ICT AT THE INTERSECTION OF PUBLIC POLICY/EDUCATION:

Emerging Technologies, Ubiquitous Learning, and Educational Transformation

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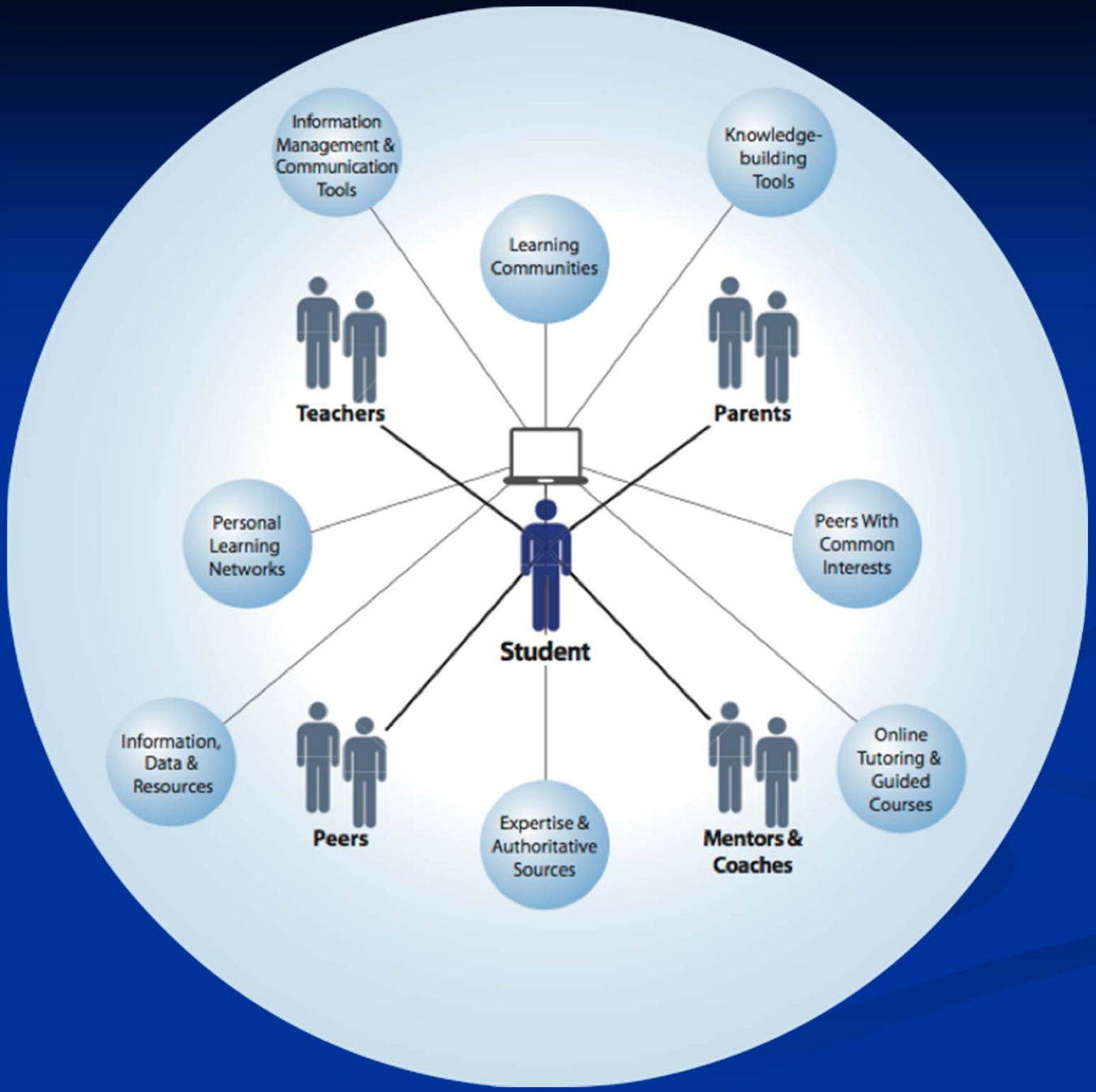
The Core Challenge We Face

- Shifts in the knowledge and skills society values
- Development of new methods of teaching and learning
- Changes in the characteristics of learners

Emerging information technologies are reshaping each of these—and changing how we learn and know.

