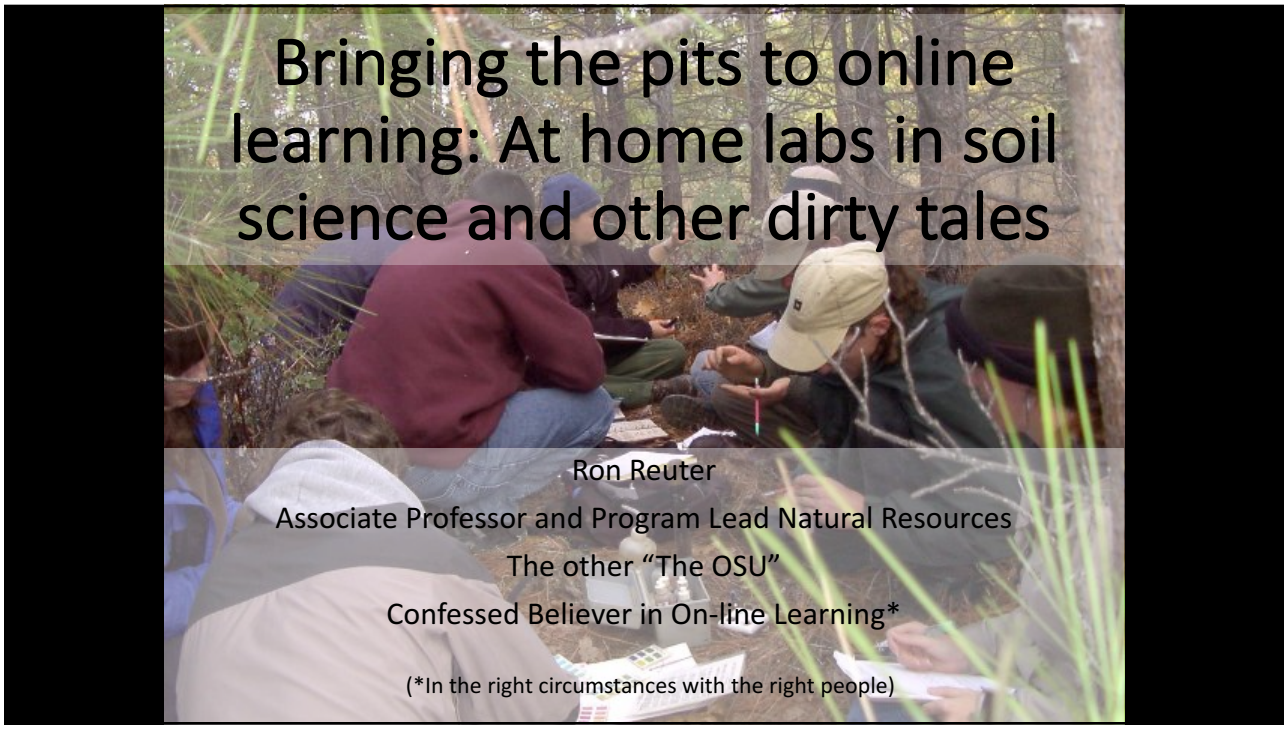


Bringing the pits to online learning: At home labs in soil science and other dirty tales

Goal: Present an informed perspective on the efficacy of hands-on, distance lab courses

- Objective 1: Provide evidence of authority to speak on the subject
- Objective 2: Define hands-on versus virtual distance labs
- Objective 3: Review of existing literature on hands-on labs
- Objective 4: Engage audience in demonstrations of effective home-based lab lessons

My Online Cred

- Hired in 2003 ½ time F2F, ½ time Ecampus
  - Teaching and advising for on-campus and distance Natural Resources students
- Developed Ecological Restoration, Wetland Ecology as online courses
- Developed Introductory Soils with lab for online delivery
  - Oregon State Ecampus (quarter system)
  - Riverside City College (semester system, lab-only course)

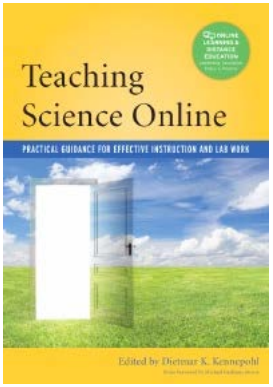
My Online Cred

- Online soil genesis lessons (NSF grant)

- Developed Wildland Soils course
- Developed Current Issues in NR: Costa Rica (online hybrid with international travel)

My Online Cred

- Reuter, R.J. 2016. Online Delivery of Field and Laboratory-based Earth Sciences Curriculum. In D. Kennepohl (ed) *Teaching Science Online: practical guidance for effective instruction and lab work*. Stylus Publishing, Sterling, Virginia.



