A Survey of Introductory Soil Science Curricula

N.A. Jelinski[1], C.J. Moorberg[2], M.D. Ransom[2], J.C. Bell[1]

[1]Department of Soil, Water and Climate
University of Minnesota-Twin Cities
[2]Department of Agronomy
Kansas State University

Image: S. Nordstrom

Survey Goals and Objectives

1. Improve knowledge of the diversity of materials, methods, and pedagogies utilized to teach Introductory Soil Science (or equivalent)

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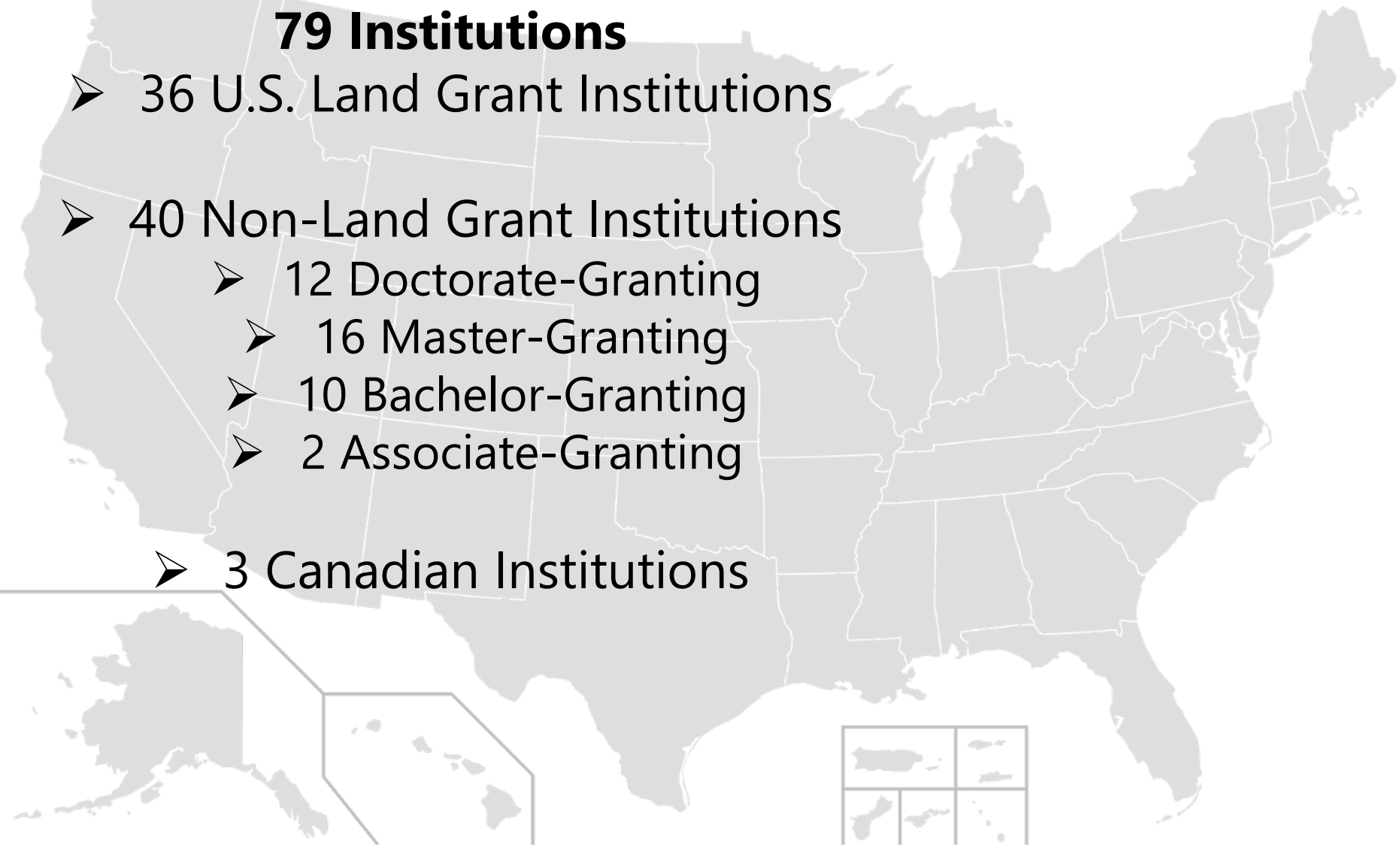
2. Assist instructors or institutions in the process of revising or reviewing their Introductory Soil Science courses

3. Identify opportunities for cross-institutional cooperation or the development of multi-user course materials and resources.

Survey Respondents

79 Institutions

- 36 U.S. Land Grant Institutions
- 40 Non-Land Grant Institutions
  - 12 Doctorate-Granting
  - 16 Master-Granting
  - 10 Bachelor-Granting
  - 2 Associate-Granting
- 3 Canadian Institutions



1. WHO are we teaching? – Class Size and Pre-Reqs

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- Average of **65 ± 29** students per course offering (< 20 to >100)

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Pre-Requisites

- **Chemistry (63%)**
- Math (24%)
- Biology/Plant Science/Crop Science (9%)
- Physics (5%)
- Geology/Earth Science (3%)
- None or HS (14%)

1. **WHO are we teaching?** – Programs

Introductory Soils Satisfies…

- **Major or Minor Requirement (91%)**
- General Science or Lab Requirement (53%)

1. **WHO are we teaching?** – Reqs and Programs

Introductory Soils Satisfies…

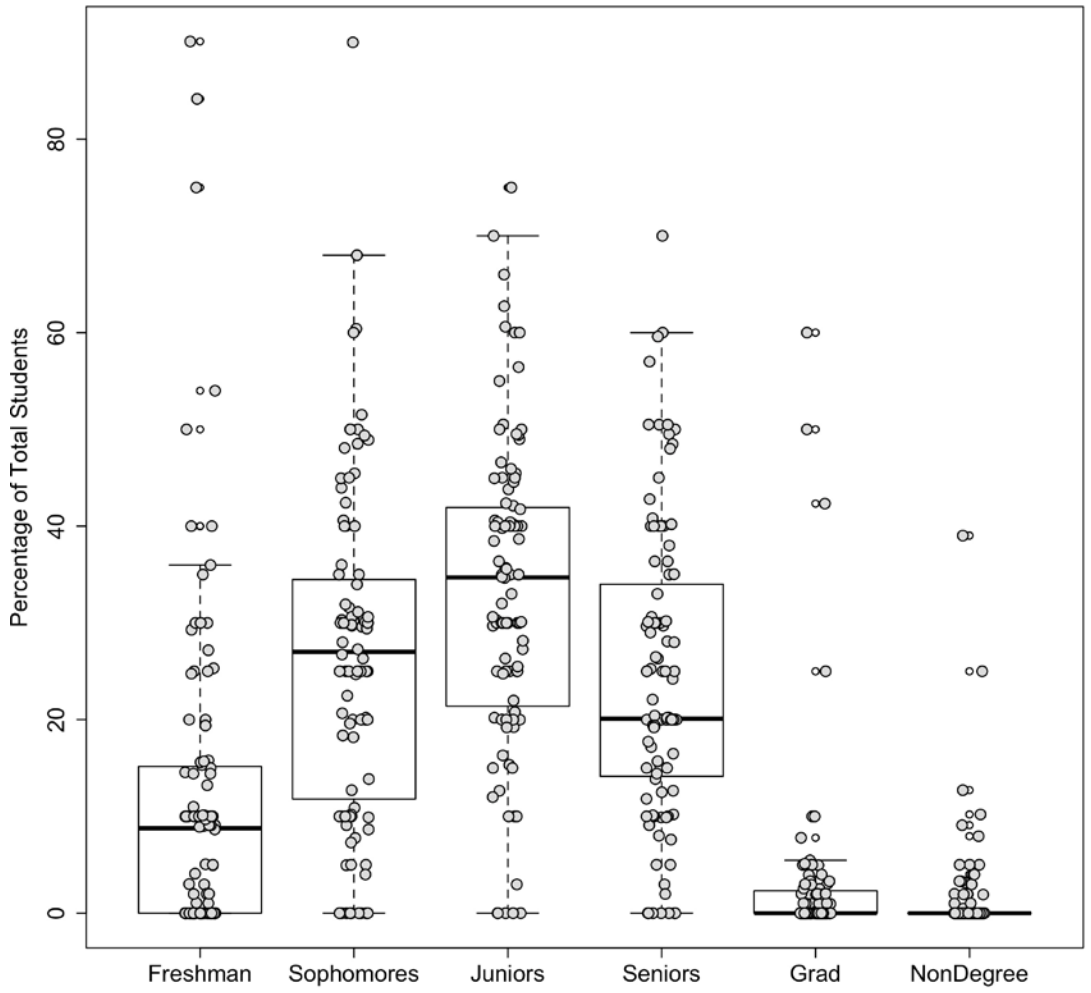
- **Major or Minor Requirement (91%)**
- General Science or Lab Requirement (53%)

…and is taught in Departments that offer:

