2019

Peer Review of Teaching Benchmark Portfolio for Soil 477/877: Great Plains Field Pedology

Judith Turk
University of Nebraska-Lincoln, jturk3@unl.edu

PEER REVIEW OF TEACHING BENCHMARK PORTFOLIO FOR SOIL 477/877: GREAT PLAINS FIELD PEDOLOGY

ABSTRACT

Pedology is a field that focuses on soil morphology, genesis, classification, and mapping. Students in pedology must learn to be keen observers, who are able to accurately evaluate the characteristics of the soil. This portfolio focuses on efforts to improve students' skills at describing soil color, texture, and morphologic features.

Judith Turk

Assistant Professor, School of Natural Resources, University of Nebraska-Lincoln

Table of Contents

Objectives of Peer Review Course Portfolio

The objective of this Peer Review Course Portfolio is to document and help develop the curriculum for SOIL 477/877: Great Plains Field Pedology. The portfolio was written in conjunction with the first time that I taught the course in Spring 2019. Though I received many positive reviews of the course from students who had taken it with the previous instructors, I still made many changes to curriculum. I made the decision to do so because I am more successful at teaching when I take steps to make a course "my own" rather than relying on materials from past instructors. Changes that I made included going paperless by using Canvas in the classroom and tablets in the field, introducing new active learning and peer instruction methods, developing new labs, and visiting a wider variety of field sites during the field trips. Though there are many pedagogical topics which I could have selected to explore in this portfolio, I decided to focus on strategies that I used to help students learn hands-on field skills, including evaluation of soil color, texture, and morphological features.

Description of the Course

Great Plains Field Pedology is a course that develops students' capacity to observe, analyze, interpret, and appreciate soil landscapes. Pedology is the study of soil morphology, genesis, classification, and mapping. Other branches of soil science study soils as a medium or plant growth, as a water purification system, as a building material, or any of the various roles that soils play in supporting life on earth. Pedologists study soils purely for being *soils*. To me, pedology is the heart of soil science. Great Plains Field Pedology is a hands-on course in which students use their visual and tactile senses to observe soils in the lab and in the field. Through this course students develop the *skills* required to observe and describe the soil and obtain the *knowledge* to classify soils and interpret their genetic history on the basis of observed morphology.

The course objectives are for student to: (1) understand the conceptual frameworks of soil genesis, (2) be able to describe a soil profile using standard methods and terminology, (3) gain familiarity with horizon nomenclature and diagnostic horizons, (4) be able to interpret the information conveyed through the taxonomic naming of soils, (5) be able to classify a soil to the family level on the basis of filed and lab data, (6) be familiar with the methods used in soil mapping, (7) recognize important players in the history of pedology, and (8) be able to read and understand the current scientific literature in pedology.

The course is an upper level elective in the Environmental Restoration Science major and a required course for the Soil Science Option of the Agronomy major. It is a 400/800 level course offered for advanced undergraduates, as well as graduate students. The only pre-requisite is Soil Resources, a 100-level course that fulfills that basic soil science requirement for a variety of majors.

The enrollment for Great Plains Field Pedology this semester was 17 students, including 1 post-graduate students with a Ph.D. in soil science, 2 graduate students, 11 seniors, 2 juniors, and 1 sophomore. The students were from a variety of majors including Environmental Restoration Science (5), Water Science (3), Integrated Science/Rawandan Agricultural Leaders (2), Biological Sciences (1), Natural Resource Sciences (1), Agronomy (1), Earth and Atmospheric Sciences (1), Environmental Studies (1), and Grassland Ecology and Management (1).

Teaching Methods

A wide variety of teaching methods were utilized, which are detailed in the syllabus (Appendix A). For the purpose of the course portfolio I will focus on the methods used to teach hands-on field skills. These include lab activities focused on soil color, soil texture, and soil morphology.

Soil Color

The standard method for evaluating soil color is by matching the soil to a chip in the Munsell soil color book. Typically, students learn this method by practice in the lab and in the field. I often notice that students quickly conclude that they are either “good” or “bad” at matching soil color, and rule out the possibility of improvement. I was curious if it was possible to teach soil color in a way that instills a growth mind-set. The innovative approach that I utilized to teach soil color was having students compare the colors that they determined using the Munsell book with chroma meter-measured colors. A chroma meter is an instrument that can measure soil color with a high degree of accuracy (Post, et al., 1993). I asked students to analyze their color results in relation to the chroma meter-measured colors in order to develop a visual color adjustment guide, consisting of a chart displaying the average position of their visually-evaluated color relative the chroma meter-measured color for each of four broad color groups (Fig. 1). After developing the guide, the students tested whether their color accuracy could be improved by correcting for known biases in their visual analysis of soils color.

Soil Texture

Accurate field estimation of soil texture is an important skill for pedologists. It is most often taught using a flow chart that walks the students through several steps of examining the soil mechanical behavior and feel (Thien, 1979). This method relies on two main tests: the ribbon test and gritty feel. In the ribbon test, the soil is worked up to a putty-like consistence and pushed between the thumb and forefinger to test how long of a ribbon it can produced. In the gritty feel test, the students must characterize the feel of the soil as “very gritty”, “very smooth”, or judge that neither characteristic predominates.

In past experience, I have found that this method often leads students to the incorrect textural class producing a great deal of confusion and frustration. I have developed a modification of this methodology that addresses some of the problems that I have identified. First, the Thien method separates texture classes along the clay axis of the texture triangle on the basis of specific ribbon lengths. Having noticed that students’ ribbon lengths often disagree with these cut-offs, I give students the opportunity to develop a calibration curve relating their ribbon length to clay percentage. Second, judgement of what constitutes “very gritty” or “very smooth” is highly subjective. I have therefore replaced this test with a method for measuring the approximate volume of sands in a sample (Fig. 2).