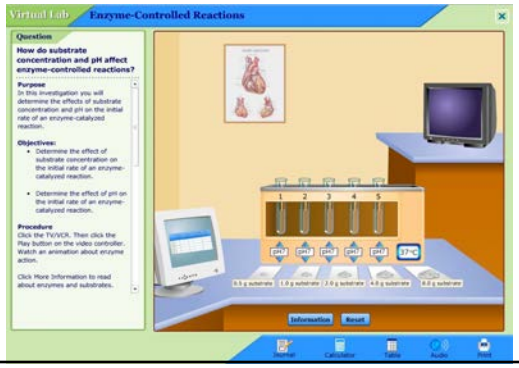
My Online Cred

- Mamo M., J. Ippolitto, T. Kettler, R. Reuter, D. McCallister, P. Morner, D. Husmann, and E. Blankenship. 2011. Learning Gains and Response to Digital Lessons on Soil Genesis and Development. Journal of Geoscience Education. 59(4): 194-204
- Reuter, R.J. 2009. Online versus in the classroom: student success in a hands-on lab class. Amer. J. Distance Ed. 23(3):151-162 (*invited manuscript*)
- Reuter, R.J. 2007. Introductory soils online – an effective way to get online students in the field. J. Nat. Resour. Life Sci. Educ. 36:139-146.
- Reuter, R.J. 2005. Learning Ecological Restoration at a Distance (Oregon). Ecological Restoration 23:290.

Evaluation of Hands-on and Virtual Lab Courses

Hands-on vs Virtual

- Hands-on requires manual manipulation of materials to perform the experiment
- Virtual uses simulated or remote manipulation of equipment via a computer



Learning outcome achievement in non-traditional (virtual and remote) versus traditional (hands-on) laboratories: A review of the empirical research

James R. Brinson

Bayh College of Education, Indiana State University, Terre Haute, IN, 47809, USA

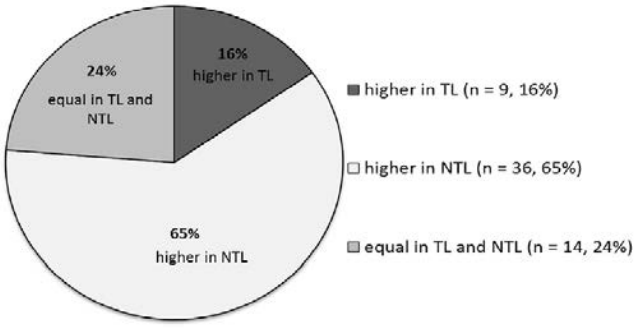


Fig. 1. Frequency of studies supporting higher (or equal) outcome achievement in NTL vs. TL.

Are Virtual Labs as Effective as Hands-on Labs for Undergraduate Physics? A Comparative Study at Two Major Universities

Marjorie Darrah · Roxann Humbert · Jeanne Finstein · Marllin Simon · John Hopkins

and email them directly to the teacher. The main goal of this research was to show that this type of virtual lab could produce the same learning outcomes as a traditional hands-on lab experience. This research was conducted with 224 students from two large universities. The analyses of the data at both universities show no evidence that one of the treatments (virtual or hands-on) was more effective than the other in conveying the concepts of the labs to the students. There was no significant difference noted in any of the tests, except to say there were significant learning gains for all groups from the Pre-FCME

My hands-on home soils lab vs traditional

- Traditional: Conducted at Central Oregon Community College
  - Mix of COCC students and OSU-Cascades students
- Hands-on: conducted through OSU-Ecampus
  - All OSU students

