

Community Service with Web-Based Geographic Information Science and Technology (GIST)

Blended Pedagogies for the Twenty-First Century

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Web GIST: A New Course at UMass

Student learning goals are to understand:

- how the World-Wide Web works;
- the nature of geographic information and how it is processed and visualized on the Web;
- the importance of open standards, software, and data;
- the value of teamwork;
- how to creatively apply their knowledge of GIST and Web programming to benefit a community organization.



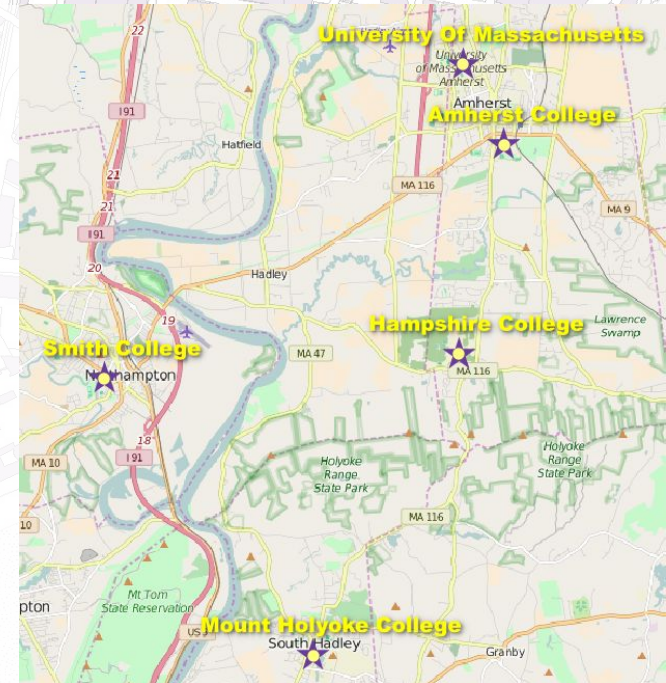
William Greenlaw

[Open Geospatial Consortium](#)

A Five College Effort

Five College Blended-Learning Grant

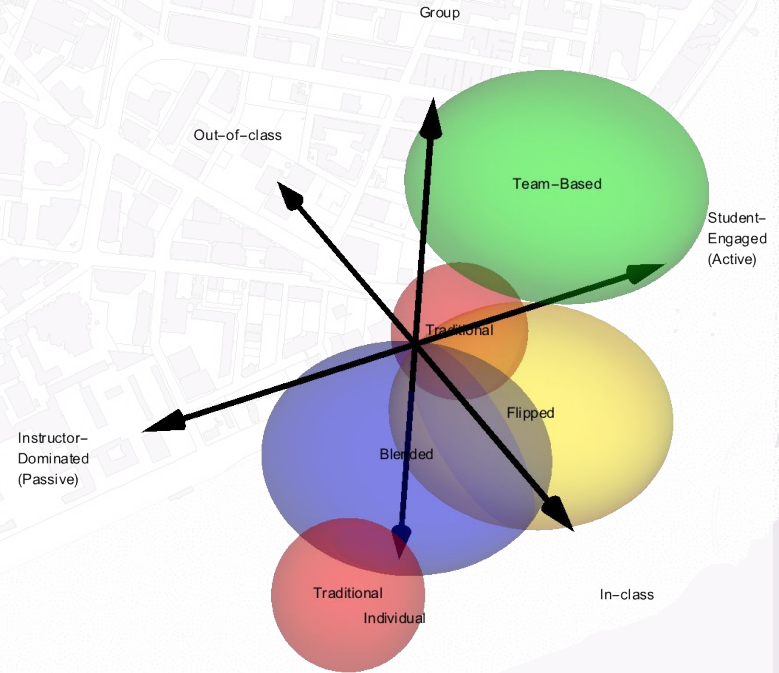
- Charlie led first half:
 - OGC, QGIS, PostGIS, GeoServer
- Andy led second half:
 - HTML/CSS/SVG, JavaScript, REST, Bootstrap, Leaflet, Node
- Jon and Scott provided content, feedback, and student support.