Soil Morphology

In addition to observing soil color and texture, pedologists must also be able to identify morphological features that provide clues about how the soil formed. These include structure, redoximorphic features, clay films, and carbonates. During the class on soil morphology, each group of students had a soil core on their table. During the class, I described each feature, showed photos and illustrations of how they form, and then asked the students to examine their core to identify and describe the feature (if present). Rather than having a long lecture, followed by a lab in which the students could easily get lost, the class was organized as series of short lectures, followed by hands-on activities where they applied concepts introduced in the preceding lecture segment.

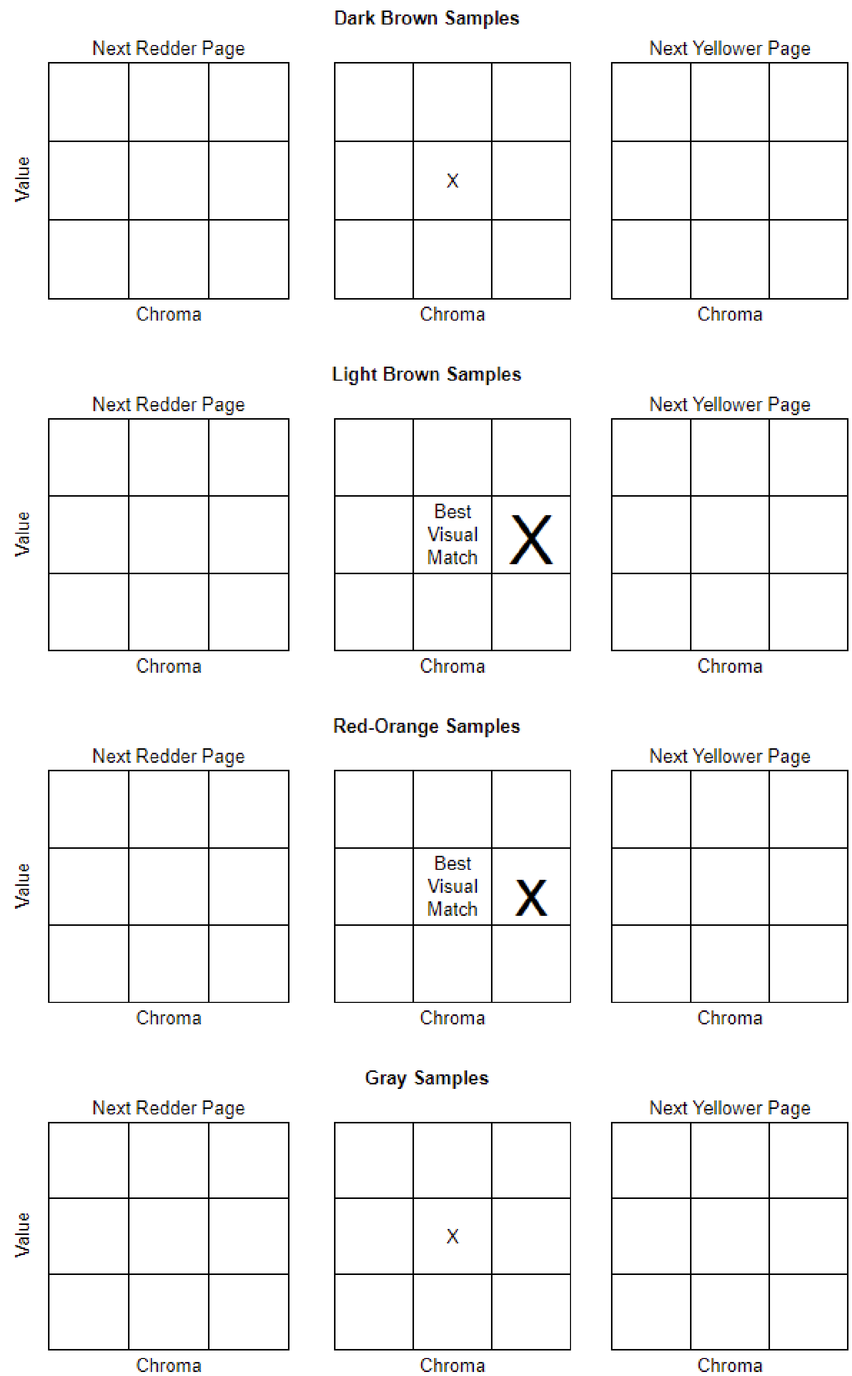

Fig. 1. Example visual adjustment guide for soil color. The "X" indicates the average position of the chroma meter color relative to the visual match made by the student with respect to the three attributes of color: hue, value, and chroma.