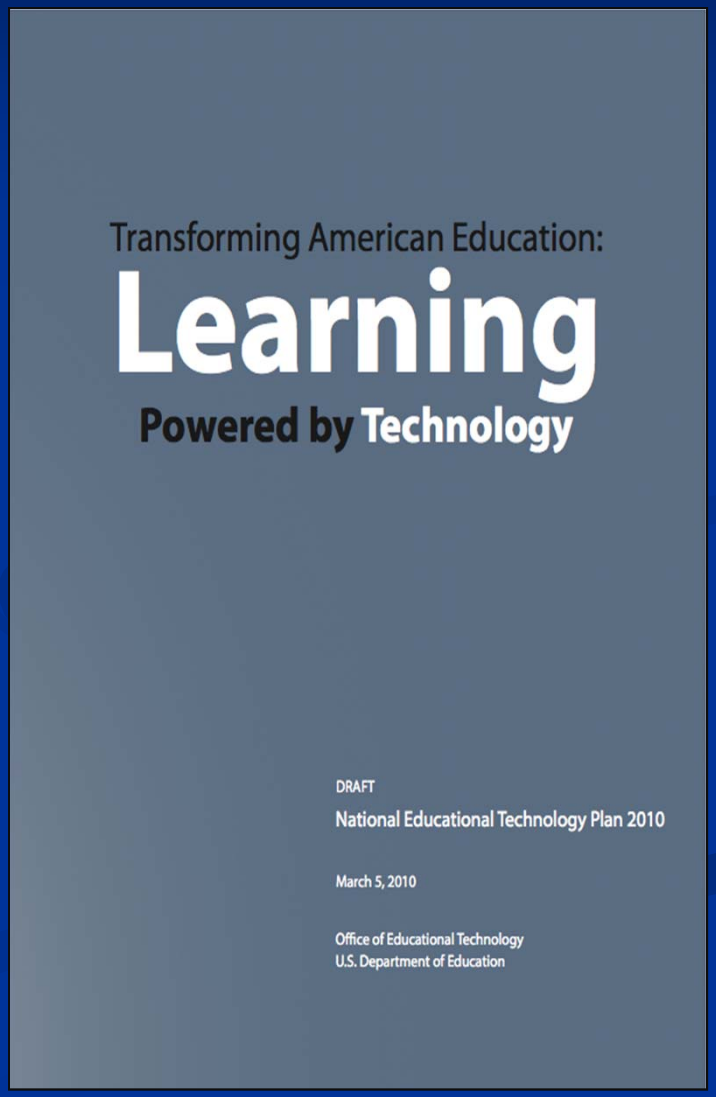
A Vision for ICT in Education

If we were to redesign education not to make historic models of schooling more efficient, but instead to prepare students for the 21st century—simultaneously transforming teaching in light of our current knowledge about the mind—what types of scalable, sustainable learning environments might sophisticated technologies enable us to create?


Information Management & Communication Tools
Knowledge-building Tools
Learning Communities
Teachers
Parents
Personal Learning Networks
Peers With Common Interests
Student
Information, Data & Resources
Online Tutoring & Guided Courses
Peers
Expertise & Authoritative Sources
Mentors & Coaches

The 2010 NETP

- Response to Congressional mandate for five-year plan for educational uses of technology
- Plan for *transforming* education with technology in response to urgent need to remain competitive in a global economy
- Reflection of increased understanding of how to support learning and of growing capabilities enabled by technology



Enabling Technology Trends

Digitally Simulated Experiences

Mobility – Lifewide Learning

Social Interactions for Learning

Perennial Challenges in Classrooms

- Classrooms are barren places without rich resources or ways to simulate the real world
- Students are bored compared to the many forms of engagement they have in the rest of their lives
- Teachers are the only way increasingly large numbers of students can get help personalized to their needs
- Paper and pencil, item-based assessments cannot measure deep knowledge and sophisticated skills

Next Generation Interfaces for "Immersive Learning"

- **Multi-User Virtual Environments**
  Immersion in virtual contexts with digital artifacts and avatar-based identities
- **Virtual Reality**
  Full sensory immersion via head-mounted displays or CAVES
- **Ubiquitous Computing:**
  Wearable wireless devices coupled to smart objects for "augmented reality"

January 2009 *Science*

EcoMUVE

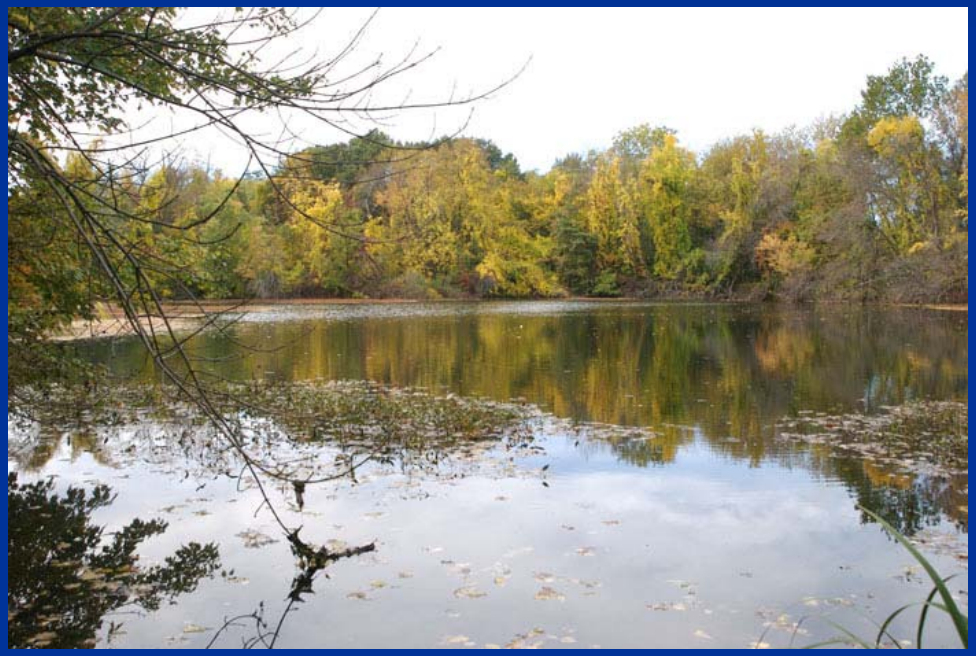
- Funded by the Institute of Education Sciences of the U.S. Department of Education
- Middle school science
  - Ecosystems, causal complexity
- Two MUVE-based modules implemented over 2 weeks within a 4-week ecosystems curriculum
- Timeline: July, 2008 – June 2012
  - Completed first set of large-scale field trials
  - Early results very encouraging.

Project Overview

- Ecosystems have complex causal dynamics.
- Even after instruction, students often retain misconceptions.
- In our experience, MUVEs can help students engage in authentic science inquiry and gain deeper understanding.
- Our goal is to develop EcoMUVE as a MUVE that, as part of a larger curriculum, will enable a richer understanding of ecosystems and complex causality.
- We also want to demonstrate the potential of MUVEs for rich situated learning in classrooms.

