Desktop to Laptop to Cloud: Challenges for Teaching and Administration

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Contents

• Context: Computer Supported Spatial Thinking
• Hardware and Software Evolution
• Ubiquity of Computation for Learning
• Challenges to Teaching and Administration
Context

• Have you ever heard of ESRI?
• Environmental Systems Research Institute
• Geographic Information Systems (GIS)?
• Seat 21E: “Computer maps”
• Do you know Google Maps?
• If so, you still don’t know GIS…
• One definition: GIS = Computer Supported Spatial Thinking
ESRI
Helping people make a difference with GIS, since 1969
What is Spatial Thinking?

• Howard Gardner’s (1983) Theory of Multiple Intelligences.
  
  • Linguistic intelligence ("word smart")
  • Logical-mathematical intelligence ("number/reasoning smart")
  • Spatial intelligence ("picture smart")
  • Bodily-Kinesthetic intelligence ("body smart")
  • Musical intelligence ("music smart")
  • Interpersonal intelligence ("people smart")
  • Intrapersonal intelligence ("self smart")
  • Naturalist intelligence ("nature smart")
Gardner’s Spatial Thinking

**Mental Rotation Test**

For each row, which of the three comparison shapes on the right is identical to the shape on the left? Psychologists have found that the farther you have to rotate an object mentally, the longer the comparison takes. The speed at which you can complete the tasks provides a general measure of your spatial ability. The answers are (1) A and (2) B.

**Paper folding tasks are classic measures of spatial visualization ability.**


Egocentric space...
San Diego Convention Center (You are ... Here?)

- Plenary Session (Monday)
- Exhibit Pavilion (Tuesday–Thursday)
- ESRI Showcase Area
- Industry Showcases
- Welcome Reception (Sunday)
- SAG Awards Ceremony (Wednesday)
- Closing Session (Friday)

Ground Level

- Tote Bag Distribution (Sat–Mon)
- Hall H
- Hall G
- Hall F
- Hall E
- Hall D
- Hall C
- Hall B2
- Hall B1
- Hall A
- User Software Applications Fair
- Spatial Outlet, Bookstore
- First Aid Services & Coat Check
- Wireless Help Desk
- Registration, Information & Attendee Services
Contour Map
Which area is highest?
US National Research Council (2006)

Learning to Think Spatially: GIS as a Support System in K-12 Education

Not just primary and secondary
- an essential tool for every person
- Needs to be taught across subjects
- Problem solving integrator/facilitator
- Needed by the workforce
- GIS can be significant
- Need research on the topic

www.nap.edu/catalog/11019.html
“the committee views the process of spatial thinking as a universal mode of thinking, one that is accessible to everyone to different degrees in different contexts.

Spatial thinking can be learned, and it can and should be taught at all levels in the education system. “

ESRI supports this idea.
Why Spatial Thinking in education?

- Epidemiology
- Natural Hazards: Coastal Erosion,
  - Seismicity, Weather Events
- International and National Security
  - Energy
- Climate Change
- Urban Growth
- Sustainable Agriculture
- Water Quality and Availability
Ways to Think Spatially

- Pattern Recognition
- Proximity and Spatial Distances
- Space and Time
- Overlays (spatial coincidence)
- Workflows & Modeling
- 3D (multi-dimensions)
- Connectivity and Interaction
- Uncertainty and Sensitivity
- Scale
1854 London – Cholera
Dr. John Snow
An obvious GIS analysis
Locate a new gas station
GIS Analysis: Calculate Service Areas
Overlay Traffic Counts
Model the Problem...
- components, interactions, dependencies, outcomes
Modeling with Technology (3rd Ed., 2005)

- **Constructivist** Education, after David Jonassen (and others)

- Use technology to **Model what you are studying**, to aid in comprehension
  - Spreadsheets
  - Visualization software
  - Databases
  - Concept Mapping
  - Expert Systems
  - GIS
Modeling Your Methodology
Modeling Your Methodology: possible outcomes
Then add Economic & Environmental Overlays

Gasoline Prices

Superfund & Toxic Sites Enterprise Zones
Established 2007 to integrate a campus-wide community of spatial thinkers at UCSB

"spatial@ucsb aims to change what people think of spatial thinking – from something that only experts need to know about, to something that everyone should use."