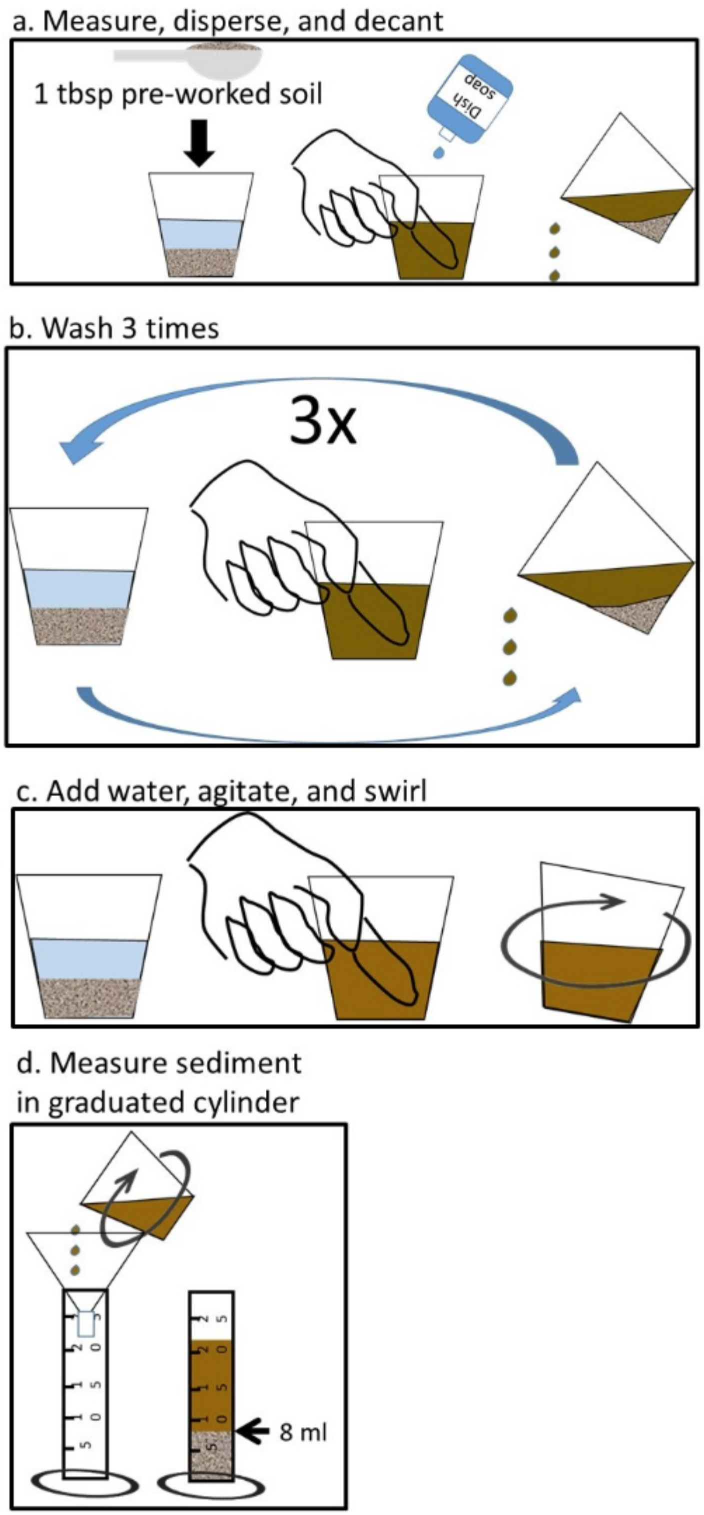

Fig. 2. Estimation of sand percentage by “sand washing”.

Analysis of Student Learning

In order to measure student improvement at evaluating soil color, texture, and morphological features throughout the semester, I gave a lab practical examination at the start and end of the class. In addition, I analyzed the outcome of individual lab activities, in order to determine areas for future improvement.

Soil Color

The soil color lab, was itself, an experiment on student learning. The hypothesis was that errors in visual assessment of soil color can be reduced by adjusting for known differences in individual perception of color. This hypothesis was tested by comparing the accuracy of colors evaluated, with and without applying corrections using the students' visual adjustment guides (Fig. 1). If the hypothesis were supported, the error would be expected to *decrease* when the students applied the correction. The results did not support the hypothesis. There was no statistical difference in error of hues determined with or without correction (P=0.42), there was statistically significant *increase* in error when students attempted to correct their value readings (P=0.04), and also an *increase* in the error for chroma when corrections were made (P=0.007) (Fig. 3). Possible reasons for the un-intended increase in error are mistakes in the direction of correction or mental exhaustion that occurred by the time the students got to the point of attempting the corrected readings. In addition to these quantitative results, I also sensed that the lab was fairly tedious and unpleasant for the students to perform.

However, upon examining the results for the lab practical, I did find that there was a significant improvement in the students' accuracy at evaluating soil color between the beginning and the end of the semester (Fig. 4). It is unclear if this improvement is a result of the soil color lab, or other instruction and practice that took place throughout the semester.

Though the results of the soil color lab itself suggested that the process of analyzing their visual color readings in relation to the chroma meter readings was not helpful, the lab practical scores do suggest that students improved in their ability to accurately describe soil color throughout the semester. So, perhaps though the development of a visual adjustment guide did not actually improve students' accuracy at evaluating color, the process of making the guide may have helped to instill the growth mindset.

Soil Texture

The lab practical score on the soil texture section did not improve significantly over the course of the semester (P=0.263) and remain well below the average accuracy of professionals (Fig. 5). Closer examination of the data reveals that there was a slight, though still statistically insignificant (P=0.166) decrease in student errors for estimation of clay percentage (Fig. 5) and there was even less change in the students' errors at estimating sand percentage (P=0.729) (Fig. 5).

It is clear from this data that there is much room for improvement in how I am teaching soil texture. For estimating clay percentages, I noticed that the ribbon test becomes less effective for students who form very long ribbons with their samples. Meanwhile, in the estimation of sands, some students have a difficult time adequately dispersing the sample and/or not losing sands during the washing step. Some modification of the methods that I am teaching, as well as more opportunities for practice are needed.