Pond Ecosystem

Modeled after Black's Nook Pond in Cambridge, MA

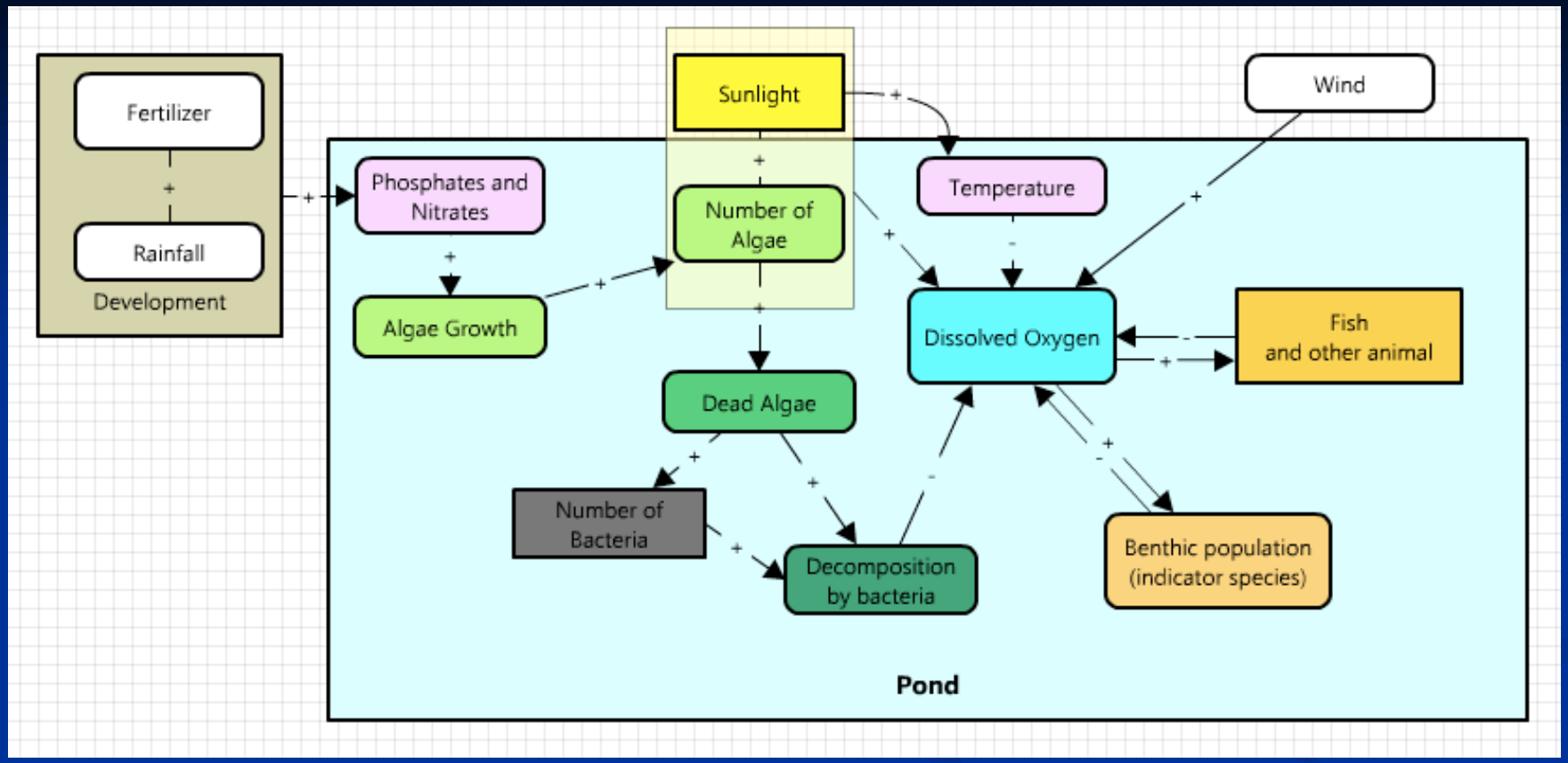


Change Over Time

TI Nspire

Non-Obvious Causes

Unintentional Agency

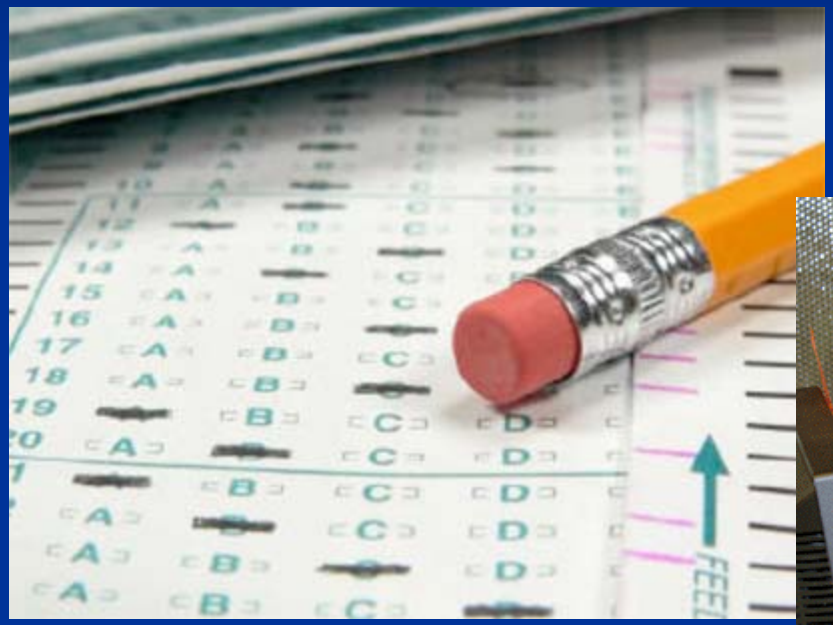


Interaction Between Biotic and Abiotic Factors

Runoff causes increased phosphate levels, leading to increased plant growth. Plant decomposition by bacteria consumes oxygen, causing the eventual fish kill.

