The Augmented Reality (AR) Sandbox

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What is an Augmented Reality Sandbox?

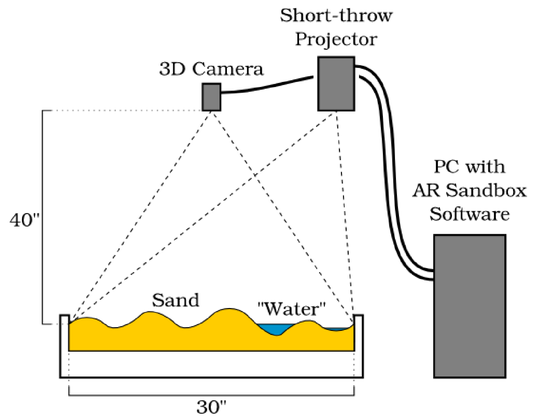
- **Augmented Reality (AR)** is the overlay of computer generated imagery on top of real world information.
- AR is used in many domains, and is used very often in televised sports.
- The AR Sandbox uses this same idea to simultaneously detect the height of the sand, and then to colorize it and draw contour lines via the projector.
- **It draws a topographic map on the sand in real time as you move it!**

How does an AR Sandbox work?

The AR Sandbox consists of four main parts; the sandbox, the projector, a Microsoft Kinect, and a computer. The box is an 8" deep, 40" x 30" box that has 3 walls made of transparent acrylic for better visibility of the sand. The sand is special type of play sand ("Sandtastik") that is colored white so that the image projected onto the sand is easily seen.

The projector is an ultra short throw projector with an aspect ratio of 4:3. The ultra short throw of the projector means it can project a relatively large image compared to the distance to the projected surface. The height of the sand is detected using a Microsoft Kinect. The computer processes the data received from the Kinect to produce topographic maps in real time!

The AR Sandbox is an open source project developed by Oliver Kreylos at the University of California Davis Keck Center for Active Visualization in the Earth Sciences (KeckCAVES).



Schematic diagram of the AR Sandbox by O. Kreylos

This project was sponsored by the NIU Student Engagement Fund. The AR Sandbox box and projector arm were constructed by LA&S Science Technical Support Services.

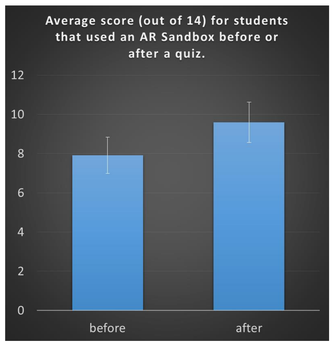
Classroom Pilot Activity

Activity

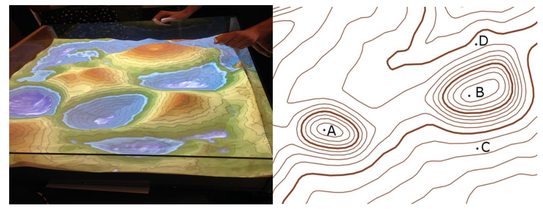
- 21 students in two sections of Introduction to Geology Laboratory.
- After a lab session on topographic maps:
- In small groups, students participated in an **open play session** with the AR Sandbox for up to 15 minutes.
- During that time they could make observations and relate what they saw to the lab.
- Half interacted with the AR Sandbox after taking a quiz, half took the quiz after playing with the AR Sandbox

Results

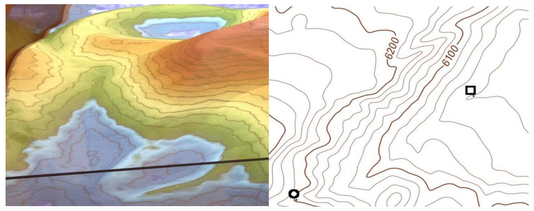
- No statistically significant difference between before and after groups, $t(19) = 1.23$, $p = 0.24$
- Open play was not structured to lead students into making predictions and strong connections.
- Our results suggest that having a **structured activity** may benefit students' understanding of topographic maps more than open play.



Features That Students Observed



Closed circles represent hills in topographic maps



Rivers make "V" shapes that point upstream

Next Steps

- Analyze data in collaboration with researchers at North Carolina State University and Eastern Michigan University that are also testing AR Sandbox designs and activities.
- Develop more classroom activities to test the efficacy of predicting topographic map features using AR versus static models

Teaching Applications

- **Topographic Map Instruction**, where students can see how changes in the terrain affect how the map is drawn.
- **Hydrology**, where students can observe how water interacts with the terrain.
- **Geomorphology**, where students can practice creating the landforms they are studying.
- **Geovisualization**, where students can see how creative visualizations can improve learning outcomes.

Research Applications

- **Geoscience Education Research** - What kind of activities with the AR Sandbox best promote learning, and why?
- **Geographic Information Science** – What modifications of the AR Sandbox platform can improve responsiveness and aid in the communication of 3D spatial information?
- **Computer Simulation** – How can the AR Sandbox be used in combination with Geographic Information Systems to allow the user more control over model inputs?