Blended Pedagogies

The course implemented several non-traditional teaching methods:

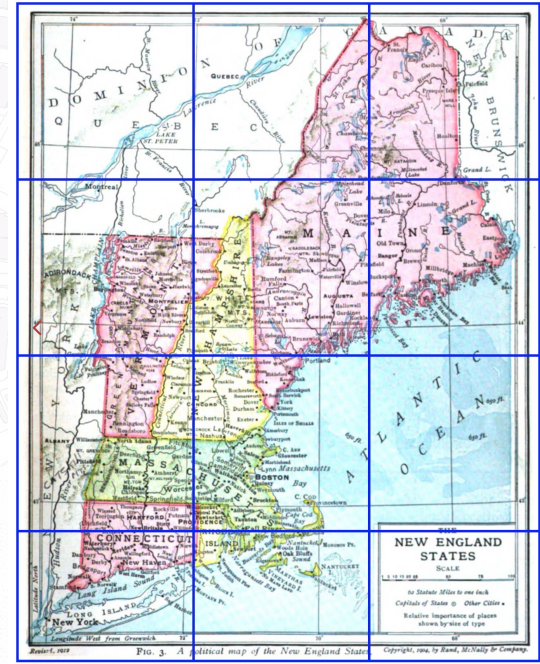
- blended learning
- flipped (workshop) learning
- open learning
- team-based learning
- service learning



Blended Learning

Course materials covered foundational knowledge and:

- were online and organized in Moodle;
- were often visual and interactive;
- used examples from local geography;
- included localized exercises;
- provided short quizzes requiring recall, understanding, and application.



In an HTML document, markup elements provide

Select one:

- Meaning
- Visual styling
- Document Structure
- All of the above ✓

Moodle Quizzes

For an object like

```
var someplace = { County: 'Hampshire', Organization: 1662, Area: 585,  
  "Population 1910": 19431, "County Seat": 'Northampton' };
```

the following method returns population density and could be assigned to similar objects.

Select one:

- a. function popDensity(someplace) { return someplace["Population 1910"] / someplace.Area }
- b. function popDensity() { return someplace["Population 1910"] / someplace.Area }
- c. function() { return this["Population 1910"] / this.Area } ✓ Correct!
- d. function() { return someplace["Population 1910"] / someplace.Area }

Flipped (Workshop) Learning

Class time was student-centered, with:

- review of exercise and quiz difficulties;
- Q&A and discussions about important concepts in the course materials;
- active learning with hands-on problem-solving tasks that encourage analysis, evaluation, and creativity;
- project work, eventually increasing to fill class time;
- shared successes as students found solutions to problems.



[Five Colleges Workshop](#)

Open Learning

The course explicitly used:

- [open educational resources](#) to build content
- [open-source software](#) in its examples
- [open data](#) whenever possible
- open standards for [GIS](#) and [Web](#) technologies
- open components in student projects
- open to all Five College students with GIS skill

Open Educational Resources

The [main course content](#) was made available via [GitBook](#), and built from many pieces:

- documentation available on-line
- openly-licensed material, some by others, some by us, repurposed with our examples
- brand-new material providing just enough background, sharable via a [Creative Commons Attribution license](#)



Introduction

1. Exploring Spatial Data Models usi...

2. Relational Database Management ...

2.1. PostgreSQL/PostGIS Installat...

2.2. Relational Databases

2.3. pgAdmin and PostgreSQL Ex...

3. Spatially Enabled Relational Datab...

3.1. The Idea of Spatial Databases ...

3.2. Building the IFRI Spatial Relat...

3.3. Spatial Analysis using SQL an...

3.4. PostGIS CartoDB

4. Mapping Raster Data

4.1. Raster datasets - formats and f...

4.2. Georeferencing a Scanned Pap...

4.3. Key Postgres and PostGIS ste...

5. Introduction to Web Mapping and ...

Chapter 7: Dynamic Data on the World-Wide Web

Lesson Goals

Students are knowledgeable composers of JavaScript, the programming language of the Web, and can create Web pages by manipulating the Document Object Model.

Lesson Outcomes

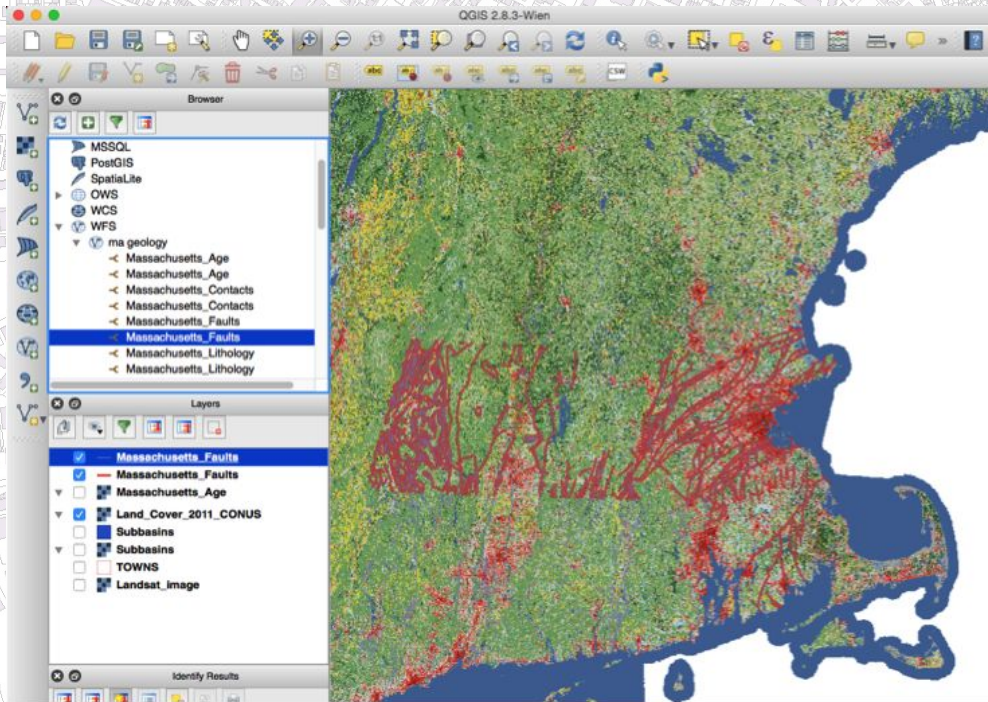
Students can:

- Program basic JavaScripts to process content
- Develop Web pages using JavaScript
- Manipulate the Document Object Model using the programming library jQuery

Introduction

Web pages are built from textual, graphic, and other content using the [HyperText Markup Language \(HTML\)](#) and [Scalable Vector Graphics \(SVG\)](#), and are styled using [Cascading Style Sheets \(CSS\)](#).

Open-Source Software: QGIS



The course introduced students to QGIS:

- a desktop application to process data
- similar to ArcMap
- focus on connecting to Internet servers

Open-Source Servers: OpenVZ



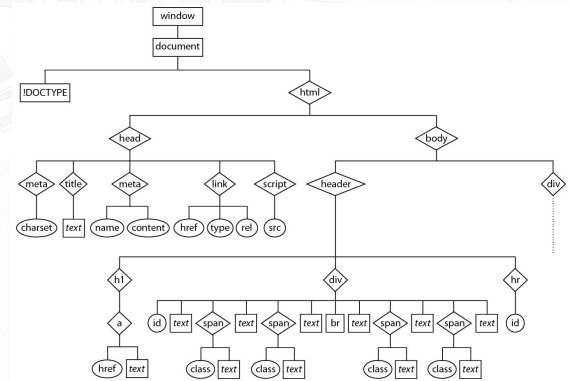
To provide servers for students, we set up an [OpenVZ](#) system:

- sits on top of an underlying Linux system
- provides multiple containers for lightweight subsystems:
 - one for the course and one for each student team
- each configured with enterprise software (an OIT first!):
 - Database: [PostgreSQL](#)
 - Web page servers:
 - [Apache](#), [Node](#)
 - Web map server: [GeoServer](#)

World-Wide Web Development

Students learned the basics of developing Web content:

- [HyperText Markup Language \(HTML\)](#) and [Cascading Style Sheets \(CSS\)](#), the languages of documents *and rasters*;
- [Scalable Vector Graphics \(SVG\)](#), the language of *vector features*;
- [JavaScript](#), the programming language that builds documents — *and maps*;

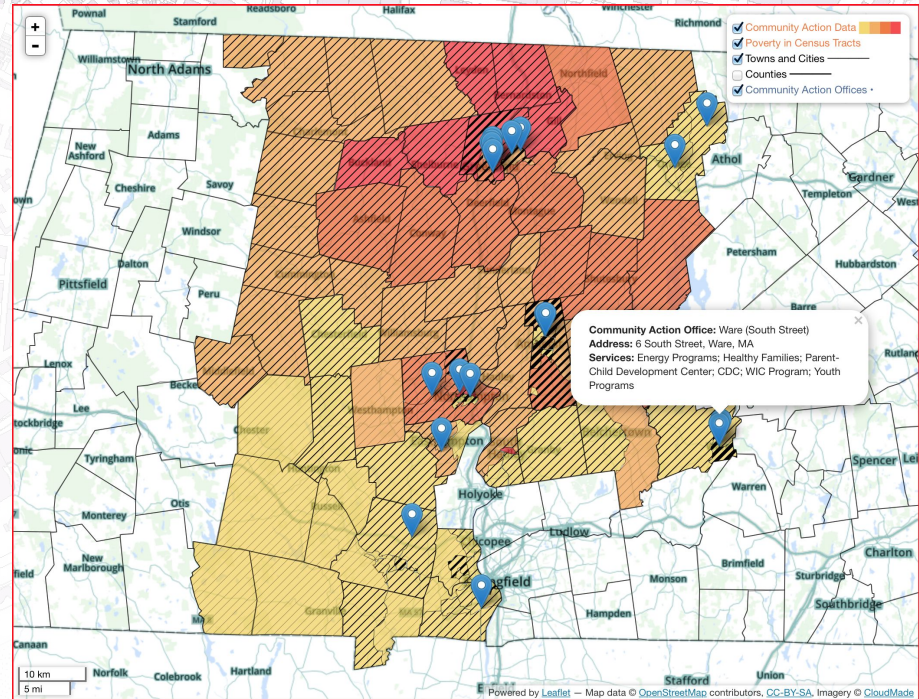


Leaflet.js



Leaflet.js greatly simplifies the creation of Web maps:

- a lightweight Google Maps-style interface
- easily load data from servers, directly or as WMS or WFS



[Hack for Western Mass](#)

Team-Based Learning

23 students (14 F, 9 M) formed
7 teams based on interests, and:

- were 2 – 5 in size
- distributed different skills:
 - on 1–5 scale: GIS skill 3 ± 0.7 ; other tech skill 2.4 ± 0.7
- learned about team roles, project management, and gender dynamics:
 - $NDGI = (F - M) / (F + M) > 0$ for all teams but one = -1



Service Learning

Students created projects that:

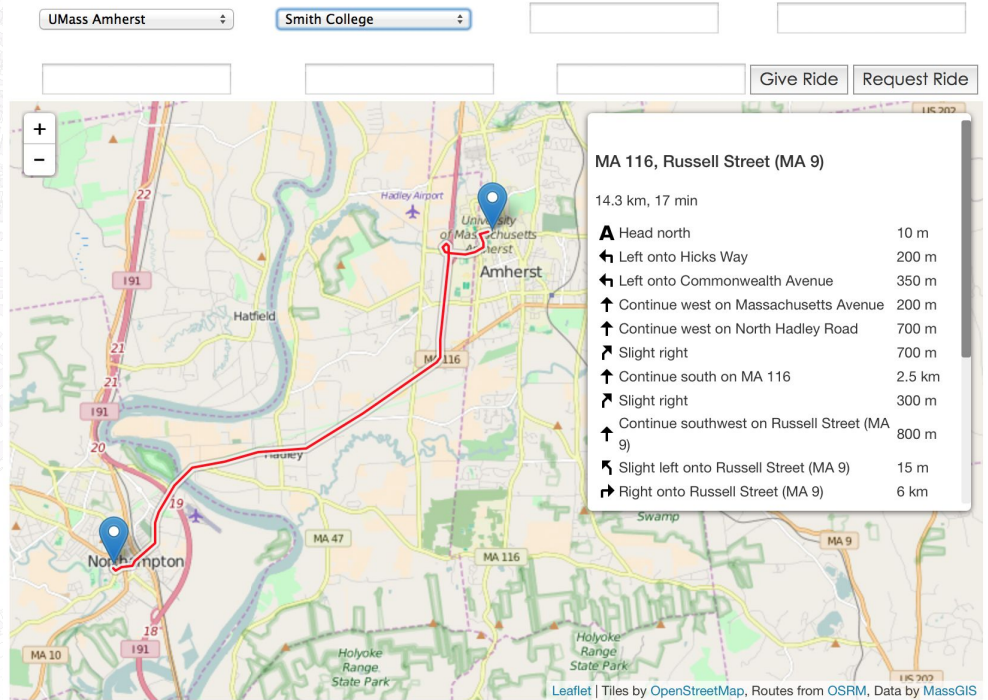
- provided a useful service for a community organization or one of the Five Colleges;
- were developed in consultation with their representatives.
- For this first run of the course, we focused on “safe” projects, i.e. our campuses or very familiar groups