We'll talk about the labs in a bit

Table 2. Results of the Online and On-Campus Comparison. Values Represent the Means for Each Class or for the Combined Means for the Two Terms

	Year 1		Year 2		Overall	
Comparison Item	Online	On-Campus	Online	On-Campus	Online	On-Campus
Course grade	81.2%	83.1%	87.2%	85.7%	85.0%	84.4%
Preassessment grade	11.9%	37.4%**	37.9%	37.1%	27.1%	37.3%
Postassessment grade	65.4%	57.5%	70.1%	57.4%*	68.1%	57.5%**
Pre- to postassessment improvement	53%	20%**	33%	21%**	42%	21%**
Corrections pre- to postassessment	14.7	7.8**	11.1	7.6**	12.6	7.8**
Correct to wrong pre- to postassessment	0.8	2.6**	2.3	2.8	1.7	2.7*
Essay scores (out of 10)	8.3	8.1	8.8	8.5	8.6	8.3
Hand texturing (out of 6)	4.5	4.7	4.6	4.4	4.5	4.5

*Significantly different at the .01 level.
**Significantly different at the .001 level.

Conclusions from study

- Online students showed higher improvement rates
- Online labs provide real hands-on experience and comprehension
- With careful and thoughtful planning, it is possible give online students meaningful lab and field experience

- What about the type of student?

Table 1. Demographic Survey Results for the Soils Course, Including Total Course Completion Numbers

	Year 1		Year 2		Overall	
Demographic	Online	On-Campus	Online	On-Campus	Online	On-Campus
n (total tested)	20	25	27	25	47	50
Female	55%	24%	67%	40%	61%	32%
Male	45%	76%	33%	60%	39%	68%
Survey respondents	13	14	28	23	41	37*
Average age	37	25	32	26	34	25*
Previous online class	92%	14%	96%	35%	94%	25%
Previous soils course	38%	7%	21%	9%	23%	8%
Soil topics covered before	77%	71%	68%	52%	62%	44%
Self or family in NR	38%	43%	43%	48%	36%	34%

*Significantly different at the .001 level.

The alternative to success: not being intentional about who you are teaching to online

- USDA Higher Education Challenge Grant: develop 15-week soils lab for Riverside Community College
  - Lecture course offered same term by different instructor, co-enrollment not required for either course

- OSU

Term	Number Enrolled	Completed	Male	Female	Completed Course Male	Completed Course Female
Spr2005	28	24	15	13	13	11
Spr2006	28	28	9	19	9	19
Spr2007	24	21	11	13	9	12
Spr2008	25	22	10	15	10	12
Total	**105**	**95 (91%)**	**45 (43%)**	**60 (57%)**	**41 (91%)**	**54 (90%)**

- Riverside

Term	Number Enrolled	Completed	Male	Female	Completed Course Male	Completed Course Female
Spr2010	41	12	16	25	4	8
Fall2010	43	10	22	21	6	4
Spr2011	37	12	18	19	7	5
Fall2011	37	14	14	23	5	9
Total	**158**	**48 (30%)**	**70 (44%)**	**88 (56%)**	**22 (31%)**	**26 (30%)**

Who was the learner?

- OSU Ecampus CSS205 Soils: Sustainable Ecosystems
  - Majority are Environmental Science and Natural Resource majors.
  - Majority junior, senior, or super-senior status
  - Majority taking other online coursework
  - Paying in-state tuition levels ($248/cr at the time) 4 credits, quarter system)
- Riverside CC BIO15 Soil Science Management Laboratory
  - Majority of majors are NOT related to a natural resource major (e.g. nursing, general studies)
  - Majority working on AA degree
  - Many are first-time onliners (and not enrolled in the lecture)
  - Resident tuition is $36/cr (2 credits, semester system)

Who the online student is, matters!

- Successful students will be
  - In the major (on need the course for their Gen Ed)
  - Plan on doing multiple online courses, or the entire degree online
  - Able to work independently

Online Soils Labs

Topics
Landscape interpretation and mapping
Rocks and Minerals, Chemistry review
Soil formation
Soil fertility
Soil sampling/collection
Bulk density
Soil moisture
Soil color and pH
Soil texture
Soil survey
Soil profile descriptions

What is a Lab?

