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.

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An Augmented Reality Sandbox Approach to Teaching Topographic Maps

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Dr. Michael Nicholl

UNLV Geoscience Department

UNLV University of Nevada, Las Vegas

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)

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	Isolines	Interpolation	Contour Lines	Rules/ Guidelines	Reading Topo Map	Map Margin	Perspective	Profiles
Miller, D. Jr., and A. Mercer. 2014. Physical Geography: Laboratory Manual. New York: Oxford Univer. Press.	X				X			
Paragraph-length introduction to isarithmic mapping, isolines and contour lines. Student read values from isohyet map.								
Porter, J., and S. O'Connell. 2014. Encounter Physical Geography: Interactive Explorations of Earth Using Google Earth. San Francisco: Pearson.	X				X		X	
One sentence descriptive definition of isolines and contour lines/interval. Steepness identified from topographic display with use of transparency and tilt to provide additional visual perspective to topography.								
Hess, D. 2014. Physical Geography Laboratory Manual: For McKnight's Physical Geography A Landscape Appreciation. San Francisco: Pearson.	X	X	X	X	X	X	X	X
Very complete coverage of contour lines and topographic maps comprising exercises 6-9. Free-hand interpolation-based drawing of contour lines, 13 rules of contour lines and construction of profiles with vertical exaggeration.								
School of Geographical Sciences. 2009. Introduction to Physical Geography: Laboratory Manual. Ridder, E., and A. Fernandez eds. Plymouth, MI: Hayden-McNeil Publishing.	X	X	X	X	X	X	X	X
Very complete coverage of contour lines and topographic maps comprising a few sections of Laboratory 2 Essentials of Geography: Tools. Guidelines for contour lines is presented and reinforced in 3-step series of drawing exercises. Map library exercise included.								
Christopherson, T., and R. Christopherson. 2015. Applied Physical Geography: Geosystems in the Laboratory. San Francisco: Pearson.	X	X	X	X	X	X	X	X
Very complete coverage of contour lines and topographic maps comprising Lab Exercise 23. Projections for contour maps covered along with basic rules for drawing contour lines. Stereoscopic contour maps are shown to connect the lines with 3D surfaces.								

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Topographic Principles: Online GEOG 104 Labs

- Complete isoline and topographic map instruction
  - TopoMap1 [10pts] – "Connecting the dots" isolines
  - TopoMap2 [10pts] – Interpolation
  - Quadr ExA [6pts] – Reading the margin
  - Quadr ExB [4pts] – Reading a topographic map
    - BM, steepness, scale changes, slope, streamflow
  - 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)

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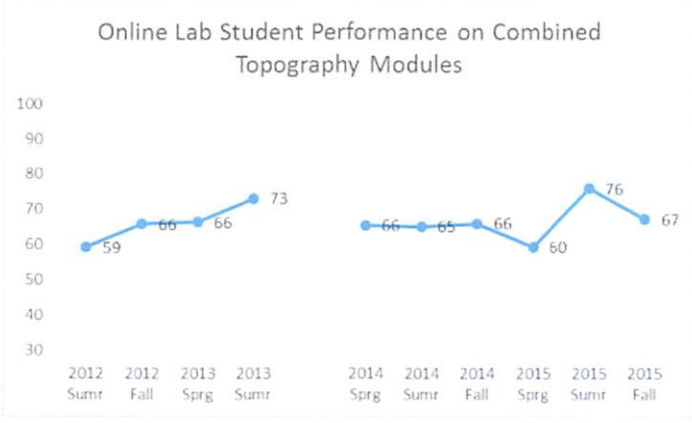
Topographic Principles: Online GEOG 104 Labs



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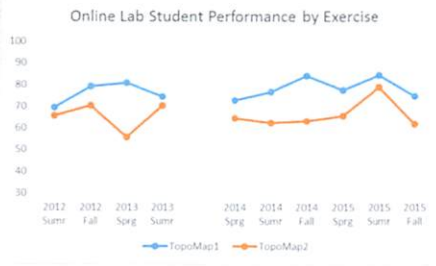
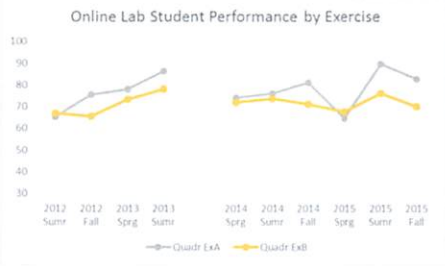
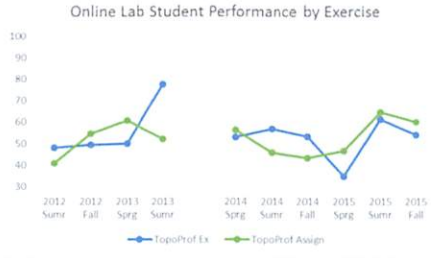