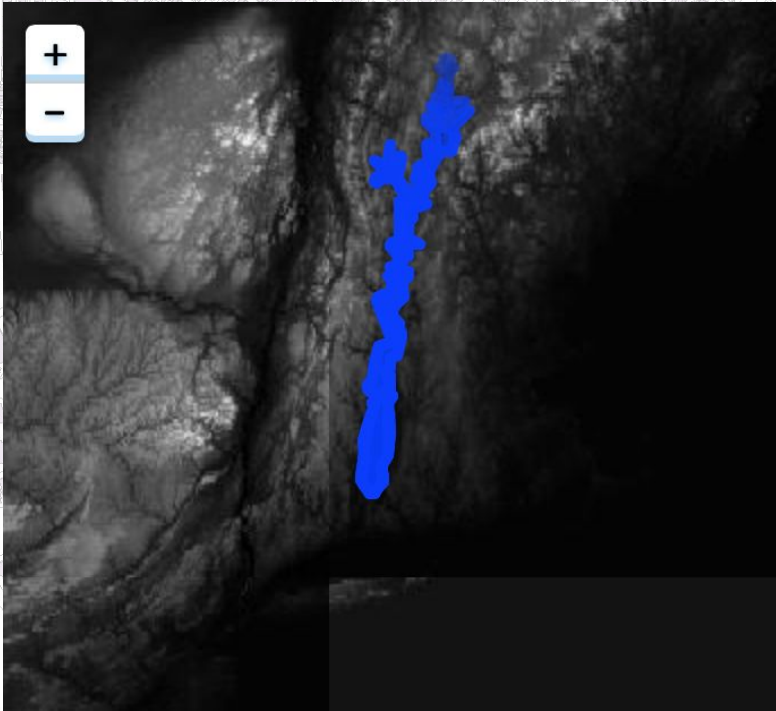
Project: 5CollegeRide

Goal: help fellow students looking for a ride or willing to offer someone else a ride.

- used Leaflet routing engine;
- eventually an account system.



Project: Glacial Lake Hitchcock



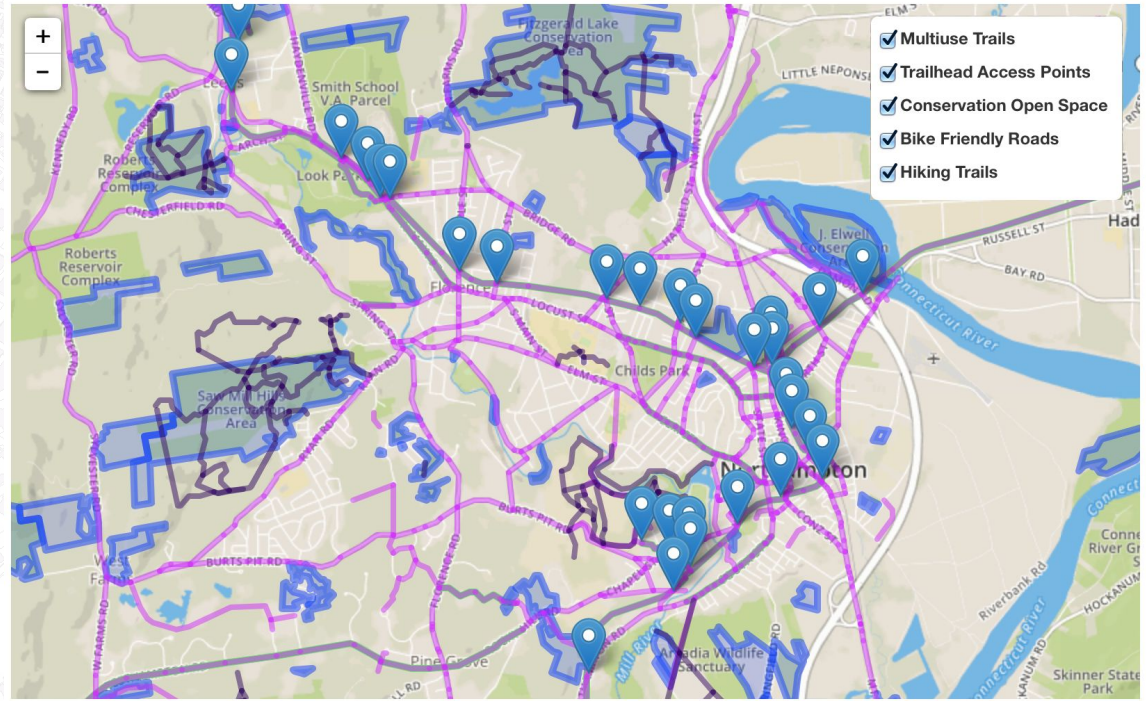
Goal: provide an animated presentation of this prehistoric lake's retreat, 16 Ky – 12 Ky BCE.

- extensive research into current knowledge of extent and locations of dams
- eventually a time slider, perhaps a 3D model

Project: Northampton Trails

Goal: provide an interactive map for the [Friends of Northampton Trails and Greenways](#).