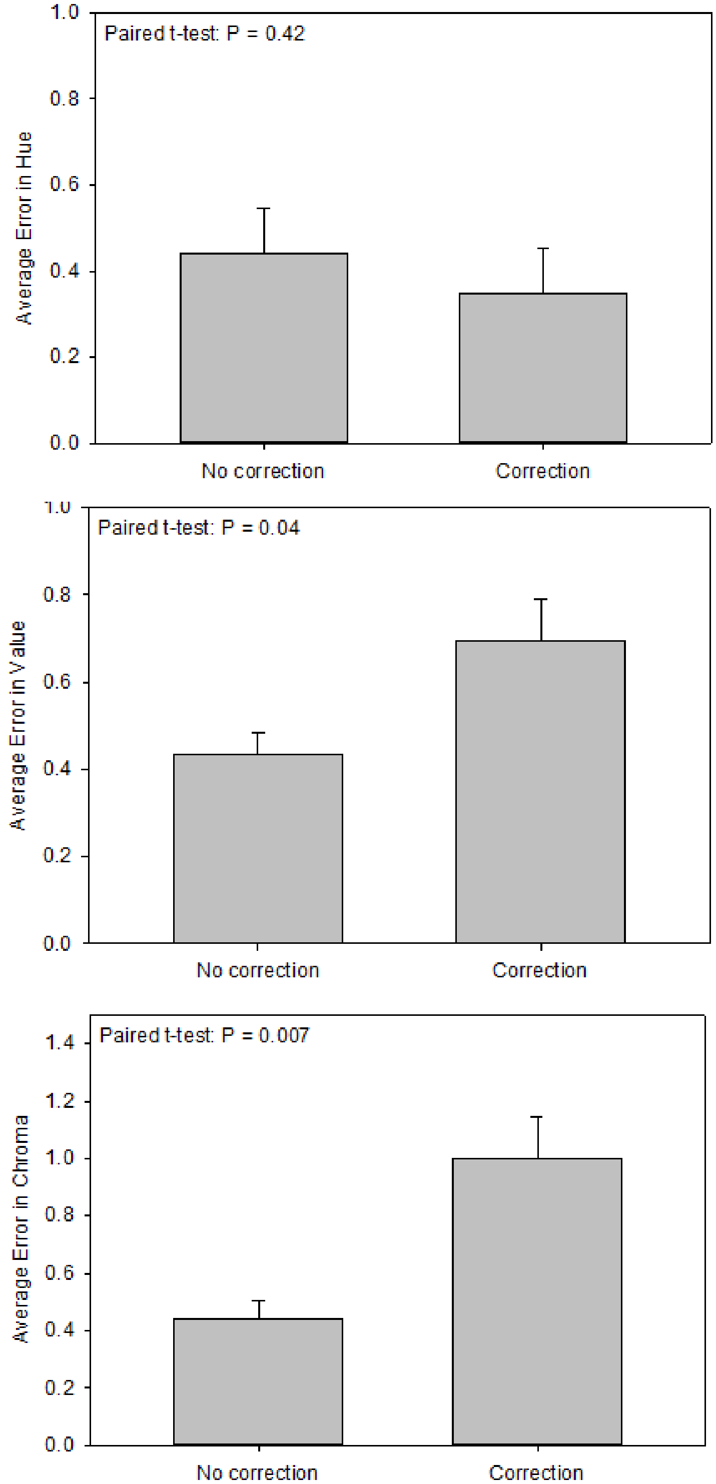

Fig. 3. Results of soil color lab, showing changes in student errors in hue, value, and chroma in response to corrections made using the visual color adjustment guide prepared by comparing their soil color readings to the chroma meter-determined colors.

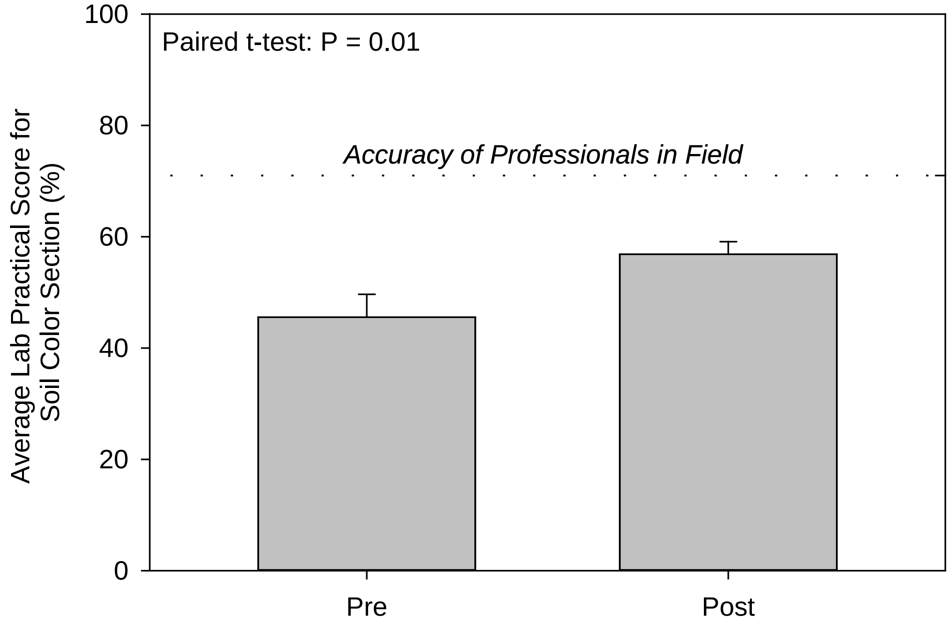

Fig. 4. Lab practical results for soil color collected at the beginning and end of the semester. Data on accuracy of professionals obtained from Post et al. (1993).

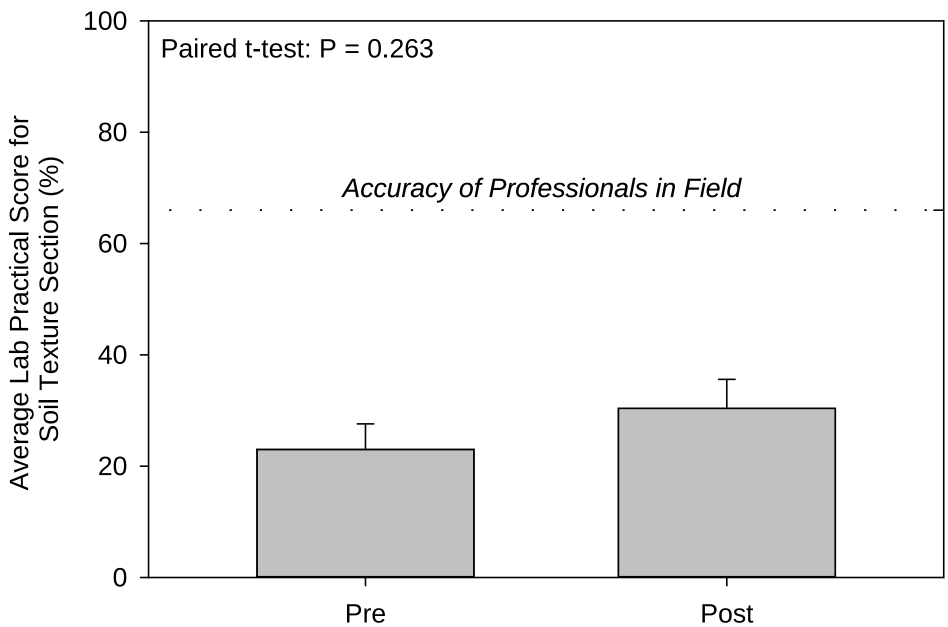

Fig. 5. Lab practical results for soil texture collected at the beginning and end of the semester. Data on accuracy of professionals obtained from Salley et al. (2018).