- A physical space
- A procedure your doctor orders
- An activity to convey a concept
  - Hands-on
  - Virtual

What is the intention of a Lab course?

- Provide a mechanism to enforce a key concept
- Experimental foundation for theoretical concepts
- Exposure to scientific apparatus
- Application of the scientific method
- Train students for laboratory jobs

Dr. Scott Geddes in the Chemistry lab

OSU Bacc Core Science Courses

- Science courses shall:

  Be at least four credits, **contain a laboratory**, and accessible to both lower and upper division students. Prerequisites or class-level restrictions for Perspectives courses must not create unreasonable barriers for students seeking to fulfill these categories;
- Emphasize **elements of critical thinking**;
- Focus on the **meaning of the fundamental concepts and theories** that broadly characterize basic (rather than applied) physical or biological science;
- **Illustrate, demonstrate, and analyze natural phenomena and systems**;
- Provide historical perspectives and context on the evolution of major theories and ideas;
- Demonstrate interrelationships or connections with other subject areas; and
- Examine the nature, value, and limitations of scientific methods and the interaction of science with society.

What is the intention of a Lab course?

What can you do at home?

- **Provide a mechanism to enforce a key concept**
- **Experimental foundation for theoretical concepts**
- *Exposure to scientific apparatus*
- **Application of the scientific method**
- Train students for laboratory jobs

What is the intention of a Lab course?

First Steps to taking course out of the lab and into the home

1. Define the learning objectives for the lab
2. Break down lab-based experiments into what pieces meet the learning objectives
3. Identify simple tasks that meet #2 and can be done in the kitchen

*Key is letting go of the idea than learning can only be done in a controlled lab environment

A lab experiment that doesn't need a lab

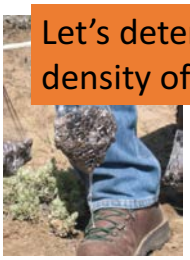
- Bulk Density
  - Bulk Density (Db) is the ratio of soil mass to volume the soil occupies
  - Critical for understanding compaction, pore space, water holding capacity, etc.
  - Influenced by particle type, organic matter content, land use
  - Formula:
    - $Db = \frac{Dry\ soil\ (g)}{Soil\ volume\ (cm^3)}$

Bulk Density Lab Learning Objectives and Goals

- Objective: Learn how to calculate bulk density; relate texture, pore space, mineralogy and land use to expected bulk densities; examine impacts of bulk density
  - *Goal 1: determine bulk density for soils using various calculations and methods*
  - *Goal 2: field sample various sites and determine approximate bulk density*
  - *Goal 3: interpret soil properties and impacts of bulk density given a combination of structure, texture, mineralogy, and land use*

Bulk Density Lab: traditional methods

- Soil Core
- Sand Cone
- Clod displacement



Let's determine the density of some rocks!

How would YOU create a home-based lab for this specific task?

$$Db = \frac{Dry\ soil\ (g)}{Soil\ volume\ (cm^3)}$$

Density Concept:

$$D = \frac{Mass}{Volume}$$ (in geology, specific gravity)

Rock/mineral	Mass (g)	Initial cylinder volume (mL)	Final cylinder volume (mL)	Density (g cm^{-3})
granite				
Orthoclase feldspar				
quartzite				
hematite				

Bulk Density Lab: Home Ideas

Goal 1: determine bulk density for soils using various calculations and methods
Goal 2: field sample various sites and determine approximate bulk density
Goal 3: interpret soil properties given a combination of structure, texture, mineralogy, and land use

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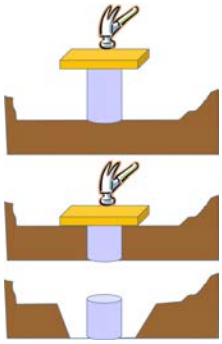
Bulk Density Lab: How to get the concept across

- Density concept: displacement with a rock
- Core sampling: tomato-paste can in softer soils
- Saran-sealed hole