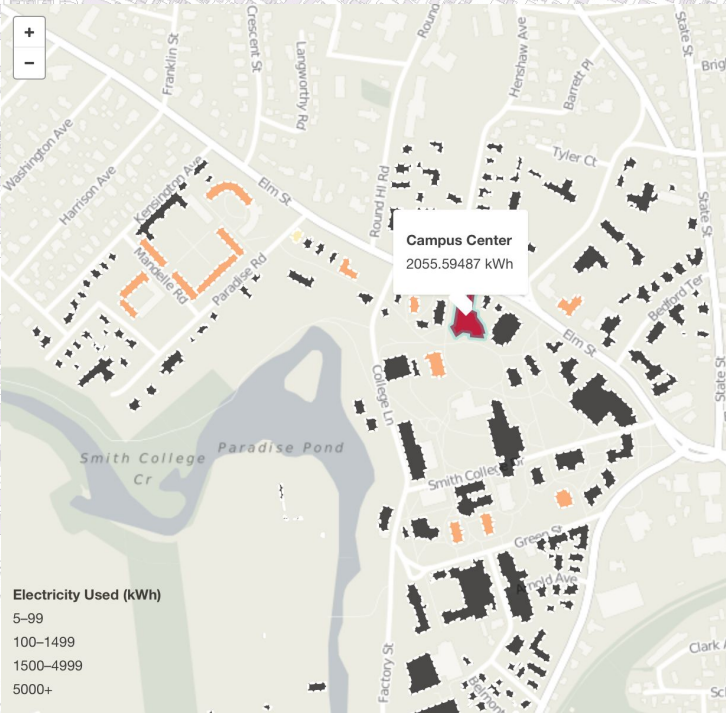
- eventually routing, mileage, elevation



Project: Smith College Dashboard

Goal: monitor campus usage of water, gas, and electricity.

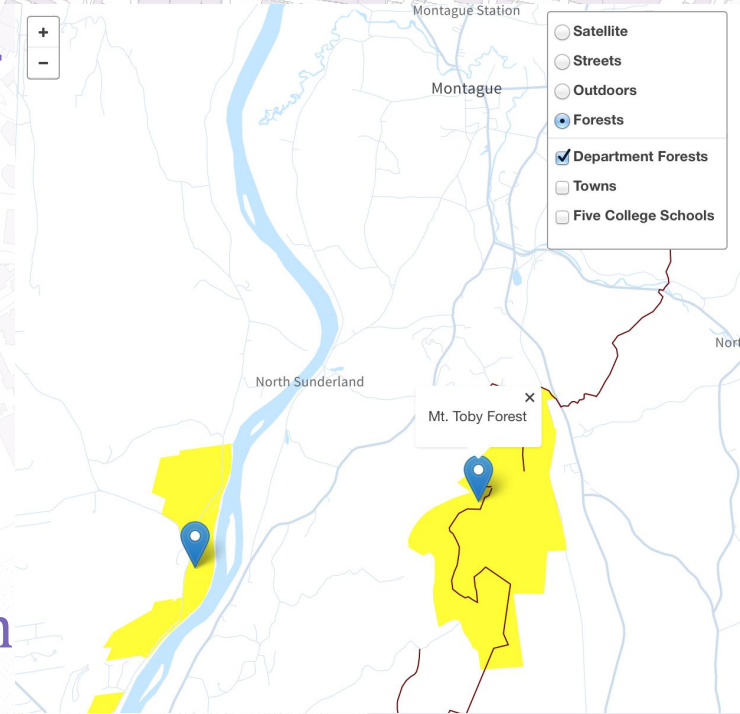
- pulled data from existing monitoring system, *Building OS*
- colored buildings by usage
- eventually real-time data and display temporal patterns



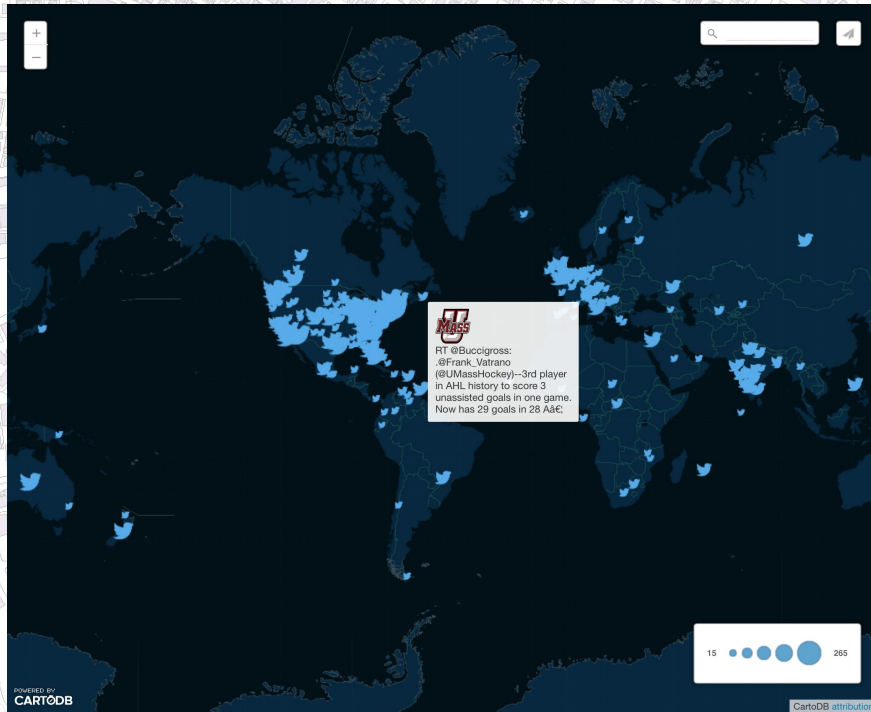
Project: UMass ECo Forests

Goal: provide an interactive map of the forest properties maintained by UMass Department of Environmental Conservation.

