Example 2

Research has demonstrated that spatial understanding is a separate category of mental ability (Ishikawa and Kastens 2005), and that a significant proportion of students struggle with spatial tasks, including reading maps and visualizing topographic landscapes. This fact has impacted student performance in our undergraduate Physical Geography labs and prevented many students from learning and succeeding at UNLV and beyond. With this in mind, I collaborated with another faculty in securing funding to support our development of an innovative augmented reality sandbox. Visualizing the topographic lines in full color on top of a sand surface gives students the ability to mentally connect form with representation, while engaging their interests. I have now implemented the sandbox tool into all sections of our undergraduate GEOG 104 labs, with promising results. I presented our sandbox project at the Annual Meetings of the American Association of Geographers (AAG) in San Francisco, California. The following is the presentation, covering the theoretical background, description of its construction, outline of the customized lab that was implemented, illustrations of the sandbox in action, and a summary of student experiences. The presentation was well received and I will continue to monitor the success of this lab tool.
An Augmented Reality Sandbox Approach to Teaching Topographic Maps

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Spatial Instructional Challenge

- Mapping is a basic element of geographic and spatial data comprehension, communication and analysis.

- However, a basic understanding of the representation of locational (2D) and 3D space on maps poses a challenge for many.

- Topographic map instruction in introductory geoscience labs is a basic but "indispensable tool" of geoscience and yet a challenge for many students (Rapp et al 2007).
Topographic Principles: Online GEOG 104 Labs

- Complete isoline and topographic map instruction
  - TopoMap1 [10pts] – “Connecting the dots” isolines
  - TopoMap2 [10pts] – Interpolation
  - Quad ExA [6pts] – Reading the margin
  - Quad ExB [4pts] – Reading a topographic map
  - TopoProf Assignment [10pts] – Vertical profile
  - TopoProf Ex [2pts] – Vertical exaggeration

- Provides quantitative perspective on student performance on wider lab experience
  - 10 semesters and 1072 students in total (summers 25-44 students, Spring/Fall 115-172)
  - Only those who participated in exercises were counted
  - Summer 2012 to Fall 2015 (missing Fall 2013)
Topographic Principles: Online GEOG 104 Labs

Online Lab Student Performance on Combined Topography Modules

Online Lab Student Performance by Exercise

Falloff in grades with interpolation

Falloff in grades on reading maps

Online Lab Student Performance by Exercise

Poor final performance on profiles
Spatial Instructional Challenge

- Research has demonstrated that spatial ability is a separate category of mental ability (Ishikawa and Kastens 2005)
  - Distinct from verbal ability and does not simply tract other student inclinations
  - Large individual differences in performance exist, challenging simply identification of those who will likely struggle the most
  - Significant proportion of students are likely to struggle with spatial tasks, including reading maps and visualizing topographic maps
  - Performance may not improve in measurable ways using traditional instructional techniques, even with repetition

Spatial Instructional Challenge

- Representational correspondence
  - Ability to find locations on a map
- Configurational correspondence
  - Ability to identify relationships among objects on a map and the real world
- Directional Correspondence
  - Ability to align a map with directionality in the real world
Landstorm

Overhead Shot of Sandbox

Computer Screen Map View

Landstorm
## BYO Sandbox

<table>
<thead>
<tr>
<th>Component</th>
<th>Purpose</th>
<th>Device</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>Processing and simulation</td>
<td>Alienware 17 ANW17-2136SLV</td>
<td>$1300</td>
</tr>
<tr>
<td>• Intel Core i5, 2 GB memory, 20 GB HD</td>
<td>• NVIDIA GeForce GTX 970M</td>
<td>• Laptop for mobility</td>
<td></td>
</tr>
<tr>
<td>• Linux Mint with Mate (17.2)</td>
<td>• Core i7, 8 GB memory, NVIDIA GeForce GTX 970M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microsoft Kinect 3D camera</td>
<td>Active depth mapping of sand's surface, providing inputs for software</td>
<td>Xbox 360 Kinect 1414</td>
<td>$40 (used)</td>
</tr>
<tr>
<td>• 1st generation support only</td>
<td>• Kinect for Xbox 360 1414 and Kinect for Windows 1473</td>
<td></td>
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<tr>
<td>Projector</td>
<td>Display of the colored contour lines across the sand's surface</td>
<td>BenQ MX620ST</td>
<td>$490</td>
</tr>
<tr>
<td>• Short throw length and 4:3 aspect ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandbox</td>
<td>Accessible sand surface</td>
<td>Baltic birch (40.30)</td>
<td>$300</td>
</tr>
<tr>
<td>• 4:3 aspect ratio</td>
<td></td>
<td>Channel construction Casters</td>
<td></td>
</tr>
</tbody>
</table>

http://dlx.unlv.edu/~obregon/ResDev/SAByoBox/Instructions.html
Laboratory Use

- Hybridized lab
  - Landstorm as principle instructional device
    - Contour Lines, rules/guidelines, reading topographic maps, perspective, and profiles
  - Christopherson (2015) lab manual as a secondary instructional aid providing
    - Pre-lab referential materials
    - Reading of the map margin information
  - Spring 2016 term was deployed in 7 labs of 19-24 students
    - Students split into 2 groups based on hybridized lab structure, switching partway through lab
Landstorm-Assisted Lab

5 • Page 4
- Construction of a vertical profile along transect with elevation display
- Calculation of exaggeration

5 • Page 5
- Comparison of graphed vertical profile to surface profile recorded from sandbox
- Plexiglass and washable overhead marker used
- Requires students to ID transect location
- Allows for final evaluation of sandbox model of landscape
- Prompts consideration of scale
Spatial Instructional Challenge

- Representational correspondence
  - Locating a profile transect on the sandbox display
- Configurational correspondence
  - Recreating a landscape using an illustration, requiring students to imagine from various points
- Directional Correspondence
  - Making it engaging and employing 3D representation is known to assist with spatial instruction and learning (Rapp et al 2007)

What was the most difficult part of using the augmented reality?

"...stopping playing with the sandbox."

"Nothing was difficult."

"I thought it was fun."

"It was easy to use."

"Nothing. We enjoyed the exercise."

"Every student...showed enthusiasm...This made teaching the lab a much better experience for me. I enjoyed answering their questions and watching them enjoy geography."
References