http://ecomuve.gse.harvard.edu

Assessing Sophisticated Performances Based on Rich Observations



NSES Model of Inquiry

- Identify questions that can be answered through scientific investigation (not independent of knowledge)
- Design and conduct a scientific investigation
- Use appropriate tools and techniques to gather, analyze, and interpret data
- Develop prescriptions, explanations, predictions, and models using evidence
- Think critically and logically to make the relationships between evidence and explanations
- Recognize and analyze alternative explanations and predictions
- Communicate scientific procedures and explanations
- Use mathematics in all aspects of scientific inquiry

An Immersive Model

- Student takes on identity of a scientist
- Students complete quests
- 90 Minutes
- Four Phases:
  1. Orientation
  2. Problem Identification
  3. Experimentation
  4. Competing Explanations

Actions as Basis for Assessments

Logfiles Indicate with Timestamps

- Where students went
- With whom they communicated and what they said
- What artifacts they activated
- What databases they viewed
- What data they gathered using virtual scientific instruments
- What screenshots and notations they placed in team-based virtual notebooks
- What hints they accessed

http://vpa.gse.harvard.edu/

Logfiles: Events, Chats, Notebooks

Database of Logdata — Track students' behaviors: where they went, what data they collected, path they took to solve problem

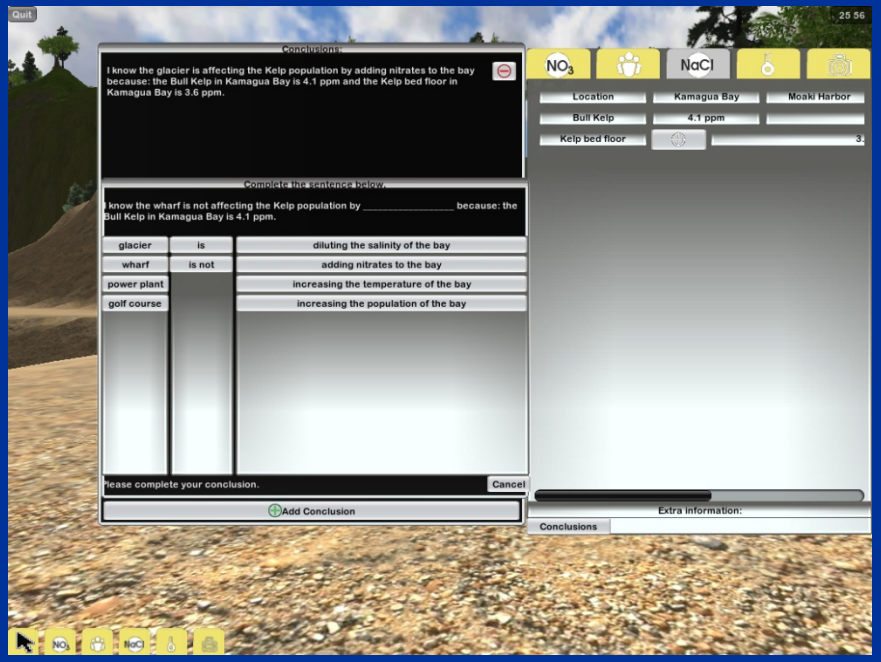
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	administra	testID	eventID	stage	timestamp	locationX	locationY	locationz	locationYa	assetID	detail	studentID	Description
2	3141592	497	0	0	2009-12-08	0	0	0	0	1	1	102282	assessment started
3	3141592	497	1	1	2009-12-08	364	23	-76	0	2	10	102282	stage started
4	3141592	497	2	1	2009-12-08	263	10	-6	270	2	10	102282	stage started
5	3141592	497	3	1	2009-12-08	263	8	-6	270	14	1	102282	notebook opened
6	3141592	497	4	1	2009-12-08	263	7	-6	270	14	2	102282	nitrate tab clicked in notebook
7	3141592	497	5	1	2009-12-08	257	8	-397	0	143	20	102282	Arrow selection of Surface of the bay in front of the tent
8	3141592	497	6	1	2009-12-08	0	0	0	0	2	11	102282	stage ended
9	3141592	497	7	1	2009-12-08	0	0	0	0	2	13	102282	stage ended ungracefuly
10	3141592	497	8	1	2009-12-08	0	0	0	0	1	3	102282	
11	3141592	498	0	0	2009-12-08	0	0	0	0	1	1	102282	assessment started
12	3141592	498	1	1	2009-12-08	364	23	-76	0	2	10	102282	stage started
13	3141592	498	2	1	2009-12-08	263	10	-6	270	2	10	102282	stage started
14	3141592	498	3	1	2009-12-08	263	8	-6	270	14	1	102282	notebook opened
15	3141592	498	4	1	2009-12-08	263	7	-6	270	14	2	102282	nitrate tab clicked in notebook
16	3141592	498	5	1	2009-12-08	263	7	-6	270	14	3	102282	pop density tab clicked in notebook
17	3141592	498	6	1	2009-12-08	263	7	-6	270	14	4	102282	salinity tab clicked in notebook
18	3141592	498	7	1	2009-12-08	263	7	-6	270	14	2	102282	nitrate tab clicked in notebook
19	3141592	498	8	1	2009-12-08	263	7	-6	270	14	1	102282	notebook opened
20	3141592	498	9	1	2009-12-08	0	0	0	0	2	11	102282	stage ended
21	3141592	498	10	1	2009-12-08	0	0	0	0	2	13	102282	stage ended ungracefuly
22	3141592	498	11	1	2009-12-08	0	0	0	0	1	3	102282	
23	3141592	499	0	0	2009-12-08	0	0	0	0	1	1	102282	assessment started
24	3141592	499	1	1	2009-12-08	364	23	-76	0	2	10	102282	stage started
25	3141592	499	2	1	2009-12-08	263	10	-6	270	2	10	102282	stage started
26	3141592	499	3	1	2009-12-08	263	8	-6	270	14	1	102282	notebook opened
27	3141592	499	4	1	2009-12-08	263	7	-6	270	14	2	102282	nitrate tab clicked in notebook
28	3141592	499	5	1	2009-12-08	233	4	-5	291	3	4	102282	teleport KB kelp
29	3141592	499	6	1	2009-12-08	236	6	-4	291	2	11	102282	stage ended
30	3141592	499	7	4	2009-12-08	129	10	125	0	2	10	102282	stage started
31	3141592	499	8	4	2009-12-08	124	2	117	108	212	20	102282	Arrow selection of Striped surfperch
32	3141592	499	9	4	2009-12-08	123	0	123	0	107	22	102282	Population density reading for Bull kelp
33	3141592	499	10	4	2009-12-08	129	10	118	180	209	22	102282	Population density reading for Sea otter
34	3141592	499	11	4	2009-12-08	137	0	121	37	200	22	102282	Population density reading for Corraline algae
35	3141592	499	12	4	2009-12-08	133	0	117	0	111	24	102282	Temperature reading for Bay floor
36	3141592	499	13	4	2009-12-08	133	0	117	0	111	25	102282	Turbidity sample taken of Bay floor
37	3141592	499	14	4	2009-12-08	108	0	107	37	200	23	102282	Salinity reading for Corraline algae
38	3141592	499	15	4	2009-12-08	133	0	117	0	111	21	102282	nitrate reading for Bay floor