Falloff in grades with interpolation



Falloff in grades on reading maps



Poor final performance on profiles

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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

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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

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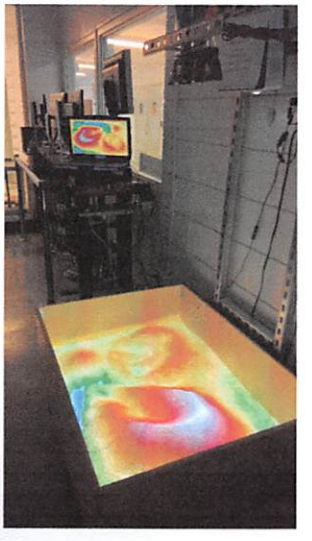
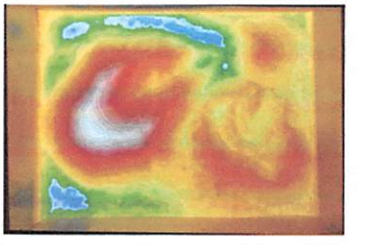
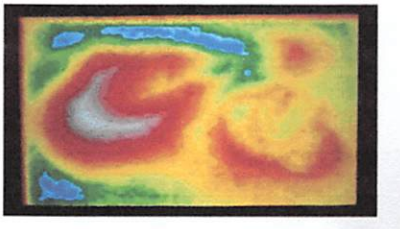
Landstorm



Overhead Shot of Sandbox



Computer Screen Map View



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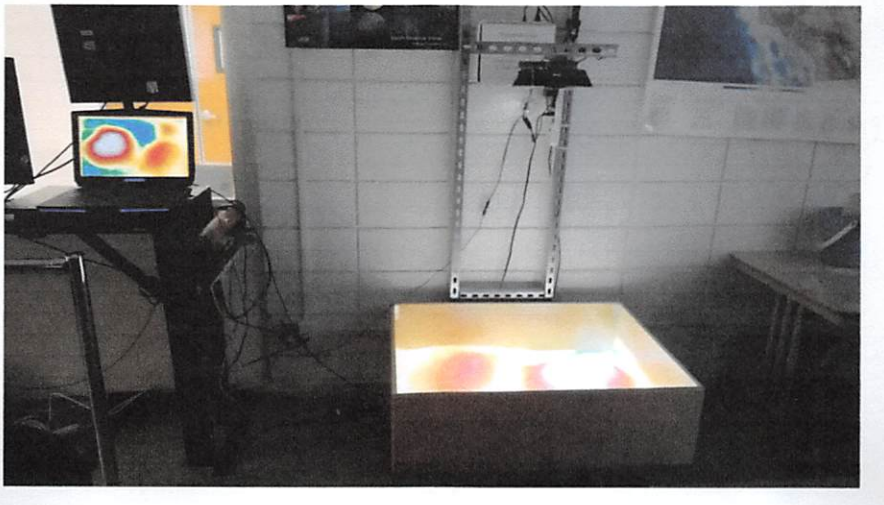
Landstorm



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BYO Sandbox

Component	Purpose	Device	Cost
Computer • Intel Core i5, 2 GB memory, 20 GB HD • NVIDIA GeForce GTX 970M • Linux Mint wit Mate (17.2)	Processing and simulation	Alienware 17 ANW17-2136SLV • Laptop for mobility • Core i7, 8 GB memory, NVIDIA GeForce GTX 970M	~$1300
Microsoft Kinect 3D camera • 1st generation support only • Kinect for Xbox 360 1414 and Kinect for Windows 1473	Active depth mapping of sand's surface, providing inputs for software	Xbox 360 Kinect 1414	~$40 (used)
Projector • Short throw length and 4:3 aspect ratio	Display of the colored contour lines across the sand's surface	BenQ MX620ST	~$490
Sandbox • 4:3 aspect ratio	Accessible sand surface	Baltic birch (40x30) Channel construction Casters	~$300