- used Mapbox API (an extension of Leaflet)
- eventually add account system to access “sensitive” information



Project: UMass Twitter Chatter



Goal: Track the on and off-campus Twitter pulse for UMass Facilities and Planning.

- Used the Cartodb platform and its Twitter interface
- Eventually expand the keyword search and control the time-frame

Project: Corporate Toxics Database

Goal: an interactive map displaying toxic air pollution facilities, for UMass' Political Economy Research Institute.

- *Nominatim* location search
- open-source database mapping framework
- eventually census info

Toxic Facilities About Charts Feature Extent Split View

Filter Data Export Data 2547 visible features Search

Action	Facility Name	Address	City	County	State	Hazard Score	ZIP Code	Metal	Carcinogen
Q E	O'CONNELL OIL NORTHAMPTON FACILITY	25 TEXAS RD	NORTHAMPTON	HAMPSHIRE	MA		10600000	NO	NO
Q E	COCA-COLA REFRESHMENTS	45 INDUSTRIAL DR	NORTHAMPTON	HAMPSHIRE	MA		1060	NO	NO
Q E	COCA-COLA REFRESHMENTS	45 INDUSTRIAL DR	NORTHAMPTON	HAMPSHIRE	MA		1060	NO	NO
Q E	SAINT GOBAIN CERAMIC MATERIALS	175 INDUSTRIAL DR	NORTHAMPTON	HAMPSHIRE	MA		1060	YES	NO
Q E	O'CONNELL OIL NORTHAMPTON	25 TEXAS RD	NORTHAMPTON	HAMPSHIRE	MA		10600000	NO	YES

Issues

- not all content was prepared in advance but JIT or delayed
- not all exercises and applications met our objectives
- some concepts didn't immediately connect to maps
- many students were overwhelmed with learning new languages and learning to program for the first time
- some students shouldered more of the work than others
- not all projects reached a completed state

Future Possibilities

Course materials will hopefully be enhanced with:

- animations and additional interactive features;
- videos of technical procedures;
- videos of instructors and guest speakers;
- build projects using git or Github for sharing and version control.

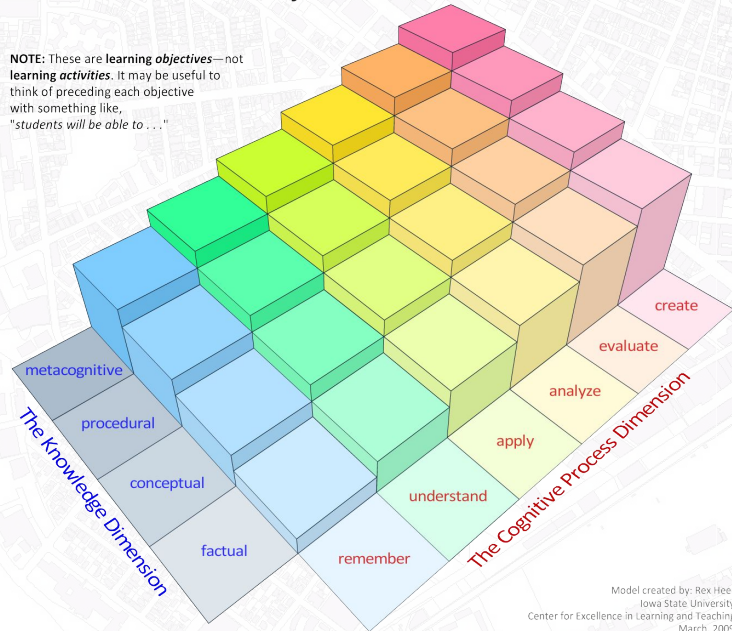
Acknowledgements

- Teagle Foundation (blended learning grantor)
- Five Colleges, Inc.: Luke Phelan, Nate Therien, Criss Guy
- UMass IT Enterprise Services: Andrew DeSiervo, Lars Marshall
- Sponsors and supporters:
 - Michael Ash, UMass PERI
 - Sasha Stepanov, UMass Facilities and Campus Planning
 - Julie Brigham Grette, UMass Geosciences
 - Tekla Harms, Amherst College Geology

Bloom's Taxonomy of Learning

Revised Bloom's Taxonomy

NOTE: These are **learning objectives**—not **learning activities**. It may be useful to think of preceding each objective with something like, "students will be able to . . ."