Differences From Item-based Tests

Multiple Forms of Complex Measures

Products of Inquiry

Create conclusions and select evidence.



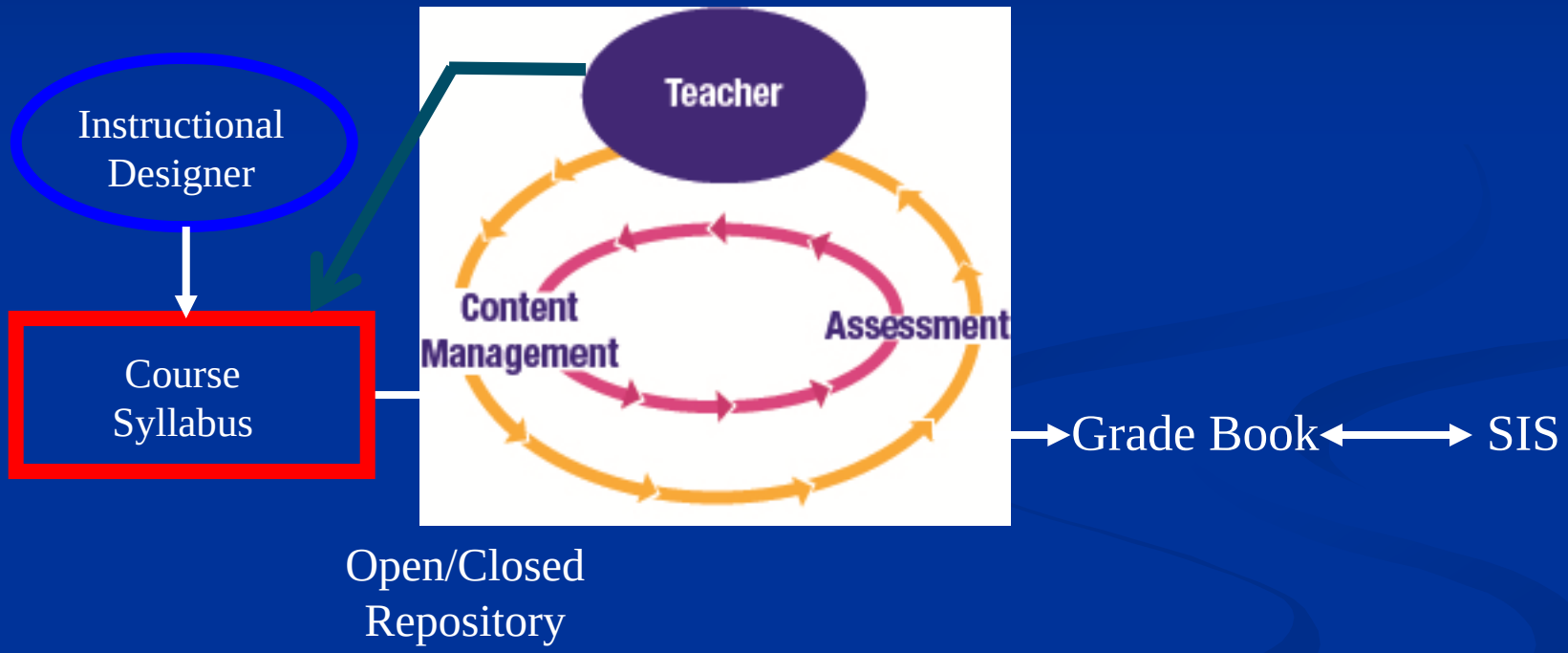
Processes of Inquiry

Gather data and interview people.