http://jdav.ucdavis.edu/~okreylos/ResDev/SARndbox/Instructions.html

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BYO Sandbox

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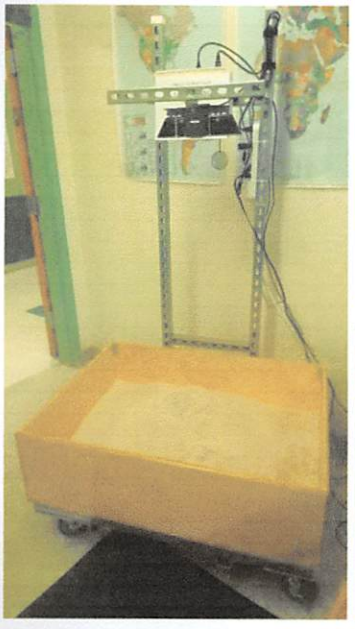

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Laboratory Use

- 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

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Landstorm-Assisted Lab

Now use the piece of plexiglass provided to check your profile using the augmented reality sandbox. Carefully identify approximately the same line of transect and forcefully insert the plexiglass while trying not to disturb the sand. Once inserted, use an overhead marker to trace the contact with the surface of the sand. Remove the plexiglass and compare it to your previous vertical profile.

Describe how similar the profiles appear and any differences that you notice.

5

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

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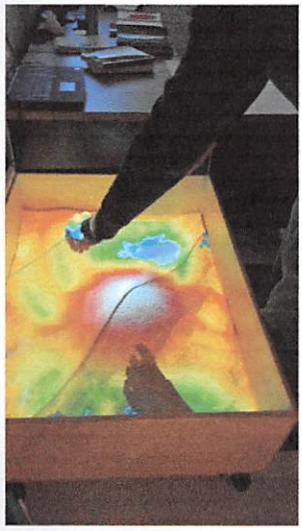

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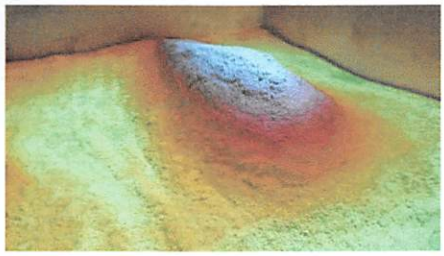
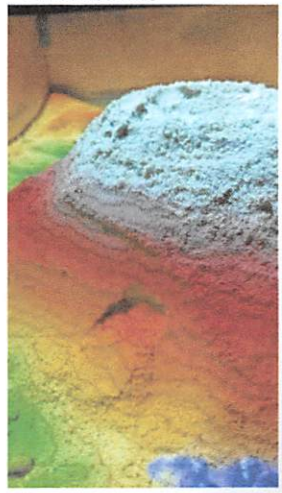
Landforms Challenges

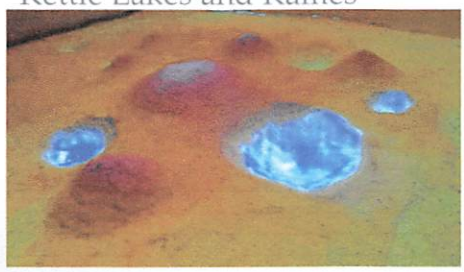


Drumlin

Landslide



Kettle Lakes and Kames



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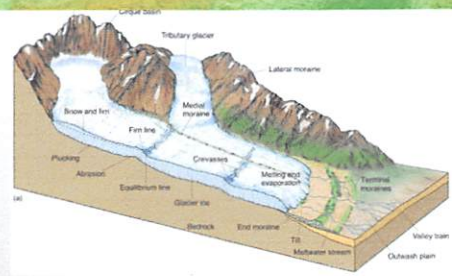
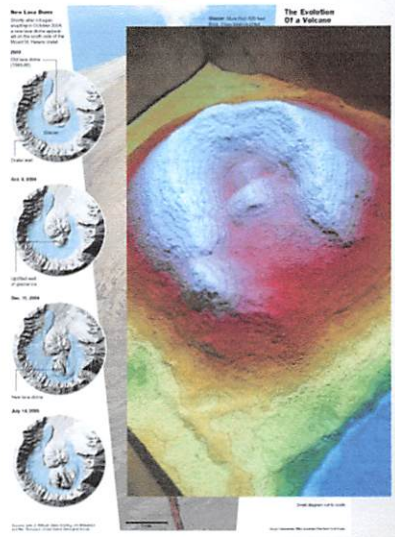
Landform Challenges





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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)

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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."

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