- Soil Science/Closely Related Major (32%)
- Soil Science Minor (34%)
- Soil Science Option (37%)

Student Demographics by Class Year

- **Juniors (33%)**
- Sophomores (26%)
- Seniors (24%)
- Freshman (12%)
- Grad Students (3%)
- Non-Degree Students (2%)



Estimated Student Demographics by Requirement

- **Required (71%)**
- General Ed (14%)
- Elective (12%)

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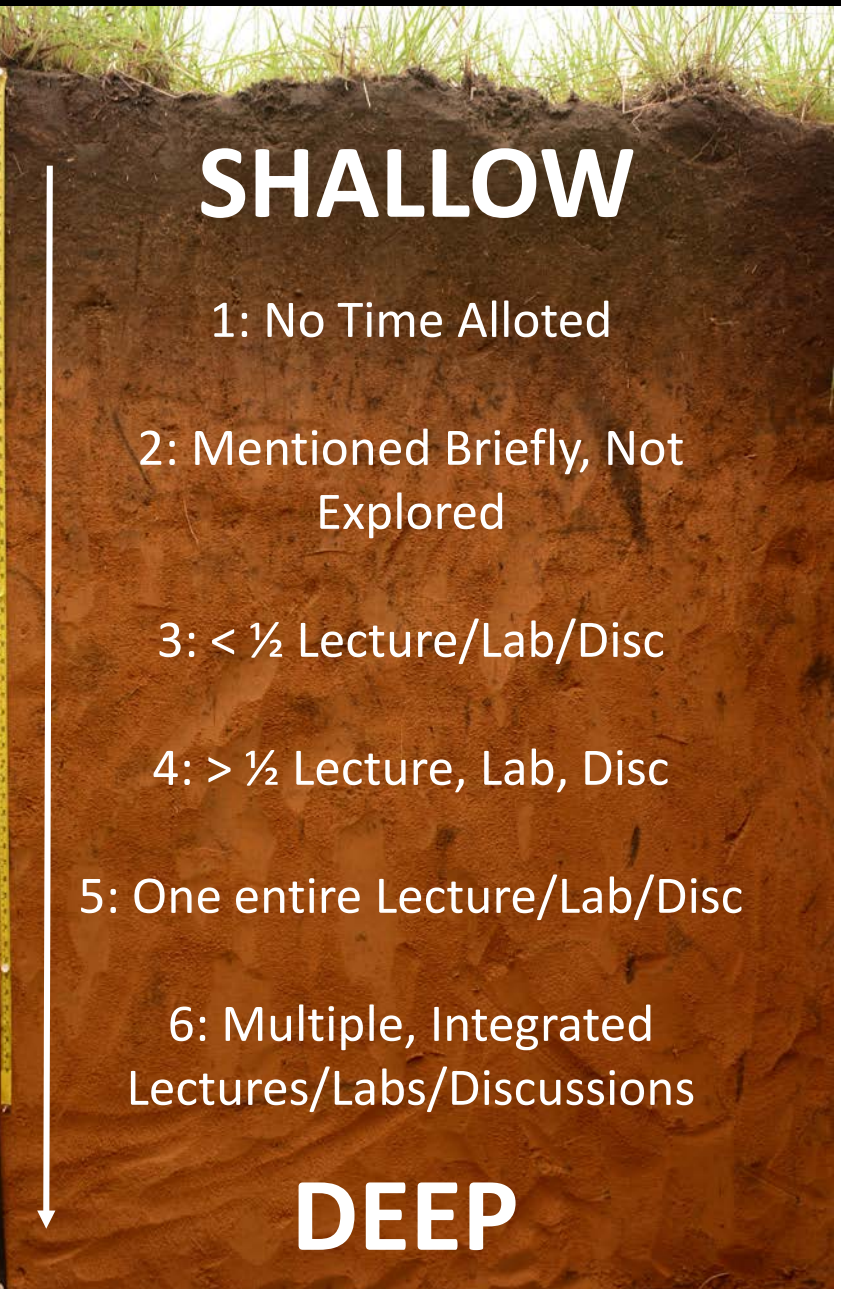
Land Grant institutions have a significantly lower proportion of students taking course as elective.

2. WHAT are we teaching? – Topical Categories

Condensed SSSA's FSS Performance Objectives into 36 Topical Categories

- 1. Soil Particle Size Classes and Soil Texture
- 2. Bulk Density/Porosity/Particle Density
- 3. Soil Structure
- 4. Soil Color
- 5. Soil Water Concepts (Water Content, Potential, Retention, and Movement)
- 6. Components of Hydrologic Cycle
- 7. Soil Temperature and Factors Affecting Soil Temperature
- 8. Soil Gases and Aeration
- 9. Soil Mineral Structures and Behavior
- 10. Engineering Properties (Atterberg Limits, Strength, Shear Stress, etc.)
- 11. Soil Parent Material Types and Diversity
- 12. Horizon Forming Processes and Horizon Nomenclature
- 13. Soil Classification and Taxonomy
- 14. Soil Mapping and Map Unit Interpretations
- 15. Soil Geomorphology
- 16. Soil Forming Factors and Soil Development
- 17. Microorganism Diversity and Abundance in Soils
- 18. Plant Root/Microbial Interactions
- 19. Plant Root/Soil Interactions
- 20. Carbon Cycle
- 21. Nitrogen Cycle
- 22. Other Nutrient Cycles
- 23. Organic Matter Forms and Decomposition Processes
- 24. Bioremediation, Phytoremediation, and Waste Management
- 25. Erosion Types and Quantification
- 26. Soil Quality and Best Management Practices
- 27. Precision Agriculture
- 28. Water Quality and Management
- 29. Urban Soils
- 30. Integration of Soils Information and GIS
- 31. Plant Nutrients and Nutrient Deficiencies
- 32. pH and its Effects on Other Soil Properties
- 33. Cation Exchange Capacity
- 34. Soil Amendments and Chemical Management
- 35. Soil Testing, Analysis and Interpretation
- 36. Redox Processes and Hydric Soils

2. WHAT are we teaching? – Depth of Topics



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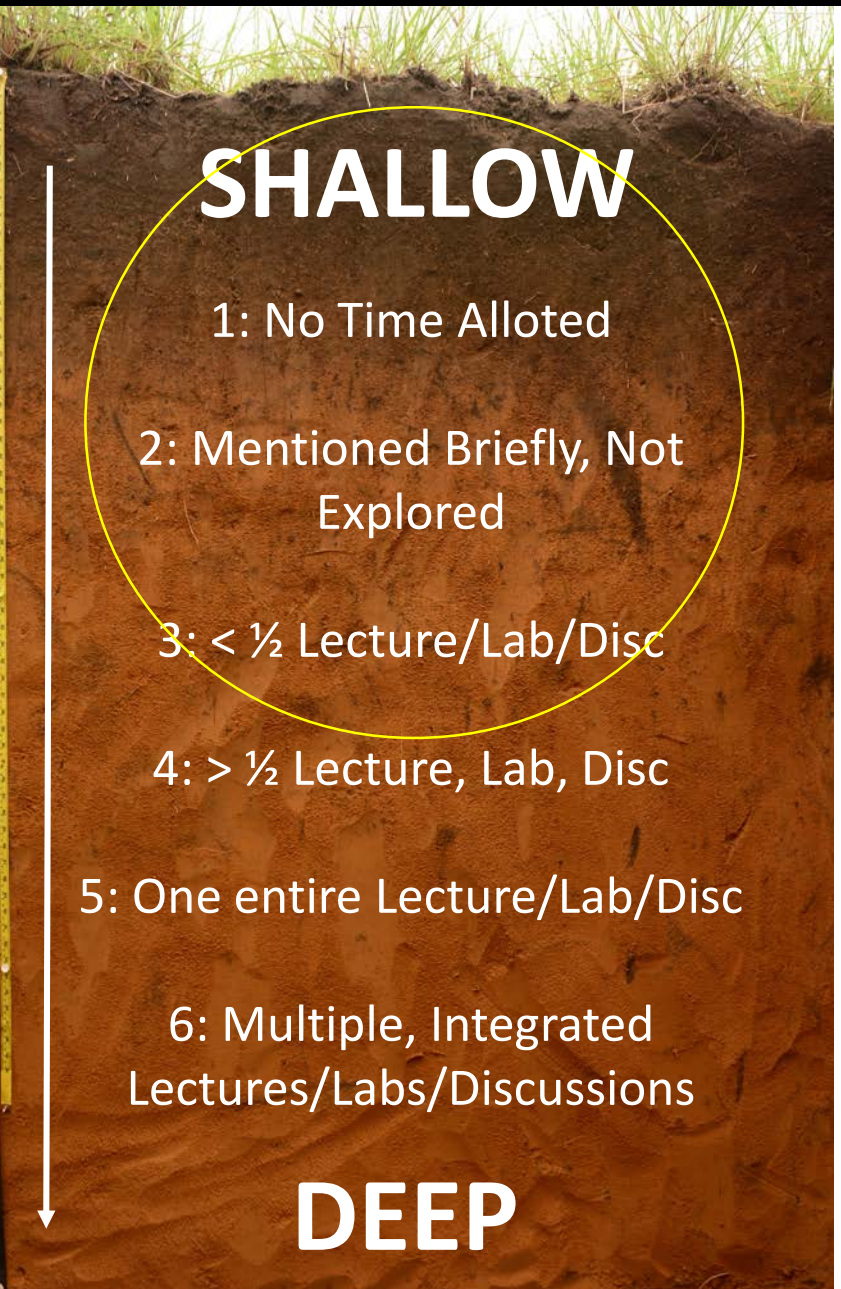