Formative and Diagnostic

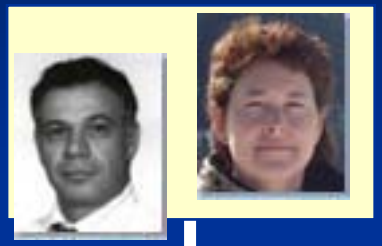
- Formative, diagnostic assessment provides *more leverage for improvement* than summative measures.
- Formative, diagnostic assessment is *richer and more accurate* than summative measures.
- Potentially, formative, diagnostic assessment *could substitute for* summative measures.

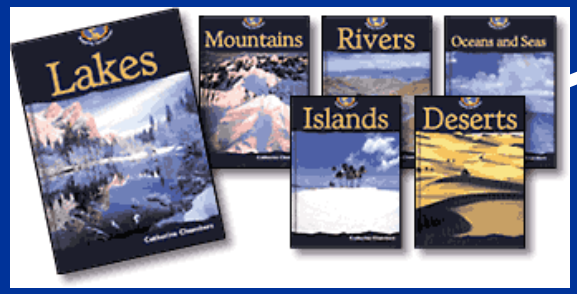
Digital Teaching Platforms



Teacher-Centered (Orchestra)

Teacher





Curriculum

Technology

Student

Disruptive Innovation Theory

Why Successful Companies Go Out of Business

- *Sustaining innovations* are incremental improvements in a product
- *Disruptive innovations* offer a new product initially not as effective as what is currently sold, but immediately meeting a specialized need (alternative is non-consumption) and potentially better in the long-run
- Over time, the disruptive product drives out the standard product (e.g., mini-computers)

Transformation via Disruption

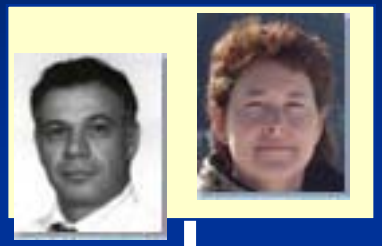
Disrupting Class **Christensen, Horn, & Johnson, 2008**

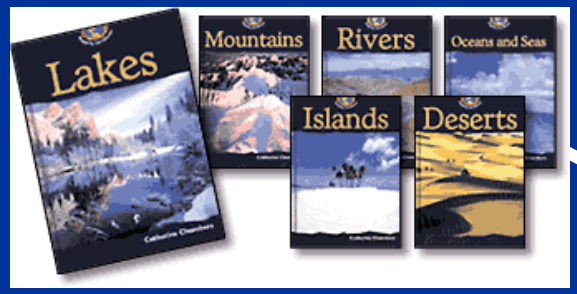
My Altered Version

- *Schooling* is the sustaining innovation (based on industrial model)
- *Customization* is the disruptive innovation (e.g., individual human tutors and the 2-sigma effect)
- Customization in *online learning* is the initial product that competes against non-consumption
- Inclusive, customized learning – *based on much more distributed "teaching"* – is the innovation that forces schooling to adapt

Student-Centered (Jazz Combo)

Teacher





Curriculum

Technology

Student

Enabling Technology Trends

Digitally Simulated Experiences

Mobility – Lifewide Learning

Social Interactions for Learning

1976

2011

Many Mobile Devices

…and More to Come

Next Generation Interfaces for "Immersive Learning"

- **Multi-User Virtual Environments**
  Immersion in virtual contexts with digital artifacts and avatar-based identities
- **Virtual Reality**
  Full sensory immersion via head-mounted displays or CAVES
- **Ubiquitous Computing**
  Wearable wireless devices coupled to smart objects for "augmented reality"

January 2009 *Science*

"Overlay Devices"

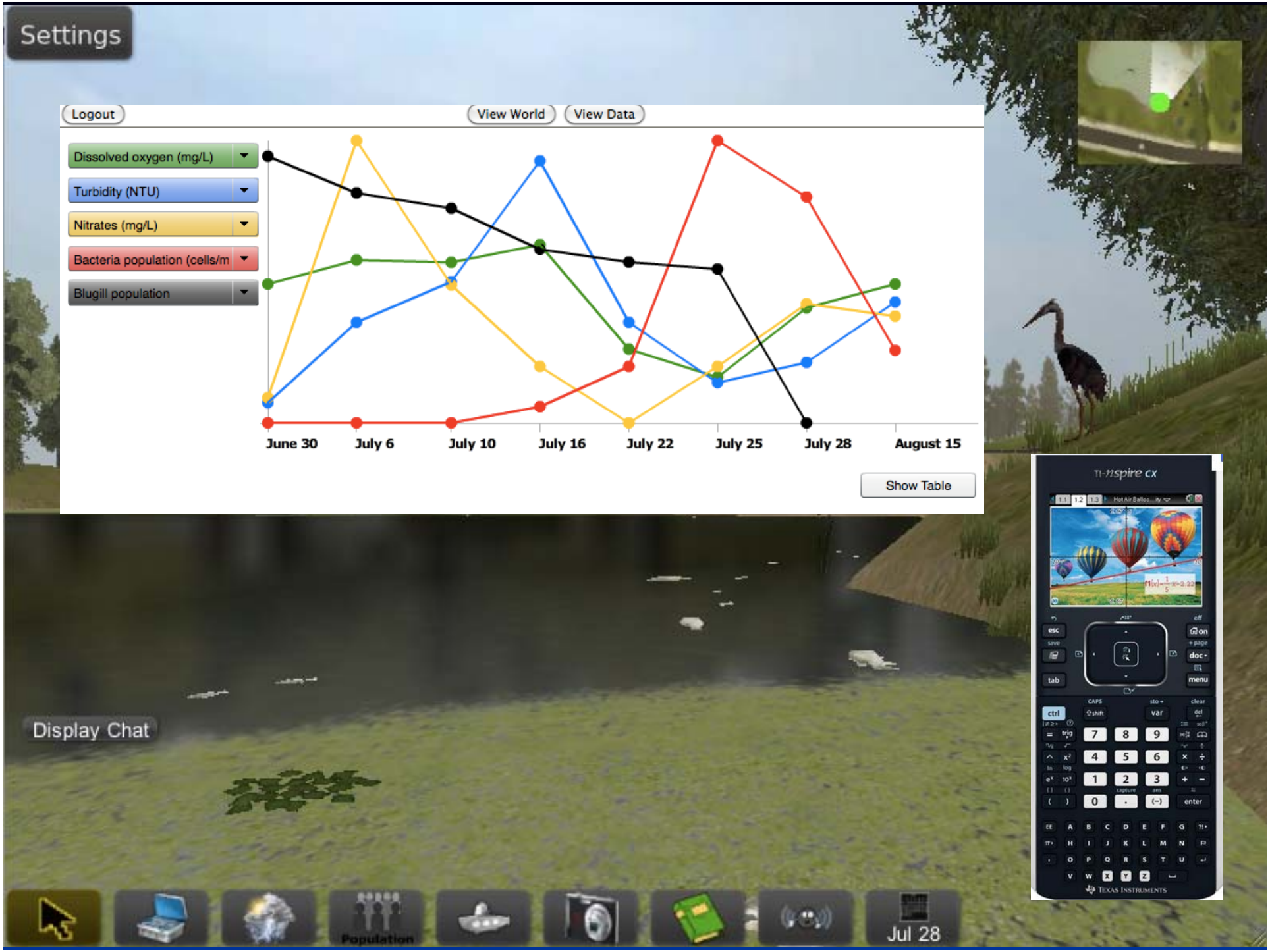
- Wireless mobile devices offer substantial power, at a fraction of the cost for laptops and with greater mobility.
- Entertainment and learning are infused anywhere.
- One-to-one person-to-device ratio becomes affordable in education.

