainable model development research
  - Creative content as commodity
  - Finance
    - Self-sustainable model – SMSONE, E-BOOK, SMS APP Development
    - Hybrid business
  - Energy
    - Efficient application
    - Playing is charging
• **Mobile Wireless Sensor-Simulation Lab**
  – STEM education mobile simulation
  – Women & Creativity in Engineering Education

• **ePortfolio STEM learning & assessment**
  – PRPL data index for data organization and visualization for In-Situ tracing in Learning
  – Mobile profile for employment matching (Pune, India & Sacramento, CA)
  – ePortfolio assessment incorporating scientific research
How did PocketSchool come about?

19th century - Tuskegee “Movable School” in Alabama

George Washington Carver (1861-1943), quite arguably, the father of African-American Science.

The Movable School reached “the hard to reach” and served the needs of “the people left behind.”

(Mayberry, 1991)
Approaches in the Past

Reaching out to children in mountainous and rural areas via van full of textbooks & science simulation kits.
Mobile School on Wheels for tribal children in rural villages
21C Approach: PocketSchool

- Programmable Open Mobile Learning Platform – anyone to program & share educational applications for kindergarten to life-long learning scenarios.
- Loaded with literacy, math, science simulation, etc.
- Low-cost
- Self-sustainable model
- Grassroots approach – participatory design
No school, No teacher, No book, No television
A child in Rwanda playing with a mobile learning device loaded with education games.
* Rural village hot-spot & content distribution station
* Peer-relayed communication
PocketSchool on Two Wheels
PocketSchool

- Africa
- Latin America
- India
- USA
Individualize learning plan
Learning games & homework

Sync and generate reports on individual performance
(Pinpointing successful and struggling areas)
Connecting those who need help with those who want to help...

Internet.
computer.
problem.
Synchronous to PCs &
Asynchronous M2M
Tags are used to indicate subject, textbook, page, and problem number, problem title, etc.
Multi-sensor Mobile-Simulation Lab

Ex. Module adapted for the wireless sonar distance sensor

• Objectives:
  – Provide highly lost-cost portable platform to enhance creativity and critical reasoning skills through problem-solving challenges.
  – Promote STEM education through mobile simulation.
  – Enable real-time data collection.
  – Outreach to women & minority groups in Engineering Education.
The Revolution in STEM Education

STEM = Science + Technology + Engineering + Mathematics

In recent decades, research on the process of learning, and particularly on the process of learning science, has blossomed leading to the development of novel ways to instruct STEM subjects.

Hands on learning takes center stage, in addition to relevant real-world applications and problem solving capabilities.

We’re developing innovative ways to teach STEM material that incorporate this new research and takes advantage of an inexpensive array of OTS sensors for applying STEM subject material to real-world applications.
Past efforts continued...

Activity Prototyping

Interactive games
Wireless connection system architecture plan
STEM Summer Camp

- A curriculum filled with design challenges in STEM topics
- Students in small groups visit 5 different task stations in which they must solve real-world problems and challenges
Task 1: Earthquakes

The real-world problem:
Many places on earth, especially the State of California, experience Earthquakes from time to time. Our buildings must be designed and built to respond to the seismic movements effectively.

The activity:
Students are to build structures with gummy bares that can withstand seismic activity simulated on a shake table.

STEM Curriculum:
“Plate tectonics accounts for important features of Earth’s surface and major geologic events.” (Grade 6, CA Standard)

In collaboration with Quake-Catcher Network (http://qcn.stanford.edu/) from Earth Science department
The Quake-Catcher Network

"Bringing Seismology to homes & schools."

Press 'S' for live view
Use '<' & '>' keys to pan
Press 'O' for world earthquake map
Press 'L' to toggle 2D/3D Plot
Press '+' to change time window

Window Width = 10 seconds
Window Start Time = 11/18/2007 23:19:05
Window End Time = 11/18/2007 23:15:15

Jesse Lawrence
Stanford University
CPU Time: 13.664278 sec
Proposed Shake-Table Exercise

Controlling the waves

Wireless seismometer

Wireless controller

Motor

Reference points

PRPL Server

Archiving, Analyzing, & Visualizing Data

Capturing seismic data & video
In Situ Tracing (Learning Behaviors)
Task 2: Solar Energy

The real-world problem:
Electricity outages in developing nations are common. Moreover, the world is seeking renewable energy sources in order to slow the effects of global warming.

The activity:
Determine the ideal angle of orientation for a solar panel on a home or building generate the most electricity.

STEM Curriculum:
“Many phenomena on Earth’s surface are affected by the transfer of energy through radiation and convection currents. ... Students know solar energy reaches Earth through radiation, mostly in the form of visible light” (Grade 6, CA Standard)

“Energy enters the Earth system primarily as solar radiation and eventually escapes as heat.” (Grade 9-12, CA Standard)
Task 3: Wind Turbines

The real-world problem:
Electricity outages in developing nations are common. Moreover, the world is seeking renewable energy sources in order to slow the effects of global warming.

The activity:
Determine how much energy can be generated by a kite on a tether being carried by natural wind energy. How high will the kite need to fly to capture the most energy?

STEM Curriculum:
“Students know different natural energy and material resources, including air, soil, rocks, minerals, petroleum, fresh water, wildlife, and forests, and know how to classify them as renewable or nonrenewable.” (Grade 6, CA Standard)
Task 4: Drinkable Water

The real-world problem:
Due to contamination, and arid conditions, many areas of the world lack access to a consistent and efficient drinkable fresh-water supply.

The activity:
Determine methods for creating a quantity of drinkable water suitable for an individual or family for a day, using ocean water or otherwise contaminated sources. Determine a methodology for locating underground freshwater sources.

STEM Curriculum:
“The geology of California underlies the state’s wealth of natural resources as well as its natural hazards. ... Students know the importance of water to society, the origins of California’s fresh water, and the relationship between supply and need.” (Grades 9-12, CA Standard)
Task 5: Biomedical Monitoring

The real-world problem:
Persons living in remote or undeveloped areas often have difficulty reaching a doctor on a regular basis or when an emergency strikes.

The activity:
Design and build, using provided sensors, basic biomedical devices that when information is transmitted wirelessly from the device allows the doctor to ascertain, from far away, the health of her patient as well as location when personal treatment is required.

* Challenge activity for advanced students
More inquiries?

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