Bulk Density Lab: set up to do other topics

- Soil moisture content (volumetric and gravimetric)
- Texture

Texture Lab: Traditional

Objective: Differentiate between the various fine earth fraction texture classes; determine soil limitations based on soil texture; learn the various soil structure types

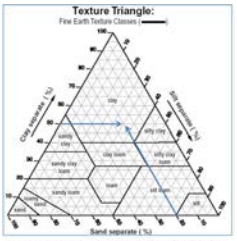
- *Goal 1: define the size classes of sand, silt, and clay; explain the unique properties of each particle type*
- *Goal 2: Use textural triangle to determine texture class and percentages of one type of soil particle given the others.*
- *Goal 3: Utilize a mechanical settling method to approximate soil particle size distribution; use hand texturing methods to determine appropriate soil particle size distribution.*

Texture Lab: traditional methods

- Hand texturing
- Hydrometer

- Key concepts: Stoke's Law

How would YOU create a home-based lab for this specific task?



From the United States Department of Agriculture

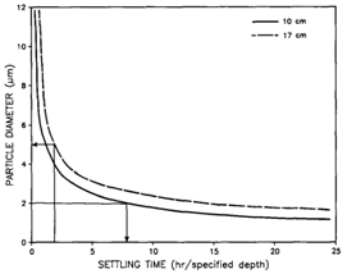


Fig. 2. Settling times for particles < 10 μm in diam. through depths of 10 cm (for pipette method) and 17 cm (typical for hydrometer method), calculated from Stokes' Law at 20°C and with ϱ_s = 2.65. Indicated points show 5 μm size cutoff after 2 h with hydrometer method and 2 μm size after 8 h using pipette method.

Texture Lab: Home Ideas

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Goal 1: define the size classes of sand, silt, and clay; explain the unique properties of each particle type
Goal 2: Use textural triangle to determine texture class and percentages of one type of soil particle given the others.
Goal 3: Utilize a mechanical settling method to approximate soil particle size distribution; use hand texturing methods to determine appropriate soil particle size distribution.

Texture La

Lab 6 – Cultivated land soil sample ribbon.

Lab 6 – Cultivated land soil sample ribbon pieces. All are less than one inch.

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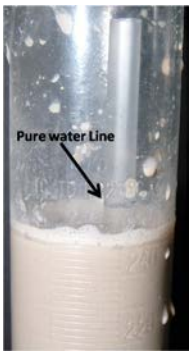


What's in the Lab Kit?

Lab Kit	Student	
clay	2-liter clear plastic soda bottle	Hammer or mallet
Graduated cylinder	8 oz. tin can, both ends removed	Home hydrometer (larg
Igneous rocks (2)	baking soda	Knife or scissors
pH strips	Block of wood	Legume seeds (peas)
Sand	Butter knife	Oven
Scale	Camera	Planting pots
Sponge	Collected soil	Rubbing alcohol (option
Thread	Computer	Shovel
	Dried collected soils (see lab 2)	Spoons
	Food coloring (blue is best)	Thread
	Glass cup	two bottle caps (like fro
	Glass jar or water glass	vinegar
	Google Earth (free download)	Water
	Google Maps (internet browser)	White paper
		Zipper baggies
	Hammer or mallet	Golf Tees (around 5)
	Measuring Tape (with centimeters preferred)	

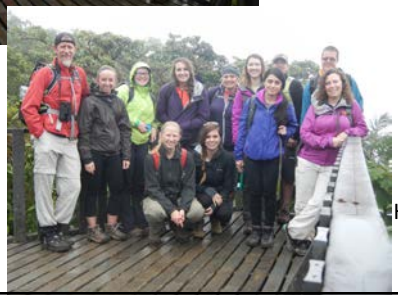
Advantages of Online Lab Courses (especially earth science ones)

- Students:
  - in a variety of locations
  - With different backgrounds and experiences, including returning adult students
  - Collaborate / commiserate more freely (often)
  - Do the entire lab (not possible to be a laboratory bystander)

The Final Say

- Final Lab report summarizes all lab work and lessons learned

Thanks and questions?



Hybrid Courses to Costa Rica