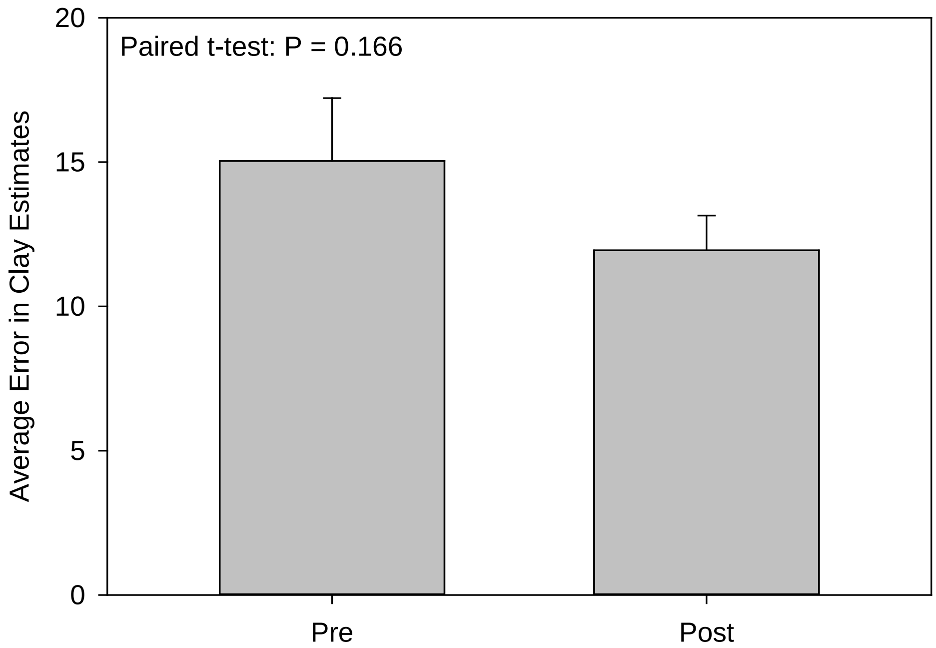

Fig. 6. Average errors in clay estimates on the lab practical given at the beginning and end of the semester.

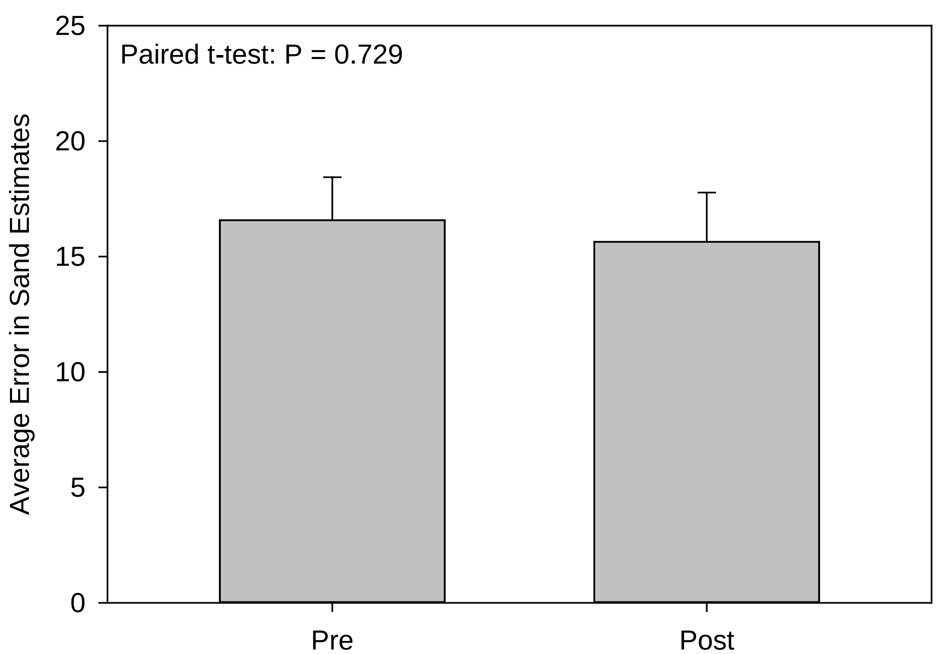

Fig. 7. Average errors in sand estimates on the lab practical given at the beginning and end of the semester.

Soil Morphology

The final section of the lab practical tested the students' ability to recognize morphological features displayed in hand-specimens (Fig.8). There was significant improvement in the students' scores in this section between the beginning and end of the course (Fig. 9). These results suggest that the methods that I used were effective at improving students' ability to recognize morphologic features of the soil. However, there is still room for improvement, considering that the average final score on this section was only 51%.

Fig. 7. Hand specimens used in the lab practical displaying: F1) manganese films, F2) redoximorphic concentrations and depletions, F3) granular structure, F4) vesicular pores, F5) carbonate nodules, F6) subangular blocky structure.