Shallowest:

- Precision Agriculture
  2.22 ± 1.14
- Urban Soils
  2.36 ± 1.18
- Engineering Properties [Atterberg Limits, etc.]
  2.37 ± 1.48
- GIS/Soils Info Integration
  2.97 ± 1.53
- Bioremediation/Waste
  2.98 ± 1.43

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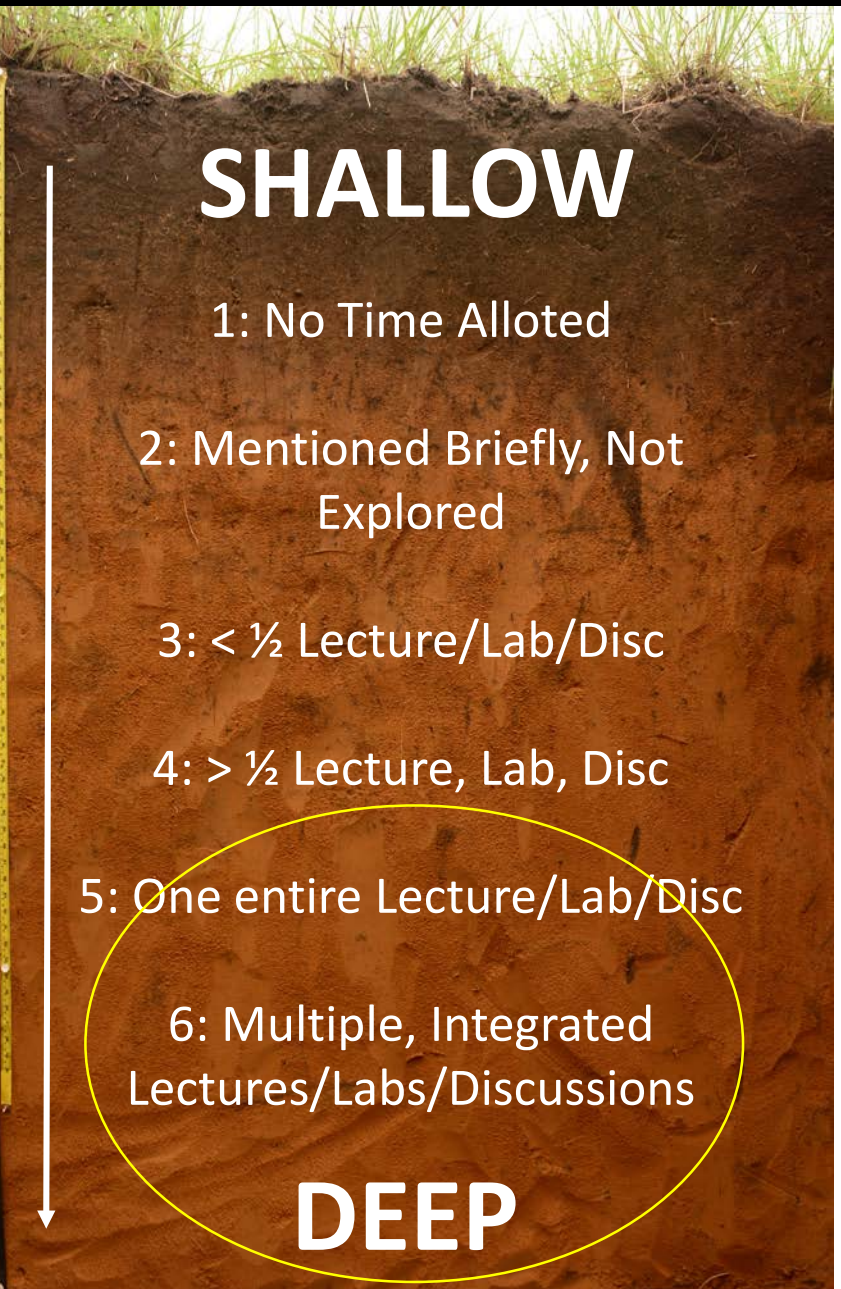
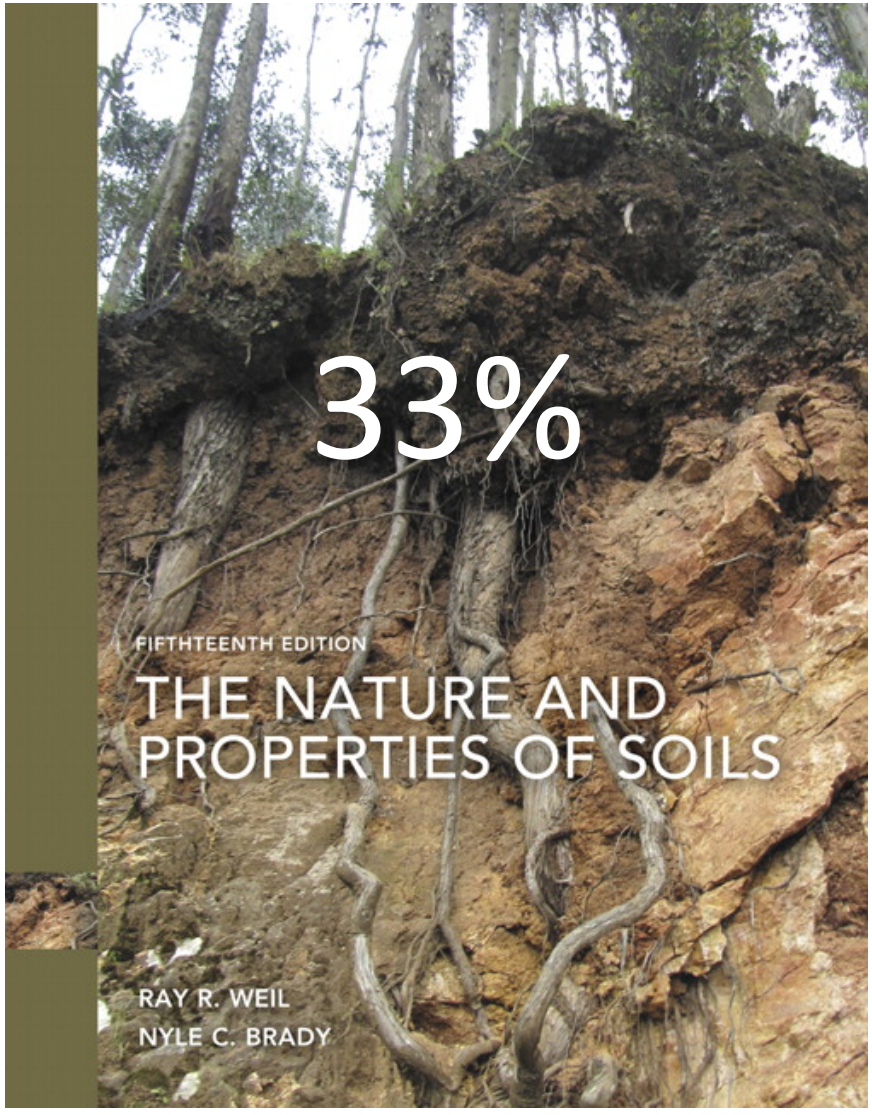


