Assessing Embedded GI ST
Student Learning Outcomes

Geographic Information Science and Technology (GI ST)

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Presentation Outline

- Why Assess GI ST?
- Study Objectives
- Structured Interviews
- Assessment Instrumentation
- Preliminary Findings
Why Assess GIS/T?

- 1981 - Duane Marble advocates for a Conceptual Model for Education in geosciences

- 1988 - NCGIA GIS Core Curriculum
  - 1995 - NCGIA GI Science Core Curriculum
  - 2001 - IAEGS Model Curriculum

- 1998 - Fisher and Toepfer survey Fisheries programs

- 2002 - Hess and Cheshire describe integration efforts at NCSU
  - Employer demand for “some experience” using the tools
Why Assess GIS/ST?

- 2004 - The Society of American Foresters (SAF) requires “spatial analysis” as a program accreditation standard.
- 2004 - Dodds and Meitner suggest that questions surrounding GIS/ST integration change from should we include it to are we doing enough.
- 2005 - US Department of Labor statistics show demand for skilled GIS/ST practitioners increasing.
- 2006 - UCGIS GIS&T: Body of Knowledge.
- 2007 - Wing and Sessions describe GIS/ST integration in the Forestry program at Oregon State University.
Study Objectives

Objective 1: Develop a flexible framework for assessing GI ST instruction embedded across the Forest Management and Natural Resources curricula.

Objective 2: Develop an ongoing and sustainable GI ST assessment plan that can accommodate the unique needs of forestry and natural resources students and faculty.

Objective 3: Test the assessment approach and instrumentation.
Objective One - framing and scoping

- Identify the type and purpose of the assessment
- Identify stakeholders
- **Identify GI ST objectives** (structured interviews)
- Identify possible data sources and assessment methods (direct/indirect, qualitative/quantitative)
- Establish common assessment language
Common Language for Assessment

- **Assessment** is a form of research that allows for the systematic evaluation of the extent to which a program is meeting its objectives and outcomes.

- **Objectives** are general statements of what students should know or be able to do and what the program or course will do to ensure students know and are able to do it.

- **Outcomes** are observable or measurable evidence that characterize the desired changes in students due to an educational experience.

- Assessment **Criteria** represent the key elements of success by which standards for determining whether an objective was met are developed (Worthen, Sanders, and Fitzpatrick 1997).

- Outcome **Indicators** provide the specific evidence demonstrating the degree to which assessment criteria are met (Patton 1997).
Objective One - framing and scoping

Structured Interviews (example questions)

- What are your geospatial objectives
- Why have you chosen to incorporate GIST in your course/program
- What do you want students to be able to do
- How do you want their thinking to change
- What are your criteria for success
- What types of indicators would provide evidence of success
Structured Interviews

Why do you include geospatial material in your course/program? (example responses)

- Students need to be comfortable working with maps
- It is necessary to make and read maps
- They are going to use it in life after school
- It’s the way they are going to work in the real world
- Our land managers need to be trained in the current technology
- Geospatial technologies allow better and faster management
Structured Interviews

How many geospatial activities do you incorporate? (example responses)

- One lecture and one lab
- A primer lecture and two to three formal labs
- It’s different every semester
- They work with maps and photos all the time

- FOM - twelve to fourteen
- NR - eight to eleven
Interview Outcomes

- Task related skills (example responses)
  - Can make a map
  - Can read a map
  - Delineate areas and select key features
  - Proficient with overlays and geoprocessing
  - Can generate a sample
  - Navigate and collect data
  - Transfer, correct, and convert datafiles
Interview Outcomes

- **Information literacy** (example responses)
  - Identify information sources on own
  - Can download their own data
  - Recognize what data they need

- **Conceptual awareness** (example responses)
  - Knows how the tools are linked
  - Awareness of tools and how they are used
  - Plan, design, analyze and communicate findings
  - Link GPS to GIS to field work and reporting
  - Understand the uses and limits of GPS, GIS, and air photo
  - Understand interactions among features on the landscape
Interview Outcomes