"Augmented reality"
for entertainment and learning

上環
西
W
九龍(西)
康樂廣場
機場快綫站
愛丁堡廣場
九龍

Sheung Wah
西
W
Kowloon (W)
Connaught Place
Airport Express Station
Edinburgh Place
Kowloon

Transport
Transport


Settings
Logout
View World
View Data
Dissolved oxygen (mg/L)
Turbidity (NTU)
Nitrates (mg/L)
Bacteria population (cells/m
Blugill population
June 30
July 6
July 10
July 16
July 22
July 25
July 28
August 15
Show Table
Display Chat
Population
Jul 28
TI-nspire cx
Texas Instruments

Role of Mobile Broadband Devices

Enable learning anytime, anyplace

- Embedded information and experience provides authenticity and fosters transfer

- Rich data on students' actions and performances enables customized instruction

Enabling Technology Trends

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Social Interactions for Learning

The Spectrum of Web 2.0 Media

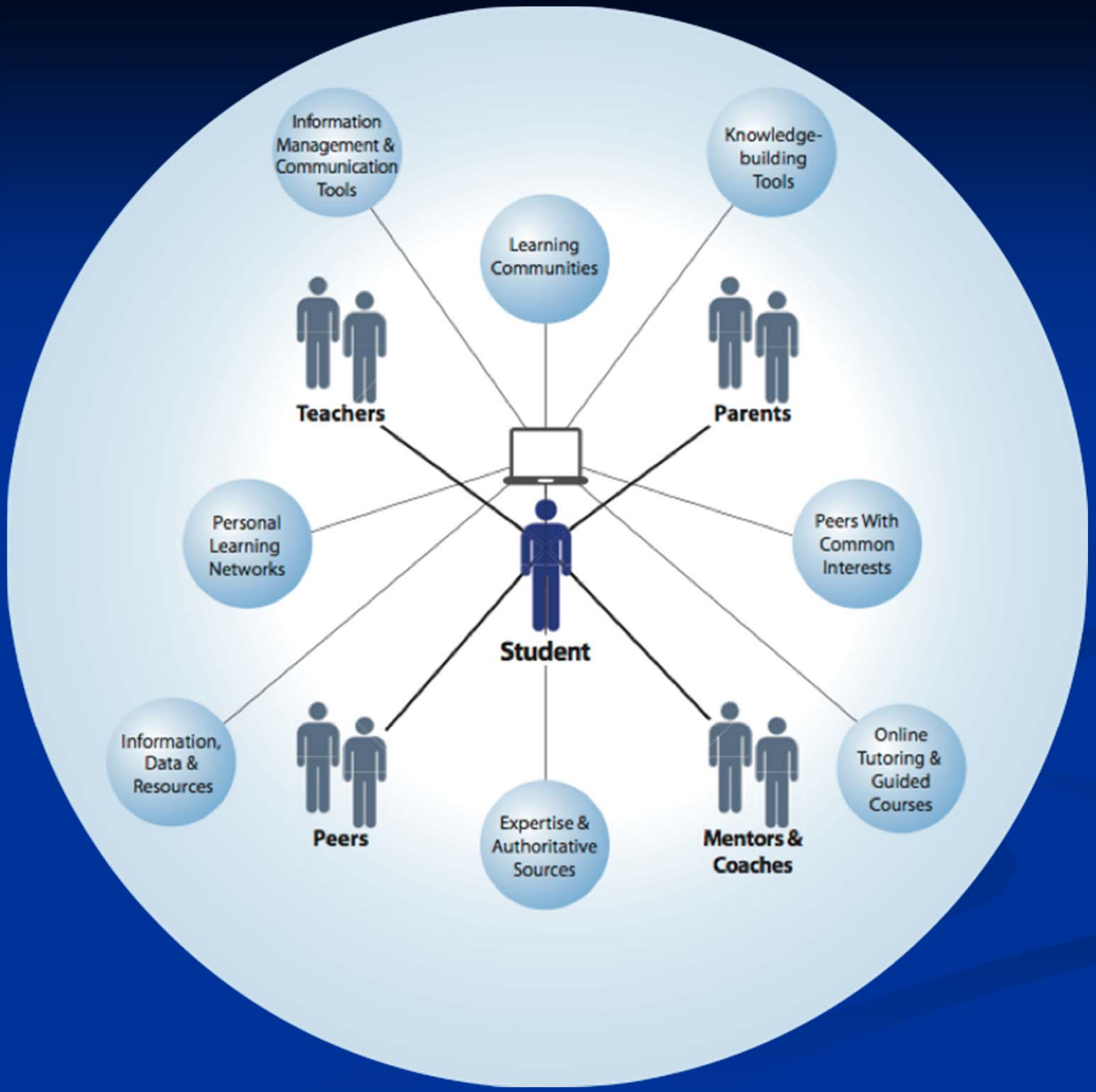
- Sharing
  - Social bookmarking
  - Photo–video sharing
  - Social networking
  - Writers' workshops and fan fiction
- Thinking
  - Blogs
  - Podcasts
  - Online discussion forums
  - Twitter
- Co-Creating
  - Wikis–collaborative file creation
  - Mashups–collective media creation
  - Collaborative social-change communities