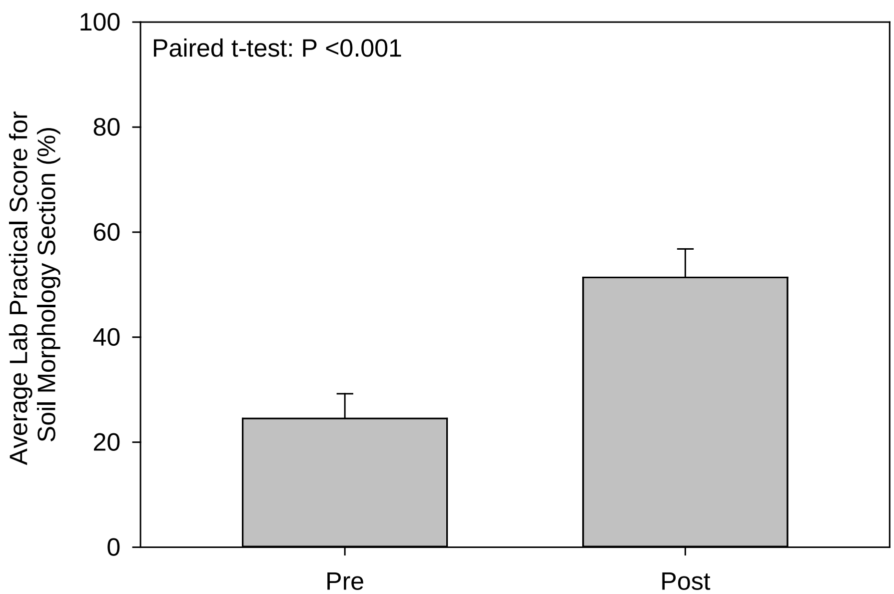

Fig. 9. Lab practical results for the soil morphology section collected at the beginning and end of the semester.

Planned Changes

Soil Color

Significant modifications to the soil color lab are needed to make it less tedious, and perhaps more effective at generating short-term improvements in the students' ability to evaluate color. Next year, instead of developing the visual adjustment guide (Fig. 1), I plan on having the students perform regression analysis relating their readings to those of the chroma meter. This method was described in a paper comparing professional soil scientists' color readings to those taken with a chroma meter (Post, et al., 1993). I believe this procedure has potential to make it easier for the students' to interpret their results. Furthermore, graduate students in the class could be assigned to read the article by Post et al. and expand the class exercise into a larger project resulting in a paper or presentation.

Soil Texture

Soil texture is where I see the most room for improvement. First, I plan to modify the methods that I present to the students. For evaluating clay, I have developed a modified procedure that places less emphasis on ribbon length (Table 1). For evaluating sand, I have developed a grid counting method that seems to offer a few advantages to the sand washing method that I used this year (Fig. 2). In the grid-counting method, a small pinch of sample is washed out over a grid and grid cells containing sand are counted (Fig. 10). The method is quicker to perform and uses less sample than sand washing. In both methods, students develop their own calibration curve relating the results of the test to lab-measured values of particle size fractions. This process allows more flexibility and accommodates variations in how individual students handle the samples as they perform the analysis.

The other modification that I plan to make is to give the students more feedback as the practice analyzing texture throughout the semester. I collected samples from each of the field sites, so that I can run lab textures for the students to compare against during the field trips. I may also implement a weekly, low-stakes texture quiz to provide the students more opportunity to practice evaluating texture throughout the semester.

Soil Morphology

One issue that I ran into was having enough good, hands-on specimens for the students to study. I plan to continue to build my collection of specimens by collecting in-tact samples from my research sites and class field trips. I also plan to increase the number of field trips as I develop the class. I will try to fit in one new field trip next year and would eventually like to organize a week-end long field trip so that the class can see more soils of the Great Plains.

Summary

Through the development of this course portfolio, I have gained insights that will help to shape the curriculum that I am developing for Great Plans Field Pedology. Examining scores from the pre- and post- lab practical provided a clear picture of which of the students' field skills are improved as a result of taking this course, and which skills are not improved. Specifically, I found that the students showed significant improvement in their ability to identify soil color and morphological features, but no improvement in their evaluation of soil texture. In response to this analysis, I plan to adjust the methods that I am using to teach soil texture and provide more opportunities for the students to practice and receive feedback on their analysis of soil texture.

Table 1. Tests and ratings for evaluating clay content.

Test	Result	Rating
Ribbon Strength: Push the sample between the thumb and forefinger to form a ribbon. Examine how the ribbon behaves as it leaves the hand.	Weak: Ribbon rests on forefinger	0
	Moderate: Ribbon supports its own weight, but curls as it leave the hand	2
	Strong: Ribbon supports its own weight and emerges in a straight line	4
Ribbon length: Push the sample between the thumb and forefinger to form a ribbon. Observe how long a ribbon can be made before it breaks.	<1 cm	0
	1-2 cm	1
	2-3 cm	2
	3-4 cm	3
	>4 cm	4
Wire plasticity: Role the sample into a wire 0.5 cm in diameter and 8 cm-long. Perform each of the actions listed below and evaluate which causes the wire to break: 1. Lift the wire 2. Shake the wire 3. Bend wire into a U 4. Bend wire into a ring	Wire cannot be formed or breaks with lifted	0
	Wire breaks when shaken	1
	Wire breaks when bent into a U	2
	Wire breaks when bent into a ring	3
	Wire does not break in response to any of the above actions	4
Shine: Rub the surface of the sample, examine it in the light, and observe how it appears.	Dull	0
	Shiny	2