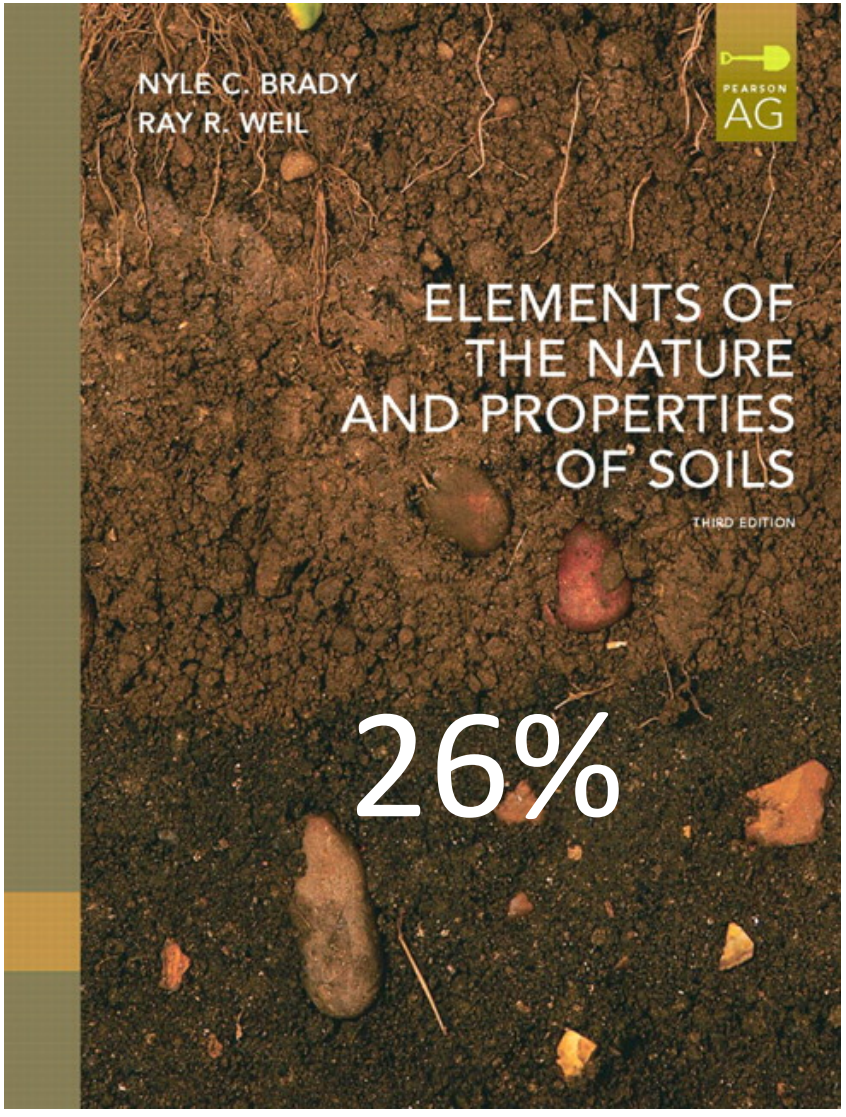
Deepest:

- Soil Water Concepts
  5.43 ± 0.94
- Classification/Taxonomy
  5.17 ± 1.03
- Horizon Genesis and Nomenclature
  5.04 ± 1.14
- Soil pH and Its Effects
  5.03 ± 0.98
- Soil Development/Factors
  5.01 ± 1.11

2. WHAT are we teaching? – Texts

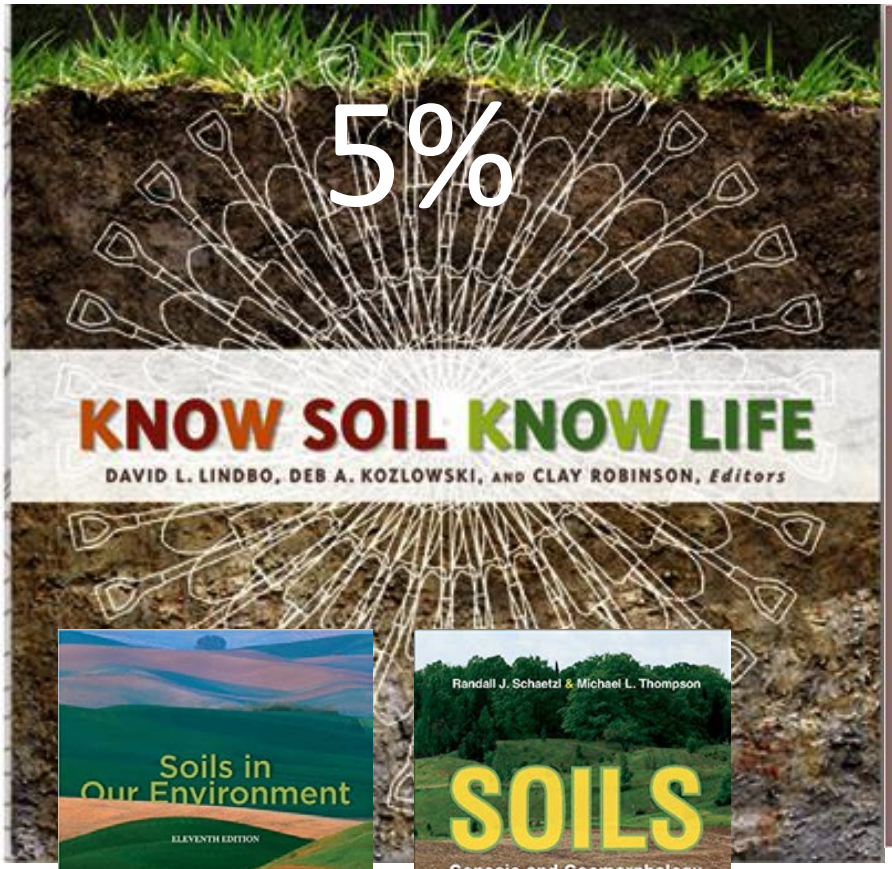
81% require a textbook

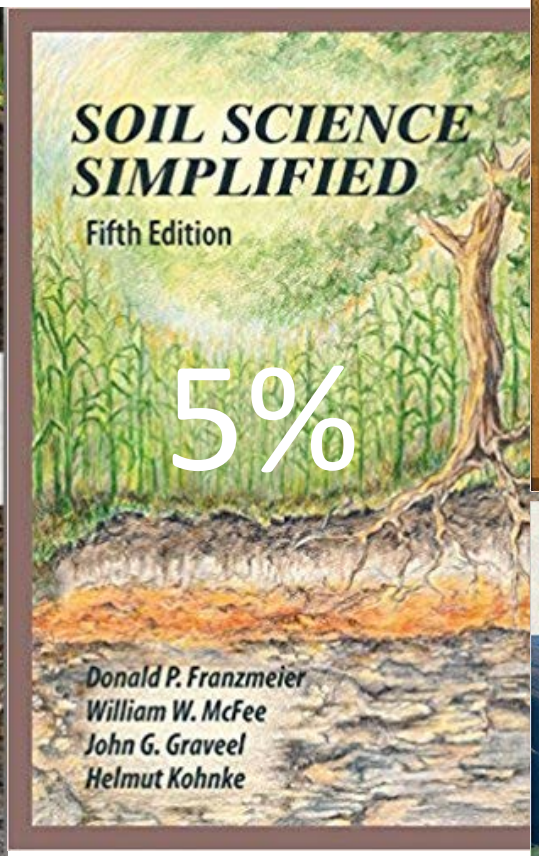


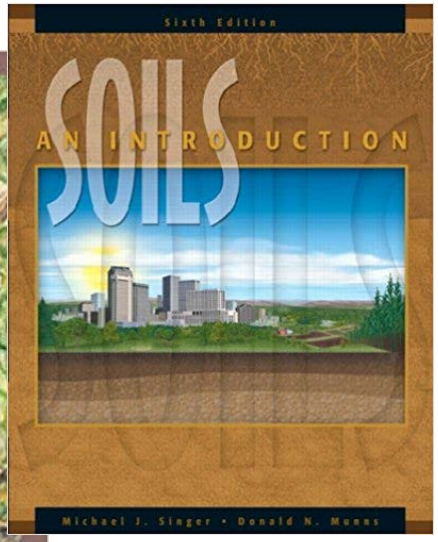


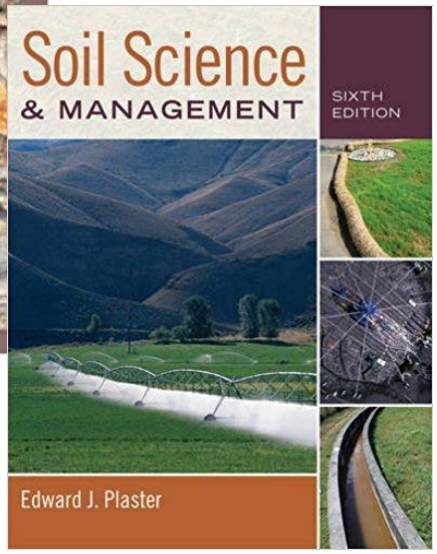
2. WHAT are we teaching? – Texts

Textbooks – Required (Alternative)