Mike Goodchild, director of spatial@ucsb

UCSB is Spatial
Desktop to Laptop to Cloud

• A story of increasing computational **ubiquity**

• Progression started with mainframes
• GIS taught since 1970, on timeshared minicomputers
• History of restricted access to highly-specialized hardware and software...becoming less and less so

• 1990s: desktop GIS became popular
  – Still expensive, difficult to maintain and customize
  – But at least it was possible
  – Special GIS support technicians hired
Challenges with Desktop Computing

• **Funding and continued maintenance of computer lab**
  – Hardware, Software, Infrastructure

• **Hardware becomes obsolete (3 yr amortization)**

• **Maintaining software licenses**
  – Licenses tied to CPU or MAC address
  – Hardware keys (dongles)
  – Keeping up with latest version
  – Different functionality on Windows, Mac, etc.
  – Compatibility with other key software

• **Multiple configurations**
  – Through continued use, machine content evolves and diverges
  – Unauthorized installations, viruses, etc.
Desktop to **Laptop** to Cloud

- Increased degree of computing ubiquity
- Checkout of school laptops
  - Different maintenance problems
  - *Nobody ever washed a rental car…*
- Student-owned laptops
  - Very interesting in principle
  - In practice, also diverse machines mean configuration and maintenance complexity
  - Cost to students: prohibitive for many families
    - Although many of the same students own $300 iPods
- 1 laptop per student = no need for a computer lab
- Computer Supported Education can happen anywhere, anytime
- Say goodbye to “computer class” (= ubiquity)
Challenges in Teaching on Laptops

• All teachers need to become computer literate

• **Difficulty moving from teaching the tool**, to using the tool to teach the domain subject
  – GIS to teach Geography, Environmental Science, History

• Management of software licenses
  – Floating license managers now available
  – Check-in/Check-out licenses via web
  – Control who has what license and for how long

• No computer labs means more server-based issues

• Processing power: are *Netbooks* enough?
  – CPU, Main memory, Graphics memory

Future: Minimal laptops connected to the **Cloud**?
Desktop to Laptop to **Cloud**

- Cloud Computing: the latest buzzword
Figure 1. Hype Cycle for Emerging Technologies, 2009

- Expectations
  - Cloud Computing
  - E-Book Readers
  - Social Software Suites
  - Microblogging
  - Green IT
  - Video Telepresence
  - Mesh Networks: Sensor
  - Online Video
  - Corporate Blogging
  - Wikis
  - Location-Aware Applications
  - SOA
  - Speech Recognition
  - Web 2.0
  - Social Network Analysis
  - Over-the-Air Mobile Phone Payment Systems, Developed Markets
  - RFID (Case/Pallet)

- Technology Trigger
- Peak of Inflated Expectations
- Trough of Disillusionment
- Slope of Enlightenment
- Plateau of Productivity

Years to mainstream adoption:
- ○ less than 2 years
- ● 2 to 5 years
- ● 5 to 10 years
- ▲ more than 10 years
- × obsolete

Source: Gartner (July 2009)
Cloud Computing Service Models

- **Software as a Service (SaaS)**
  - End-user applications, delivered as a service, rather than on-premise software

- **Platform as a Service (PaaS)**
  - Application platform or middleware as a service on which developers can build and deploy custom applications

- **Infrastructure as a Service (IaaS)**
  - Compute, storage, or other IT infrastructure as a service, rather than as dedicated capability.
## Changes to the Computing Model

<table>
<thead>
<tr>
<th>Models</th>
<th>Traditional</th>
<th>Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procurement</td>
<td>Buy assets and build technical architecture</td>
<td>Buy service(s)</td>
</tr>
<tr>
<td>Business Model</td>
<td>Pay for fixed assets, overhead, administration</td>
<td>Rent assets; pay based on use</td>
</tr>
<tr>
<td>Access</td>
<td>LAN, WAN, client</td>
<td>Ubiquitous Network</td>
</tr>
<tr>
<td>Technical</td>
<td>Static and single tenant</td>
<td><strong>Elastic and multitenant</strong></td>
</tr>
</tbody>
</table>
Multitenency = Virtualization

- Server virtualization allows the conversion of one server into many virtual machines

- Main components
  - Physical Computer (Host)
  - Host Operating System + Virtualization Component (Hypervisor)
  - Virtual Machines
  - Management Suite + Tools
In favor of cloud computing

• Reduce costs and improve cash flow.

• Minimize your financial and business risks.

(Graphics courtesy: aws.amazon.com/economics)
Hybrid: “Own the Base, Rent the Spike”
### This Month's Activity as of March 21, 2010

The billing cycle for this report is March 1 - March 31, 2010. The AWS service usage charges on this page currently show activity through approximately 03/21/2010 16:59 GMT.