Metacognitive knowledge (example response)

- When stuck, students know enough to help themselves or ask the appropriate questions

Affective Domain (example responses)

- Willingness to adopt the use of the technologies (domain level 5, Characterization by Value)
- Have a basic awareness and actually consider using the tools (domain levels 1 & 3, Accepting and Valuing)
Interview Outcomes

Assessment Criteria (example responses)
- many restated objectives
- If there are X number of GIST instructional opportunities, students should satisfactorily complete Y
- Seamless integration of tools into regular business

Outcome Indicators (example responses)
- many restated objectives
- Projects and reports include maps and analysis where appropriate
- You know it when you see it
Interview Outcomes

Performance Standards (example responses)

- Boolean, they can do it or not
- These are basic skills so 100%
- Maybe 80% would be realistic
- A minimum percentage, maybe 80%
- What I really want to know is if they consider using it after they are gone
Figure 1: Classification of GIST Educational Objectives

<table>
<thead>
<tr>
<th>The Knowledge Dimension</th>
<th>Remember</th>
<th>Understand</th>
<th>Apply</th>
<th>Analyze</th>
<th>Evaluate</th>
<th>Create</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual Knowledge</td>
<td>Recognizing&lt;br&gt;Recalling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conceptual Knowledge</td>
<td>Interpreting&lt;br&gt;Explaining</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedural Knowledge</td>
<td></td>
<td>Executing&lt;br&gt;Implement</td>
<td></td>
<td></td>
<td>Differentiate&lt;br&gt;Organizing</td>
<td></td>
</tr>
<tr>
<td>Meta-Cognitive Knowledge</td>
<td>Recognizing&lt;br&gt;Recalling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Study Objective Two

- Assessment planning and instrumentation
  - Develop observable or measurable student learning outcomes for each objective
  - Identify when and how the learning event occurs
  - Prepare Instructional materials
  - Prepare assessment instruments
  - Facilitate the assessment
Planning and instrumentation

- Embedded Assessments
  - Tracking Questions
  - In-class Exercises
  - Capstone Courses and Group Projects

- Direct Assessments
  - Pre-Post Intervention Questionnaire
  - Prior-Graduation Knowledge Survey
### Figure 2: Assessment Implementation Plan

<table>
<thead>
<tr>
<th>Course</th>
<th>Semester</th>
<th>Instructional Opportunities</th>
<th>Rubric for Specific Exercises</th>
<th>Tracking (test) Questions</th>
<th>Pre-Post Intervention Questionnaire</th>
<th>Rubrics for Group and Capstone Projects</th>
<th>Prior-Graduation Knowledge Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR100</td>
<td>Fall</td>
<td>one lecture, one formal lab</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>FOR172</td>
<td>Fall</td>
<td>one lecture, one formal lab</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOR273</td>
<td>Summer</td>
<td>two lectures, three formal labs</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>NR300</td>
<td>Spring</td>
<td>on demand mini-lectures, three formal labs</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>FW311</td>
<td>Summer</td>
<td>one lecture, one formal lab</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NR400</td>
<td>Spring</td>
<td>2008 = 1 lab, 2009 = 0 labs, 2010 = 2 labs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>FOR406</td>
<td>Fall</td>
<td>on demand mini-lectures, 4 to 5 labs</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>FOR406</td>
<td>Spring</td>
<td>on demand mini-lectures, two formal labs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>ET460</td>
<td>Spring</td>
<td>on demand mini-lectures, two formal labs</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>NR484</td>
<td>Fall</td>
<td>one proposed mini-lecture and lab</td>
<td></td>
<td></td>
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<td></td>
<td>x</td>
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</tbody>
</table>
Study Objective Three
Testing the assessment approach

Tracking Questions

- List two ways GPS can be used to aid in the design and implementation of an environmental assessment.