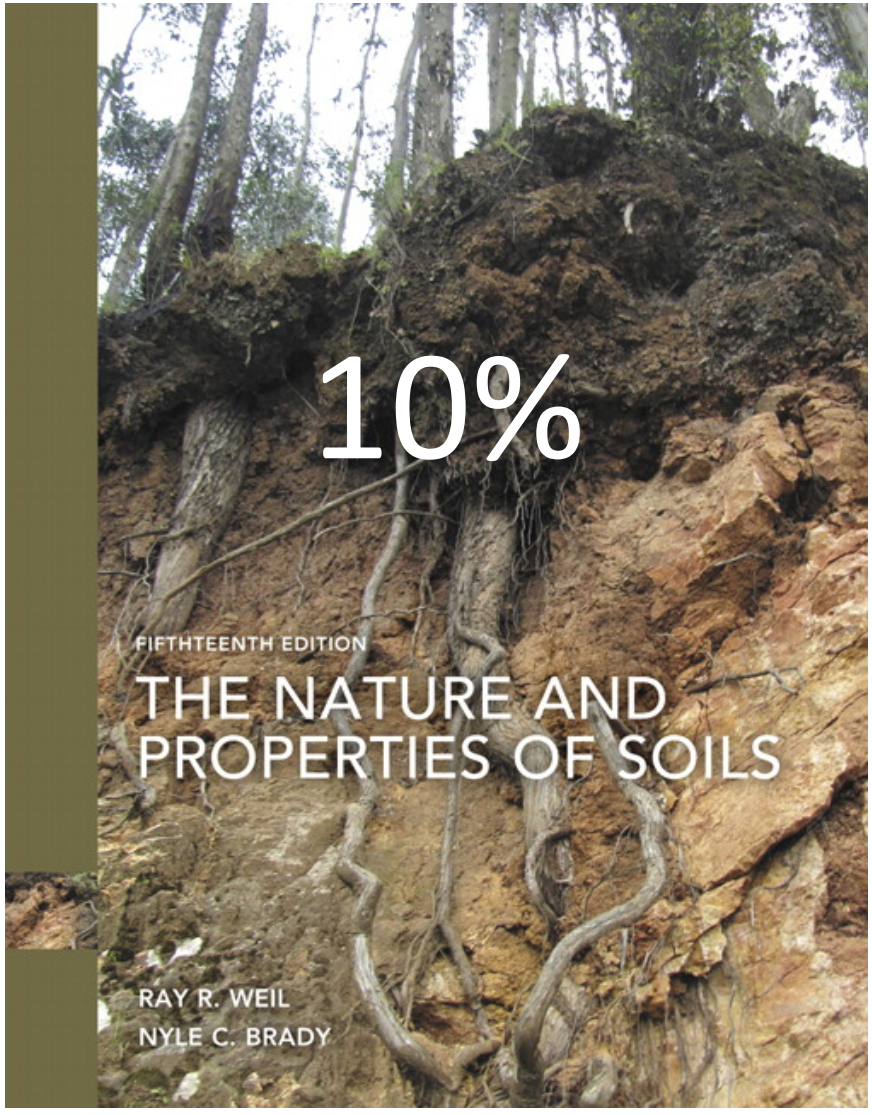


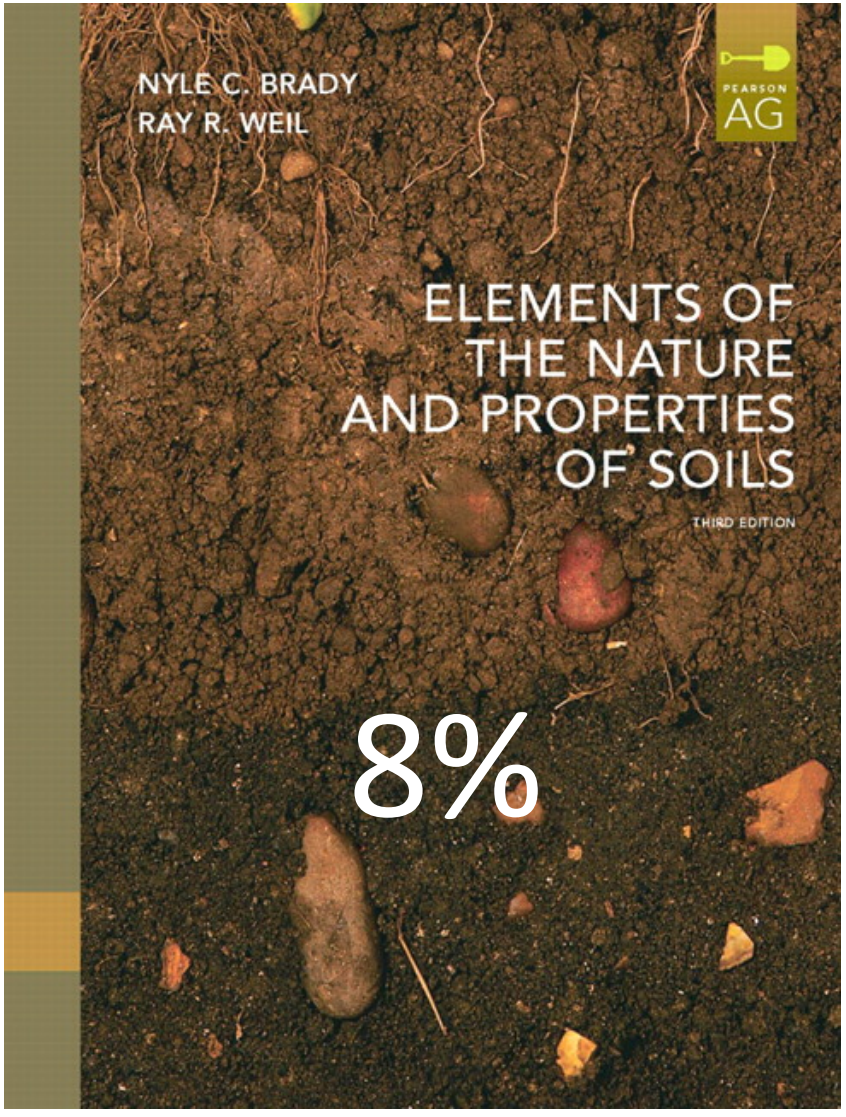


3% Require Purchase of Course-Specific Lecture Notes

2. WHAT are we teaching? – Texts

39% recommend texts





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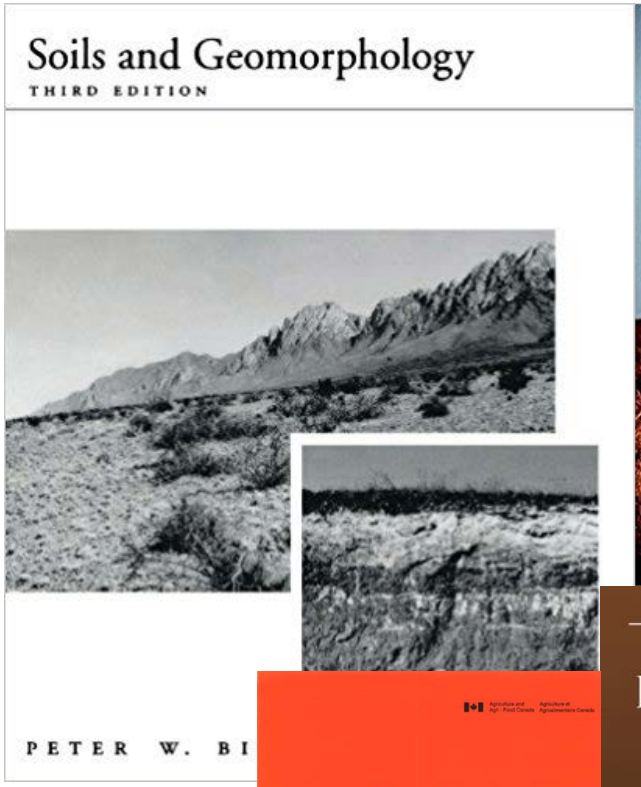