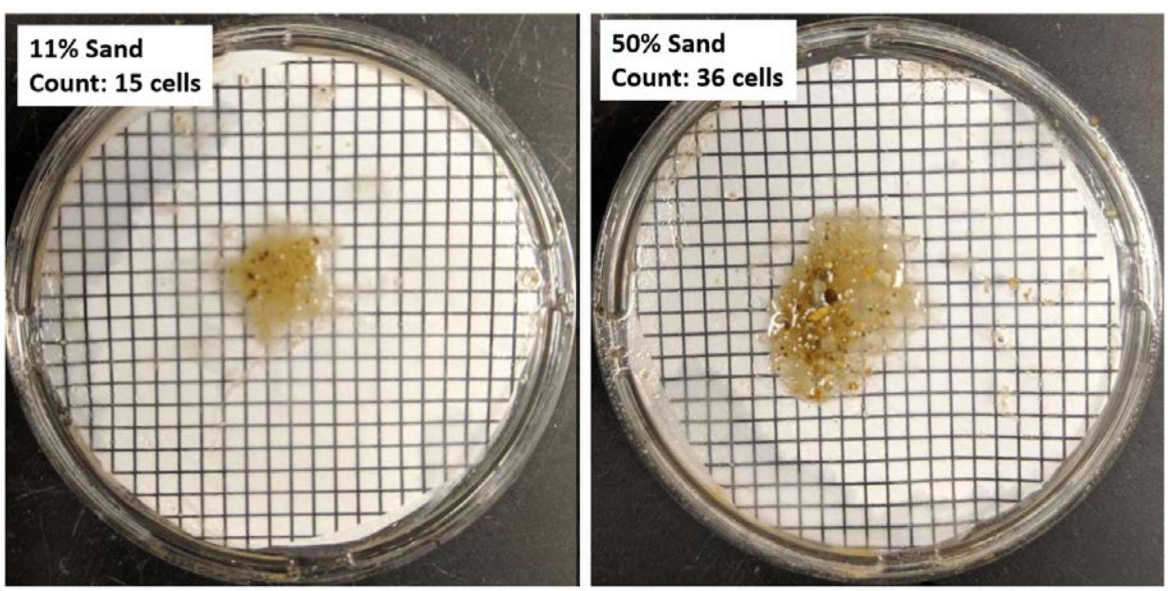

Fig. 10. Grid disc containing sands washed from samples with 11% and 50% sand.

References

Post, D.F., R.B. Bryant, A.K. Batchily, A.R. Huete, S.J. Levine, M.D. Mays, et al. 1993. Correlations between Field and Laboratory Measurements of Soil Color. Sssa Spec Publ 31: 35-49.

Salley, S.W., J.E. Herrick, C.V. Holmes, J.W. Karl, M.R. Levi, S.E. McCord, et al. 2018. A Comparison of Soil Texture-by-Feel Estimates: Implications for the Citizen Soil Scientist. Soil Sci Soc Am J 82: 1526-1537. doi:10.2136/sssaj2018.04.0137.

Thien, S.J. 1979. A flow diagram for teaching texture by feel analysis. Agronomic Education 8: 54-55.

Appendix A: Syllabus

GREAT PLAINS FIELD PEDOLOGY

AGRO 477, GEOG 467/867, NRES 477/877, SOIL 477

Spring 2019

Tuesday 12:30-1:45PM and Thursday 12:30-4:50PM

Hardin Hall 023

Instructor: Dr. Judith (Judy) Turk

Email: jturk3@unl.edu (mailto:jturk3@unl.edu)

Office: 607 Hardin Hall, East Campus

Phone: (402) 472-8024

Office Hours: Open door 8am-5pm Monday through Friday (leave a note on the door if I am not in)

COURSE GOALS:

Great Plains Field Pedology is a course designed to develop students' capacity to observe, analyze, interpret, and appreciate soil landscapes. Pedology is the study of soil morphology, genesis, classification, and mapping. Other branches of soil science study soils for their role as a medium or plant growth, as a water purification system, as a building material, or any of the various roles that soils play in supporting human life. Pedologists study soils purely for being *soils*. Pedology is the heart of soil science. Great Plains Field Pedology is a hands-on course in which students use their visual and tactile senses to observe soils in the lab and in the field. Through this course students will develop the *skills* required to observe and describe the soil and obtain the *knowledge* to classify soils and interpret their genetic history on the basis of observed morphology.

COURSE OBJECTIVES:

1. Understand the conceptual frameworks of soil genesis including the soil forming factors, pedogenic processes, Harden's soil development index, and McBratney's *scorpan* variables
2. Be able to describe a soil profile using standard methods and terminology
3. Gain familiarity with horizon nomenclature and diagnostic horizons
4. Be able to interpret the information conveyed through the taxonomic naming of soils
5. Be able to classify a soil to the family level on the basis of field and lab data
6. Be familiar with the methods used in soil mapping
7. Recognize important players in the history of pedology

8. Be able to read and understand the current scientific literature in pedology

COURSE MATERIALS:

- Laptop or tablet: Bring to every class
- Reverence materials from NRCS (free, see **Ordering Materials from NRCS) (https://canvas.unl.edu/courses/52047/pages/ordering-materials-from-nrcs)**
  - Keys to Soil Taxonomy
  - Field Book for Describing and Sampling Soils
- Textbook (optional): Soil Genesis and Classification (6th) by S.W. Buol, R.J. Southard, R.C. Graham, and P.A. McDaniel

ATTENDANCE and PREPAREDNESS

- Regular attendance required
- Arrive on time and check-in at computer (wait until the end of class to check-in if you arrive after class starts)
- Complete assignments on time
- Read/review assigned material prior to class
- Be prepared to contribute to discussion
- Anticipate weather conditions and be dressed appropriately for scheduled field work
- Bring needed tools and personal supplies for field work (water, boots, hat, sunscreen)
- If an emergency situation arises that interferes with your attendance and preparedness please notify the instructor

GRADING:

Your final grade will be based on:

- Literature circles (100 pts)
- Quizzes (100 pts)
- Lab practical (100 pts)
- Mid-term (200 pts)
- Field trip reports (100 pts)
- Scientist spotlight presentations (150 pts)
- Comprehensive final (250 pts)

Letter grades will be assigned as follows:

≥94	A
90-93.9	A-
87-89.9	B+
83-86.9	B

80-82.9	B-
77-79.9	C+
73-76.9	C
70-72.9	C-
67-69.9	D+
63-66.9	D
60-62.9	D-
<60	F

ADDITIONAL INFORMATION

Student code of conduct

Students are expected to adhere to guidelines concerning academic dishonesty outlined in Article III B.1 of the **University's Student Code of Conduct (http://stuafs.unl.edu/dos/code)**. A first offense will result in a 10% penalty on the assignment. A second offense will result in a grade of zero for the assignment. A third offense will result in a grade of F for the course. Students are encouraged to contact the instructor for clarification of these guidelines if they have questions or concerns. The SNR policy on Academic Dishonesty and procedures for appeals are available **here (http://snr.unl.edu/employeeinfo/information/employeehandbook-single.asp?infocode=S162)**.