- Describe the three main categories of spatial technologies and give an example of their use in an environmental problem.
Figure 4: Tracking Question Response Form

<table>
<thead>
<tr>
<th>Assessment Findings:</th>
<th>% of Class with Satisfactory Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall 2009</td>
</tr>
<tr>
<td><strong>Student Artifact</strong></td>
<td></td>
</tr>
<tr>
<td>Tests</td>
<td></td>
</tr>
<tr>
<td>Question A</td>
<td>___ %</td>
</tr>
<tr>
<td>Question B</td>
<td>___ %</td>
</tr>
<tr>
<td>Question i</td>
<td>___ %</td>
</tr>
<tr>
<td>Observation</td>
<td></td>
</tr>
<tr>
<td>Observation A</td>
<td>___ %</td>
</tr>
<tr>
<td>Observation B</td>
<td>___ %</td>
</tr>
<tr>
<td>Observation i</td>
<td>___ %</td>
</tr>
<tr>
<td>Projects and Reports</td>
<td></td>
</tr>
<tr>
<td>Criteria A</td>
<td>___ %</td>
</tr>
<tr>
<td>Criteria B</td>
<td>___ %</td>
</tr>
<tr>
<td>Criteria i</td>
<td>___ %</td>
</tr>
</tbody>
</table>
In-class Exercises

“A positive for the interpolated method is that it combines the data from the other points to fill open areas. A negative is that if you do not have many points in the stand you are relying on points from other stands to fill in the gaps.

A positive for the stand average method is that it clumps the data from the stand to one number and makes it easy for management. A negative is that some points in the stand could be completely different but it averages the data and warps it like those soil erosion hot spots.”
### In-class Exercises

#### Figure 3: Spatial Analysis Lab Rubric

<table>
<thead>
<tr>
<th>Student Performance Assessment</th>
<th>Weak 0 points</th>
<th>Satisfactory 1 point</th>
<th>Very good 3 points</th>
<th>Excellent 4 points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surface interpolation</strong></td>
<td>response does not indicate that all sample points are considered in analysis regardless of point’s merit</td>
<td>response does indicate an understanding of how sample points are being used</td>
<td>tradeoffs are addressed by example using data ex. discussion of “continuous” elevation data</td>
<td>argues that landscape features provide ecosystem services that are dynamic and often follow a continuous data model ie. no hard boundary</td>
</tr>
<tr>
<td><strong>Averaging by stand</strong></td>
<td>response does not indicate that all sample points outside stand are excluded from analysis regardless of point’s merit</td>
<td>response does indicate an understanding of how sample points are being used</td>
<td>tradeoffs are addressed by example using data ex. discussion of “discrete” GPS positions</td>
<td>argues that discrete management units are necessary in order to implement recommendations so boundaries must be delineated somewhere</td>
</tr>
<tr>
<td><strong>Overall feature symbolization and cartographic representation</strong></td>
<td>poor color selection; data not classified in a thoughtful way; missing map elements; improper legend names</td>
<td>data classified thoughtfully; no missing map elements; no improper names in the legend</td>
<td>pattern and color selections mimic characteristics of the features they represent; map is well organized</td>
<td>transparency used to depict spatial interaction among features; a truly ‘polished’ map</td>
</tr>
<tr>
<td><strong>Indented use and audience appropriateness of maps</strong></td>
<td>map is not appropriate for intended use ex. unusable scale on field map; the audience is not actively targeted ex. use of jargon on maps intended for laypersons</td>
<td>map is appropriate for intended use; audience is actively targeted; purpose of map is not readily apparent</td>
<td>purpose of map is somewhat apparent; map requires some explanation by author</td>
<td>purpose of map is apparent; map requires no explanation by author</td>
</tr>
</tbody>
</table>
Capstone Courses and Group Projects