#### Amazon Elastic Compute Cloud

<table>
<thead>
<tr>
<th>Service</th>
<th>Usage Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amazon EC2 running Windows</strong></td>
<td>$0.48 per Large Windows Instance (m1.large) instance-hour (or partial hour) 468 Hrs</td>
</tr>
<tr>
<td><strong>Amazon EC2 Bandwidth</strong></td>
<td>$0.00 per GB Internet Data Transfer - all data transfer into Amazon EC2 0.001 GB</td>
</tr>
<tr>
<td></td>
<td>$0.150 per GB Internet Data Transfer - first 10 TB / month data transfer out of Amazon EC2 0.000277 GB</td>
</tr>
<tr>
<td></td>
<td>$0.010 per GB Regional Data Transfer - in/out /between AZs or when using public or Elastic IPs or Elastic Load Balancing 0.000015 GB</td>
</tr>
<tr>
<td><strong>Amazon EC2 EBS</strong></td>
<td>$0.10 per GB-month of provisioned storage 131.695 GB-Mo</td>
</tr>
<tr>
<td></td>
<td>$0.10 per 1 million I/O requests 1,650,004 IOs</td>
</tr>
<tr>
<td></td>
<td>$0.15 per GB-Month of snapshot data stored 2.045 GB-Mo</td>
</tr>
</tbody>
</table>

#### Amazon Simple Storage Service

<table>
<thead>
<tr>
<th>Service</th>
<th>Usage Details</th>
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</thead>
</table>

#### Amazon Virtual Private Cloud

<table>
<thead>
<tr>
<th>Service</th>
<th>Usage Details</th>
</tr>
</thead>
</table>

#### Taxes

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Taxes (Due April 1, 2010)</td>
<td>$0.00</td>
</tr>
</tbody>
</table>

**Charges due (your AWS Account)**

| Amount | \$238.36 |
Administrative Challenges (Cloud)

• Budgets often distinguish hardware from services
  – My ex-university: annual hw maintenance budget (SGI Onyx)
  – Cloud services are essentially rented hardware
  – Software fees do not disappear

• Controlling usage: school work versus play
  – School pays for x-hours of computer time; student pays the rest

• Difficulty judging peak and valley usage
  – Summer school
  – Big final projects (remembering timeshare days)

• Computing staff change management
Administrative Opportunities (Cloud)

- Transparent server hardware maintenance
- Client hardware can be minimal
- Centralized software maintenance

- Combined with student laptop use, allows fixed school computer labs to .... disappear.

- Opportunities to capture distance learning students
  - Or to lose students to better distance learning programs elsewhere
What is the primary reason your organization will not use public cloud services?

- Fear of loss of control of data: 28%
- Fear of unauthorized access to our customer information: 17%
- Features & general maturity of Technology: 12%
- Security defects in the technology itself: 8%
- Unpredictable costs: 6%
- Business viability of provider: 5%
- Vendor lock-in: 5%
- Application/system performance: 4%
- Other: 15%

Information Week analytics, January 2010
November 23, 1999

Microsoft® Passport "wallet" service is now live at 24 leading merchant sites. In addition to these live sites, there are now over 100 e-commerce sites committed to supporting Passport, a 90% increase since the service was launched in October. …

Microsoft Passport can help streamline the online purchasing process for consumers by giving them one electronic wallet for use across multiple Web sites, making it faster and easier to purchase their gifts online.

Cloud Computing Service Models

**Software as a Service (SaaS)**
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**Platform as a Service (PaaS)**
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Concluding: Implication for Education

• In theory:
  – Software (databases, CAD, GIS, Modeling, Graphic Design) resides in the cloud, cost shared among whole school district or university
  – Students have diverse, owned, laptops (just part of being a student)
  – Laptops access school software via ordinary web browser+cloud
  – Minimal system requirements
  – Student has access to Learning Technology platform, in class, in the library, in the cafeteria, at home, on vacation,…
  – Technology ceases being a special academic subject, and becomes a natural part of the school day
  – Less time spent teaching Technology
  – More time teaching Problem-Solving, Critical Thinking using technology
  – Students play learning games rather than watch TV at home!
  – Many become scientists, entrepreneurs, and go off and save the world.
• In practice:
  – 100 reasons why this might not happen
  – “technology *engages* students” is not enough
  – Teaching to standardized tests is not enough
  – Teachers must be retrained, education changed

  – Number 1 Challenge for Teaching and Administration: Having the Courage to make it happen.

  – We must improve learning, not merely make it fun and adjust the performance measuring stick.
Conclusions

- Critical Thinking, not only visualization (GIS case)
- Emphasis on Constructivist Education
- Ubiquity of Computing
- Cloud Computing as future possibility
- Possibility of lessening emphasis in the Technology per se, in favor of technology to improve learning

- You are the people who can make a difference, because you understand both sides: technology and education!
Thank you for your attention

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• http://edcommunity.esri.com