May 2009 *Educational Researcher*

Jenkins' Framework for New Literacies

- ***Play*** — Experimenting with one's surroundings in problem solving
- ***Performance*** — Adopting alternative identities for improvisation and discovery
- ***Simulation*** — Interpreting and constructing dynamic models of real-world processes
- ***Appropriation*** — The ability to meaningfully sample and remix media content
- ***Multitasking*** — Scanning one's environment and shifting focus to salient details
- ***Distributed cognition*** — Fluently using tools that expand mental capacities
- ***Collective intelligence*** — Pooling knowledge with others toward a common goal
- ***Judgment*** — Evaluating the reliability and credibility of different information sources
- ***Transmedia navigation*** — The ability to follow the flow of stories and information across multiple modalities
- ***Networking*** — The ability to search for, synthesize, and disseminate information
- ***Negotiation*** — The ability to travel across diverse communities, discerning and respecting multiple perspectives, and grasping and following alternative norms

WHAT IF YOUR DEVICE HAD A 6TH SENSE?


Information Management & Communication Tools
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Teachers
Parents
Personal Learning Networks
Peers With Common Interests
Student
Information, Data & Resources
Online Tutoring & Guided Courses
Peers
Expertise & Authoritative Sources
Mentors & Coaches

Distributed Education

Who educates?

- Teachers in school
- Coaches, guides, and mentors in rest of life
- Self-directed learning through access to information and experience everywhere

How prepared?

- Schools of education prepare and certify
- Apprenticeships for each within all settings
- Self-directed learning through access to information and experience everywhere

Current State of ICT in Education

- Technology as hood ornament, not engine
- Device usage as the innovation
- What sells is ways to automate presentational teaching and assimilative learning
- Emphasis not on value, but on fear of misuse
- Pace of change driven by teachers' comfort-level

Jet engine on a Stagecoach

Transformation of Formal Education

Policy Barriers and Enablers

Teaching

Assessment

Infrastructure

Productivity

Learning

Key Policy Recommendations from 2010 NETP

- 1.1 States should continue to revise, create, and implement standards and learning objectives using technology for all content areas that reflect 21st-century expertise and the power of technology to improve learning.
- 1.3 States, districts, and others should develop and implement learning resources that exploit the flexibility and power of technology to reach all learners anytime and anywhere.
- 5.2 Rethink basic assumptions in our education system that inhibit leveraging technology to improve learning, starting with our current practice of organizing student and educator learning around seat time instead of the demonstration of competencies.

Key Policy Recommendations from 2010 NETP

- 2.1 States, districts, and others should design, develop, and implement assessments that give students, educators, and other stakeholders timely and actionable feedback about student learning to improve achievement and instructional practices.
- 2.3 Conduct research and development that explores how embedded assessment technologies, such as simulations, collaboration environments, virtual worlds, games, and cognitive tutors, can be used to engage and motivate learners while assessing complex skills.

Key Policy Recommendations from 2010 NETP

- 3.2 Leverage social networking technologies and platforms to create communities of practice that provide career-long personal learning opportunities for educators within and across schools, preservice preparation and in-service education institutions, and professional organizations.
- 3.3 Use technology to provide all learners with online access to effective teaching and better learning opportunities and options especially in places where they are not otherwise available.
- 3.5 Develop a teaching force skilled in online instruction.

Key Policy Recommendations from 2010 NETP

- 4.2 Ensure that every student and educator has at least one Internet access device and appropriate software and resources for research, communication, multimedia content creation, and collaboration for use in and out of school.
- 4.4 Build state and local education agency capacity for evolving an infrastructure for learning.
- 4.5 Develop and use interoperability standards for content and student-learning data to enable collecting and sharing resources and collecting, sharing, and analyzing data to improve decision making at all levels of our education system.

Grand Challenges for Research from 2010 NETP

- 1.0: Design and validate an integrated system that provides real-time access to learning experiences tuned to the levels of difficulty and assistance that optimize learning for all learners and that incorporates self-improving features that enable it to become increasingly effective through interaction with learners.
- 3.0: Design and validate an integrated approach for capturing, aggregating, mining, and sharing content, student-learning, and financial data cost-effectively for multiple purposes across many learning platforms and data systems in near real time.