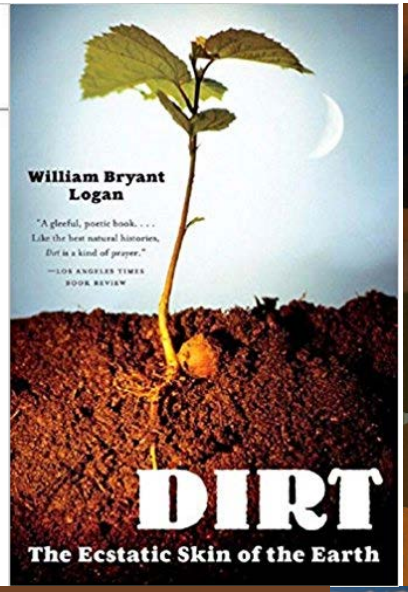

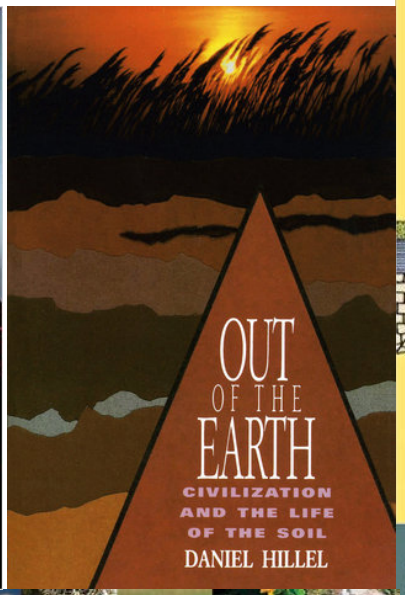

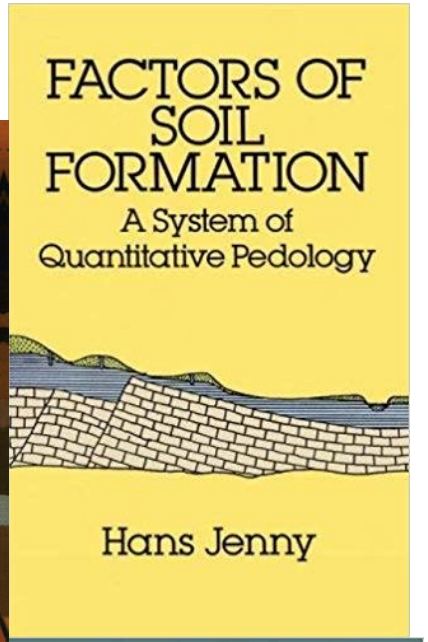

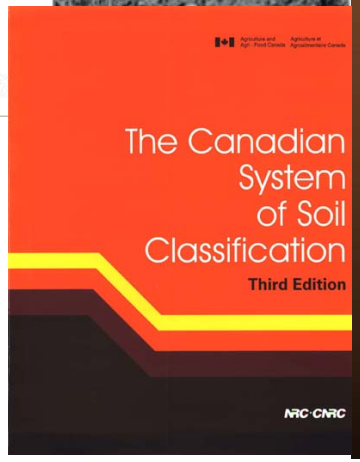

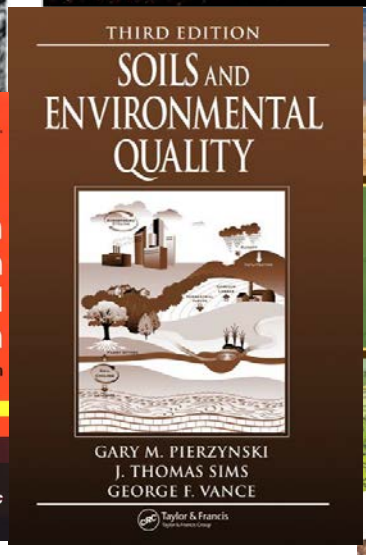

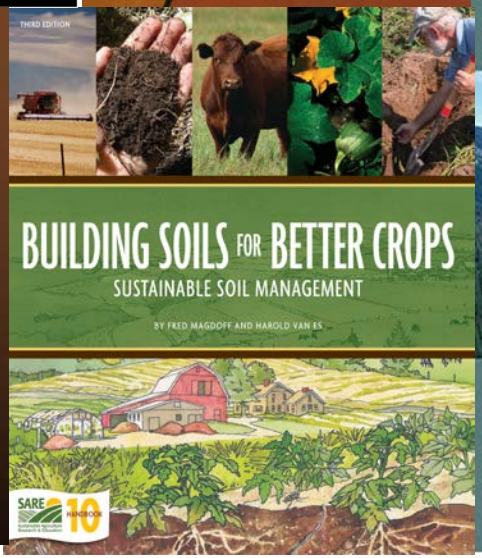

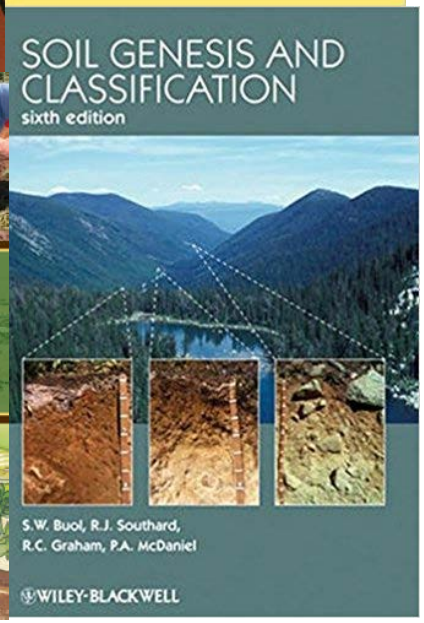

3. HOW are we teaching it? – Non-Lab Pedagogies

Images: (UL) University of Iowa, (UR) (BR) (BL): University of Minnesota

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No significant relationship between class size and proportion taught as lecture vs. alternative styles.

No significant difference between Land Grant, Non-Land Grant, or Carnegie Classification Categories

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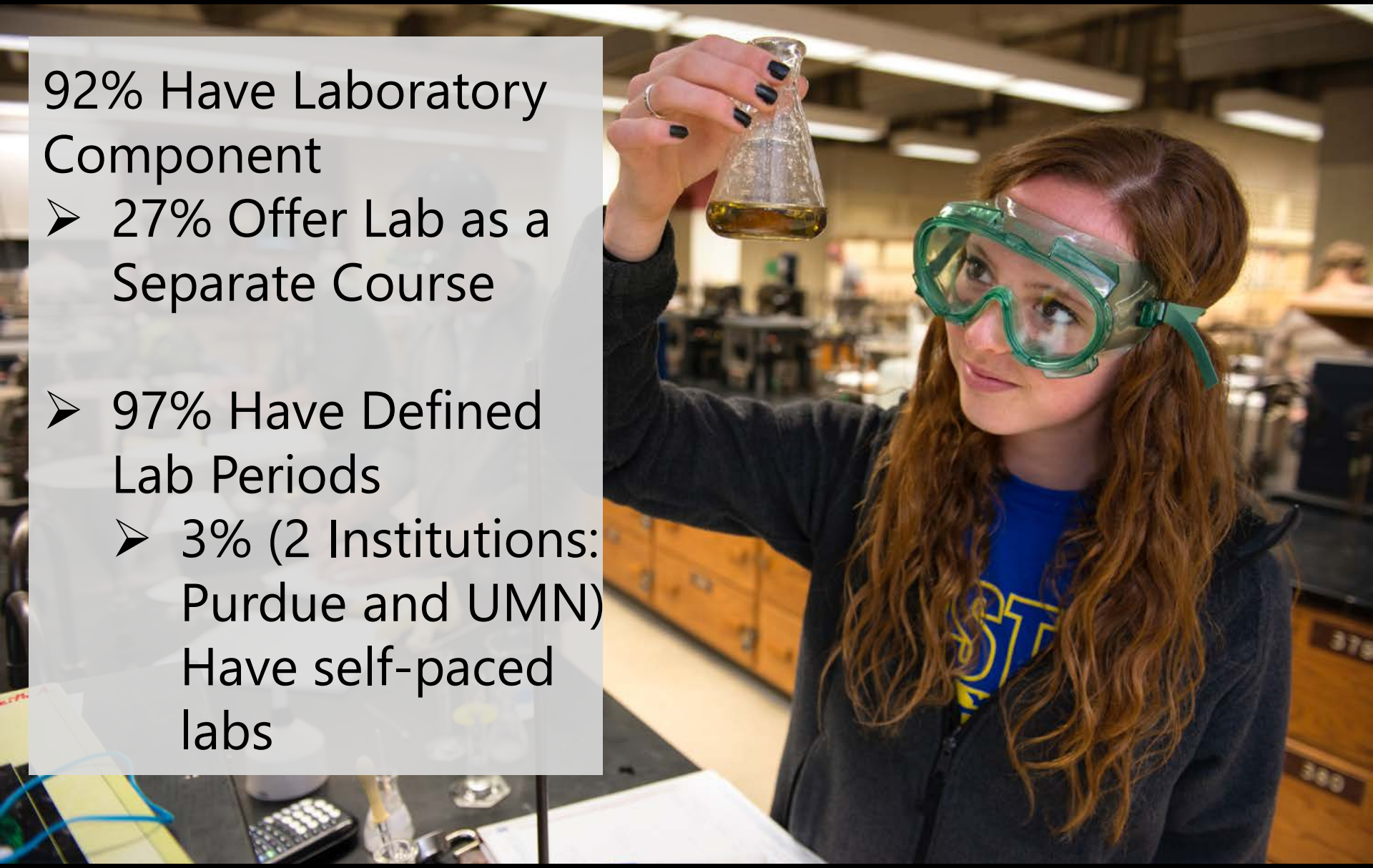
3. HOW are we teaching it? – Labs

92% Have Laboratory Component

- 27% Offer Lab as a Separate Course

- 97% Have Defined Lab Periods
  - 3% (2 Institutions: Purdue and UMN) Have self-paced labs