Students with disabilities

Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.

EMERGENCY RESPONSE:

- Fire Alarm (of other evacuation): In the event of a fire alarm: Gather belongings (purse, keys, cellphone, NCard, etc.) and use the nearest exit to leave the building. Do not use the elevators. After exiting, notify emergency personnel of the location of persons unable to exit the building. Do not return to building unless told to do so by emergency personnel.

- Tornado Warning: When sirens sound, move to the lowest interior are of the building or designated shelter. Stay away from windows and stay near an inside wall when possible.
- Active Shooter:
  - Evacuate: If there is a safe escape path, leave belongings behind, keep hands visible and follow police officer instructions.
  - Hide out: If evacuation is impossible, secure yourself in your space by turning out lights, closing blinds, and barricading doors if possible.
  - Take action: As a last resort, and only when your life is in imminent danger, attempt to disrupt and/or incapacitate the active shooter.
- UNL Alert: Notifications about serious incidents on campus are sent via text message, email, unl.edu website, and social media. For more information, go to: **http://unlalert.unl.edu (http://unlalert.unl.edu)** .
- Additional Emergency Procedures can be found **here (https://emergency.unl.edu/procedure/emergency)** . **(http://emergency.unl.edu/doc/Emergency_Procedures_Quicklist.pdf)**

Schedule

Dates marked with an * indicate that class will not meet. Online activities or small group meetings are still required on most of these days.

Week	**Dates**	**Reading/Assignments due**	**Class activities**
1	**T Jan. 8***		• No in person meeting (Judy at SSSA) • Watch course introduction video on Canvas • Order materials from NRCS (see **Ordering Materials from NRCS (https://canvas.unl.edu/courses/52047/pages/ordering-materials-from-nrcs)**)
	R Jan. 10*		• No in person meeting (Judy at SSSA) • Course pre-test on Canvas • Be prepared for quiz and literature circle next Tuesday (quiz will be on introduction video/syllabus)
2	**T Jan. 15**	Read Jenny Chapter 1& 2 Prepare for lit. circle	• Quiz 1 • Introduction to pedology • Literature circle: Jenny 1 and 2
	R Jan. 17		• Pre-lab practical

3	**T Jan. 22**	~~Read Jenny Chapter 3~~ Prepare for lit. circle	• ~~Quiz 2~~ • ~~Time lecture/activity~~ • ~~Literature circle: Jenny 3~~ • Weather closure
	R Jan. 24		• Soil color lecture/lab
4	**T Jan. 29**	Read Jenny Chapter 3 Prepare for lit. circle	• Quiz 2 • Time lecture/activity • Literature circle: Jenny 3
	R Jan. 31		• Texture lecture/lab
5	**T Feb. 5**	Read Jenny Chapter 4 Prepare for lit. circle	• Quiz 3 • Parent material lecture/activity • Literature circle: Jenny 4
	R Feb. 7		• Soil morphology/Soil core lab
6	**T Feb. 12**		• Quiz 4 • Finish core descriptions • Soil morphology
	R Feb. 14		• Cover Crops and Soil Health Conference
7	**T Feb. 19**	Read Jenny Chapter 5 Prepare for lit. circle	• Quiz 5 • Literature circle: Jenny 5 • Topography lecture/activity
	R Feb. 21		• Horizon nomenclature/Soil core lab • Introduce Scientist spotlight activity and select papers with group
8	**T Feb. 26**	Read Jenny Chapter 6 Prepare for lit. circle	• Quiz 6 • Climate Lecture/activity • Literature circle: Jenny 6
	R Feb. 28		• Mid-term and 2nd core lab
9	**T Mar. 5**	Read Jenny Chapter 7&8 Prepare for lit. circle	• Quiz 7 • Organisms lecture/activity • Literature circle: Jenny 7&8

	R Mar. 7		• Introduction to soil taxonomy
10	**T Mar. 12**	Read Pedogenic process Prepare for lit. circle	• Quiz 8 • Pedogenic processes lecture/activities • Literature circle: Pedogenic processes
	R Mar. 13		• Classifying soils using Soil Taxonomy
Spring	**T Mar. 19***	No class	
Break	**R Mar. 21***	No class	
11	**T Mar. 26**	Read DSM paper Prepare for literature circle	• Quiz 9 • Literature circle: DSM paper • Soil mapping notes/activity
	R Mar. 28		• Field trip report guidelines • Field trip 1: Nine mile prairie
12	**T Apr. 2**	Read Spotlight paper 1 Prepare for lit. circle	• Quiz 10 • Literature circle: Spotlight paper 1 • Classification to the family level
	R Apr. 4	Field trip report 1 due	• Field trip 2: Rogers farm
13	**T Apr. 9**	Read Spotlight paper 2 Prepare for lit. circle	• Quiz 11 • Literature circle: Spotlight paper 2 • More classification exercises
	R Apr. 11	Field trip report 2 due	• Field trip 3: Shoemaker marsh
14	**T Apr. 16***	Read Spotlight paper 3 Prepare for lit. circle	• Independent small group meetings (Judy at Soil Judging) • Quiz 12 (On canvas) • Literature circle: Spotlight paper 3
	R Apr. 18*	Field trip report 3 due	• Independent small group meetings (Judy at Soil Judging) • Work on spotlight presentation • Texture practice samples

15	**T Apr. 23**	Be prepared to give your presentation	• Scientist spotlight presentations
	R Apr. 25		• Course evaluations • Lab practical
Finals week	**F May 3 10:00 am-12:00pm**		• Final Exam