- Rubrics for capstone courses and group projects

Examples

1. The NLCD change layer was masked to the region to show the land cover in only the study area

2. To generate the sample, we placed stream data into ArcGIS, and used Hawth’s tools to randomly create a series of points
Capstone Courses and Group Projects

Example 1

2001 Developed and Forested Land Cover

- Red is Developed land
- Green is Forested land

Example 2

Main and Centennial Campus Points Location Map

- Streets
- Streams
- Sample Points

0 15 30 Kilometers
Pre-Post Intervention Questionnaire

Example Questions:

1. Have you ever taken PRT462 (NCSU’s introductory GIS course)? ___ Yes ___ No

2. List three different types of vector data:
   ___________ , ___________ , and ___________

3. In your own words, give an example of how the Buffer tool and Clip tool can be used in succession to perform a spatial analysis task
Pre-Post Intervention Questionnaire

Table 1: Cross tabulation of Time 1 * Time 2 responses to Buffer-Clip Analysis Question

<table>
<thead>
<tr>
<th>T1_Q9</th>
<th>T2_Q9</th>
<th>Count</th>
<th>0</th>
<th>1</th>
<th>Total</th>
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<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td>4</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>% within Time 1</td>
<td>33.3%</td>
<td>66.7%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>0</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>% within Time 1</td>
<td>.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td></td>
<td>4</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>% within Time 1</td>
<td>16.7%</td>
<td>83.3%</td>
<td>100.0%</td>
<td></td>
</tr>
</tbody>
</table>

Note: N=24, chi-square=4.8, $X^2=3.84$ at .05, p=.028, df=1
Prior-Graduation Knowledge Survey

Example Questions:

1. Do you know what a geographic information system (GIS) is?

2. Do you know what aerial photography or satellite imagery are?

3. During your time at NCSU, how frequently have you used aerial photography or satellite imagery in each of the following contexts?

Example Response Scale:

(a) Never  (b) 1-2 times  (c) 3-4 times  (d) 5-6 times  (e) More than 6 times
Table 2: Cross tabulation of Time 1 * Time 2 responses
Do you know what a geographic information system (GIS) is?

<table>
<thead>
<tr>
<th>T1_Q1</th>
<th>T2_Q1</th>
<th>Count</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>% within Time 1</td>
<td></td>
<td>14.3%</td>
<td>14.3%</td>
<td>71.4%</td>
<td>.0%</td>
<td></td>
<td>100.0%</td>
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<tr>
<td>2</td>
<td></td>
<td></td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>% within Time 1</td>
<td></td>
<td>.0%</td>
<td>31.3%</td>
<td>62.5%</td>
<td>6.3%</td>
<td></td>
<td>100.0%</td>
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<tr>
<td>3</td>
<td></td>
<td></td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>% within Time 1</td>
<td></td>
<td>.0%</td>
<td>22.2%</td>
<td>55.6%</td>
<td>22.2%</td>
<td></td>
<td>100.0%</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>% within Time 1</td>
<td></td>
<td>.0%</td>
<td>12.5%</td>
<td>50.0%</td>
<td>37.5%</td>
<td></td>
<td>100.0%</td>
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<td>1</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>% within Time 1</td>
<td></td>
<td>16.7%</td>
<td>.0%</td>
<td>66.7%</td>
<td>16.7%</td>
<td></td>
<td>100.0%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>2</td>
<td>9</td>
<td>28</td>
<td>7</td>
<td>46</td>
</tr>
<tr>
<td>% within Time 1</td>
<td></td>
<td>4.3%</td>
<td>19.6%</td>
<td>60.9%</td>
<td>15.2%</td>
<td></td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Note: N=46, chi-square=12.93, $X^2=21.02$ at .05, $p=.374$, df=12
Findings

- We hope to have a better idea of how well we are meeting our GIST objectives
- We hope to discover better assessment methods
- We hope to discover better teaching practices
- We hope to provide assessment leadership
Questions

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