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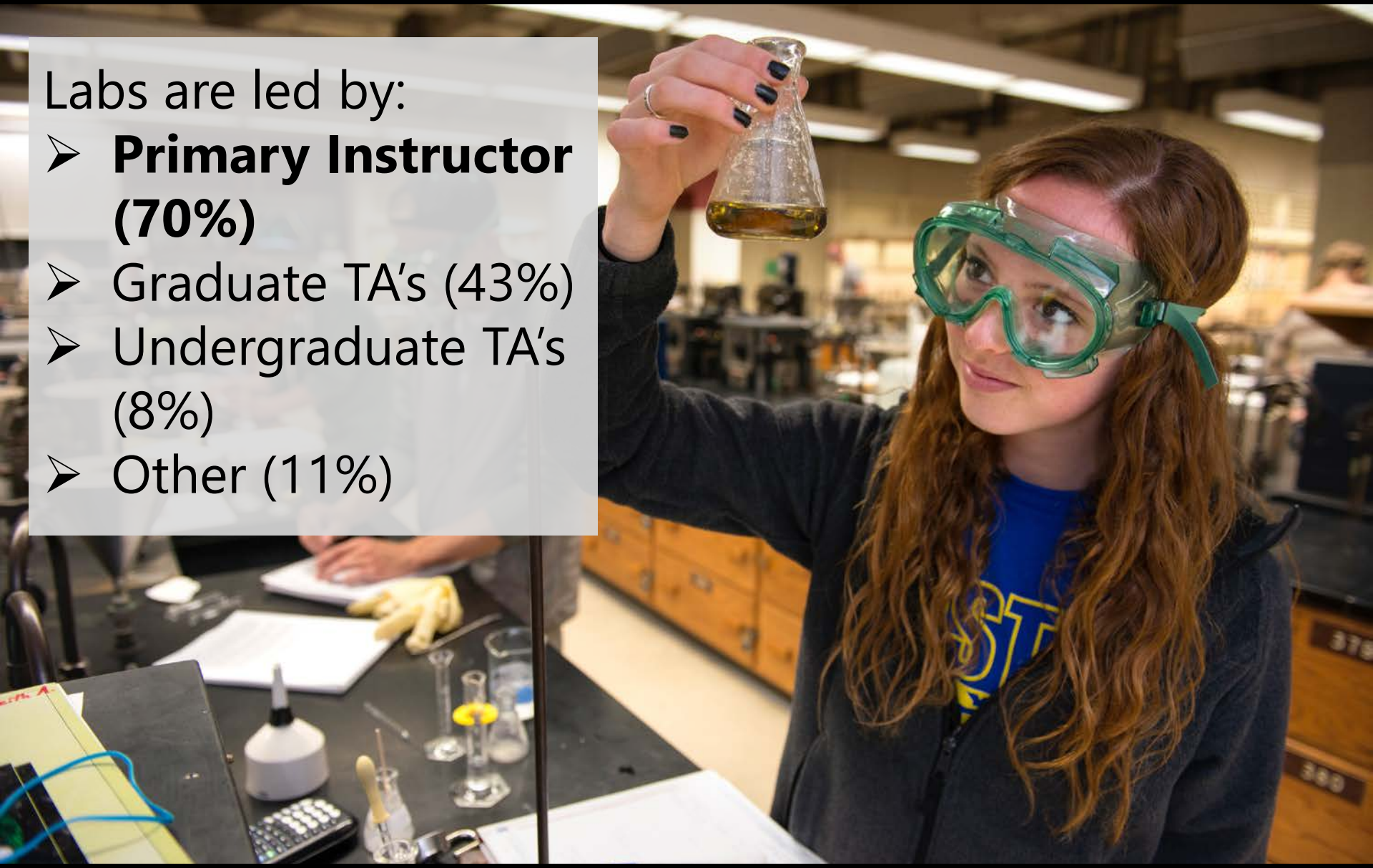

Labs are led by:

- **Primary Instructor (70%)**
- Graduate TA's (43%)
- Undergraduate TA's (8%)
- Other (11%)

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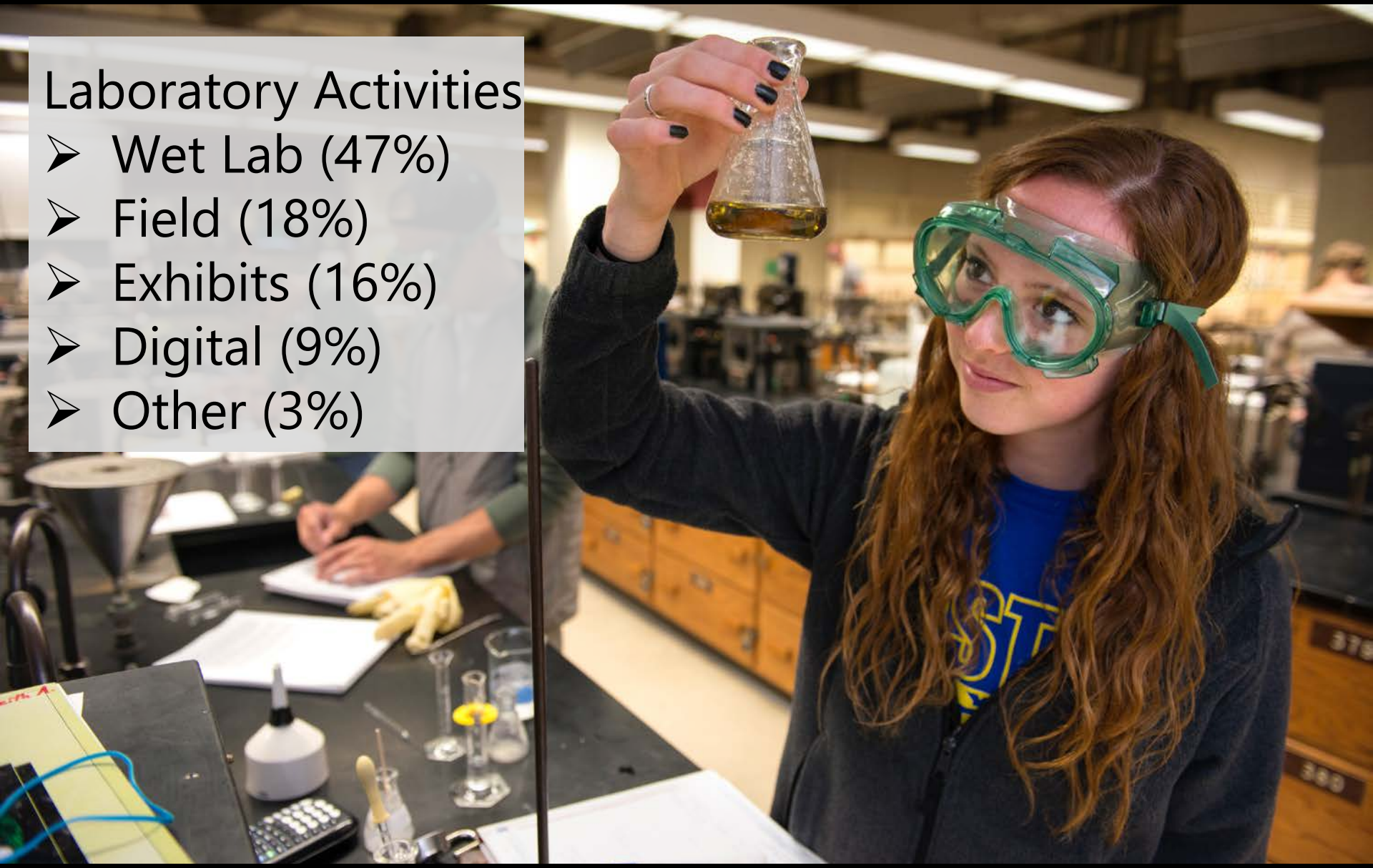

Laboratory Activities

- Wet Lab (47%)
- Field (18%)
- Exhibits (16%)
- Digital (9%)
- Other (3%)

Image: University of Minnesota

3. HOW are we teaching it? – Field Component

76% of Laboratory Sections have a field component

- Average of 2 field trips (1-6)
- Does not appear to vary by latitude!

Image: University of Minnesota

3. HOW are we teaching it? – Lab Manuals

What type of laboratory manual is used?

- **Custom (62%)**
- Commercially Published (8%)
- Other (8%)

Image: open.soilscience.info

3. HOW are we teaching it? – Lab Manuals

Is there a cost to the student?

Yes: 49% No: 51%

Image: open.soilscience.info

3. HOW are we teaching it? – Distance Learning

14% (11 institutions) offer completely online/distance learning format.

Average Class size: 39.5 ± 34 (< 10 to > 100)

Audience: Predominantly Undergraduates (79%)

Image: elearningindustry.com

3. HOW are we teaching it? – Distance Learning

2 Programs tailored heavily to graduate students, professionals, continuing Ed

45% (5 institutions) have lab section in conjunction with distance learning.