Many of these pedagogies aim to improve learning by reaching more of these cognitive objectives:

- remembering
- understanding
- applying
- analyzing
- evaluating
- creating

Model created by: Rex Heer
Iowa State University
Center for Excellence in Learning and Teaching
March, 2009

Open-Source Server: PostgreSQL



To make data available, students learned to use [PostgreSQL](#) + [PostGIS](#):

- a spatial database
- remote administration with [pgAdmin](#) + [QGIS](#)
- learned to write SQL

A screenshot of the pgAdmin III web interface. The 'Object browser' on the left shows a tree view with 'Server Groups' > 'Servers (1)' > 'localhost (localhost:5432)' > 'Databases (2)' > 'your_username' > 'postgres' selected. The 'Properties' tab is active, displaying a table of role properties. The 'SQL pane' at the bottom shows the SQL command to create the role. The status bar at the bottom indicates 'Retrieving details on login role postgres... Done.' and 'postgres on postgres@localhost:5432' with a response time of '25 msec'.

Property	Value
Name	postgres
OID	10
Account expires	
Can login?	Yes
Superuser?	Yes
Create databases?	Yes
Create roles?	Yes
Inherits?	Yes
Replication?	Yes
Connection Limit	-1
Comment	
Member of	

```
CREATE ROLE postgres LOGIN
  ENCRYPTED PASSWORD 'md51355640fa6a148ed18aec37733d529ef'
  SUPERUSER INHERIT CREATEDB CREATEROLE REPLICATION;
```

Open-Source Server: GeoServer



Students also worked with GeoServer:

- provides a REST interface for the Web

e.g. <http://geoserver/ows?service=WFS&typeName=massachusetts:towns&outputFormat=application%2Fjson>

- tiled basemap imagery via WMS
- feature data as GeoJSON via WFS

The screenshot shows the GeoServer web interface. At the top, there is a search bar with 'massachusetts' entered. Below it is a table titled 'Layer Preview' with columns: Type, Name, Title, Common Formats, and All Formats. The table lists four layers: 'massachusetts:towns', 'massachusetts:CampusBuildings2014', and 'massachusetts:MAJOR_ROADS'. A dropdown menu is open for the 'All Formats' column, showing a list of output formats including WMS, AtomPub, GIF, GeoRSS, GeoTIFF, GeoTIFF 8-bits, JPEG, KML (compressed), KML (network link), KML (plain), OpenLayers, PDF, PNG, PNG 8bit, SVG, TIFF, TIFF 8-bits, WFS, CSV, GML2, GML3.1, GML3.2, GeoJSON, GeoJSON(SONP), KML, and Shapefile.

Type	Name	Title	Common Formats	All Formats
■	massachusetts:towns	towns	OpenLayers KML GML	✓ Select one WMS
■	massachusetts:towns	towns	OpenLayers KML GML	AtomPub GIF GeoRSS GeoTIFF GeoTIFF 8-bits
■	massachusetts:CampusBuildings2014	CampusBuildings2014	OpenLayers KML GML	JPEG KML (compressed) KML (network link) KML (plain) OpenLayers PDF PNG PNG 8bit SVG TIFF TIFF 8-bits
■	massachusetts:MAJOR_ROADS	major_roads	OpenLayers KML GML	WFS CSV GML2 GML3.1 GML3.2 GeoJSON GeoJSON(SONP) KML Shapefile

Open-Source Server: Node.js



A lightweight and efficient web server: [Node.js](#)

- [Express.js](#) framework
- JavaScript can be used:
 - to process forms
 - interact with Postgres
 - apply templates

```
var express = require('express');
var path = require('path');
var favicon = require('serve-favicon');
var logger = require('morgan');
var cookieParser = require('cookie-parser');
var bodyParser = require('body-parser');

var routes = require('./routes/index');
var users = require('./routes/users');

var app = express();

app.set('views', path.join(__dirname, 'views'));
app.set('view engine', 'ejs');

app.use(logger('dev'));
app.use(bodyParser.json());
app.use(bodyParser.urlencoded({ extended: false }));
app.use(cookieParser());
app.use(express.static(path.join(__dirname, 'public')));
```

World-Wide Web Libraries



Web development is greatly enhanced by the use of libraries that hide cross-browser complexities:

- [jQuery.js](#) to facilitate document object management and server interaction `$('#map').click(function)`
- [Bootstrap.js](#) to build “responsive” Web pages that work well on mobile devices
- [Leaflet.js](#) to build Web maps