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Outcomes

1. Manuscript (*in prep*) containing detailed results will be submitted to Natural Resources Education

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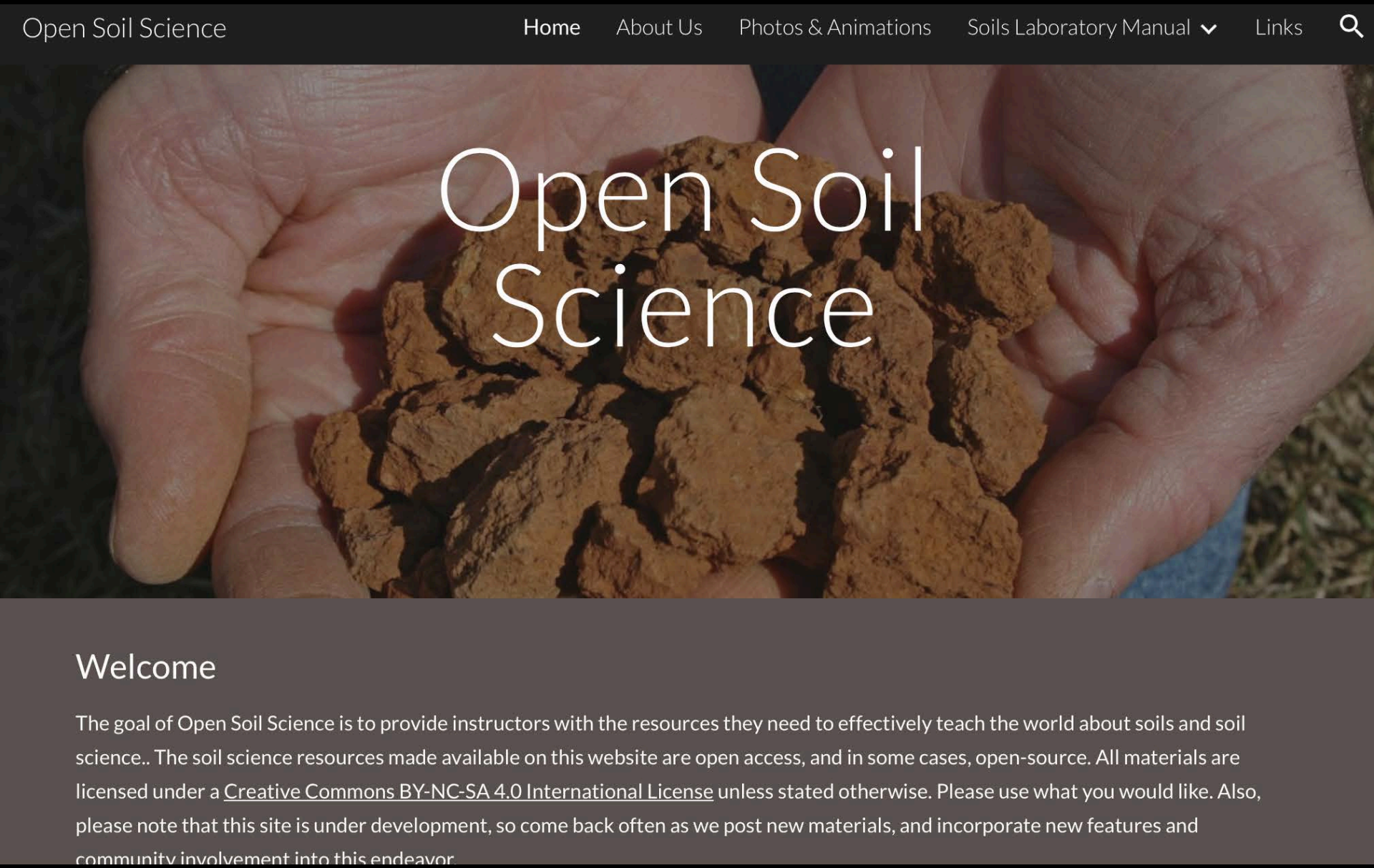
2. First step in understanding state of soil science education and potential high-payoff collaborative tasks. Move to open source?

3. **42%** of surveyed instructors interested in connecting with other introductory soils instructors to explore new approaches.

Opportunities to connect and share: open.soilscience.info



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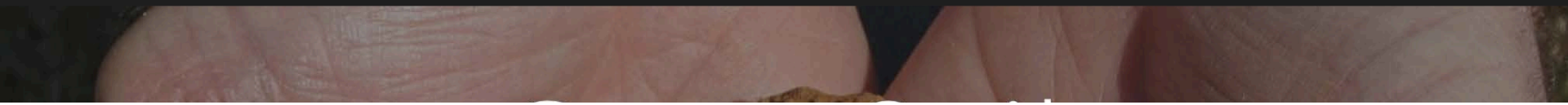
Open Soil Science | Home | About Us | Photos & Animations | Soils Laboratory Manual | Links



Natural Sciences Education 2017. 46: 170013

UNDERGRADUATE EDUCATION

An Open-Source Laboratory Manual for Introductory, Undergraduate Soil Science Courses

Colby J. Moorberg* and David A. Crouse

Abstract

High textbook cost is a major obstacle to affordable higher education. Open textbooks present one solution, but open laboratory manuals must be developed for lab-based courses to successfully reduce overall textbook costs. Here, we present the *Soils Laboratory Manual*, an open-source lab manual for undergraduate, introductory soil science courses. The manual facilitates the ability for instructors to develop their own

The continued rising cost of textbooks has become a serious limitation to affordable higher education. The College Board reports that students at 4-year, public institutions of higher education spend $1,250 per year on textbooks (The College Board, 2017). According to a survey conducted by Senack and the Student Public Interest Research Groups, 65% of students surveyed claimed they had forgone purchasing a textbook required for a class due to the high cost of the text, despite 94% of students admitting

science.. The soil science resources made available on this website are open access, and in some cases, open-source. All materials are licensed under a Creative Commons BY-NC-SA 4.0 International License unless stated otherwise. Please use what you would like. Also, please note that this site is under development, so come back often as we post new materials, and incorporate new features and community involvement into this endeavor.

Image: open.soilscience.info

Acknowledgement

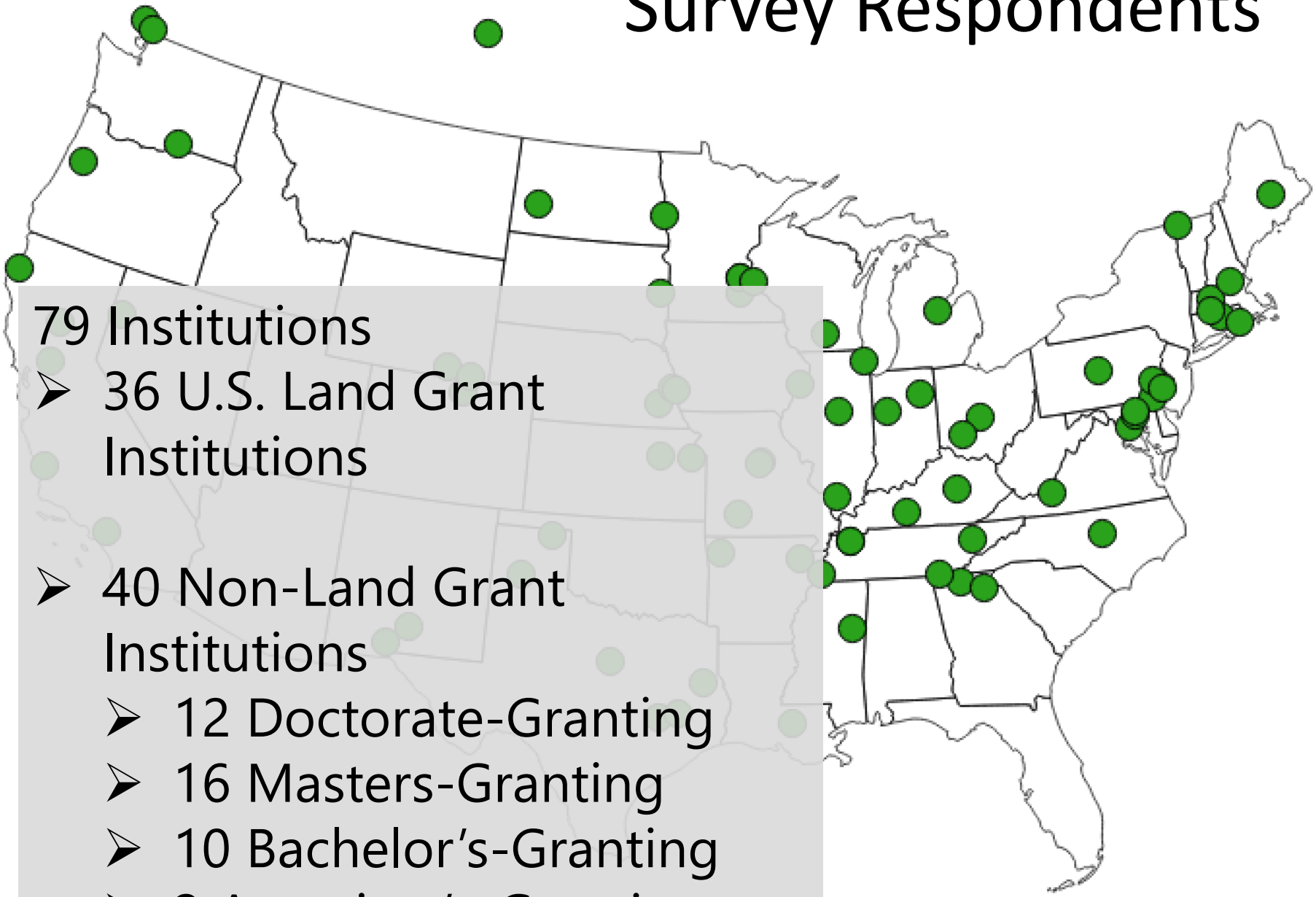
- **Over 80 instructors of Introductory Soil Science from across the country. Thank you for sharing your thoughts and opinions!**

- Minnesota Agricultural Experiment Station, SSSA, NACTA

- Dr. J.D. Walker – UMN

Images: (T) S. Nordstrom, (B) B. Wenell

Survey Respondents



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3. HOW are we teaching it? – Non-Lab Pedagogies

No significant relationship between class size and proportion taught as lecture vs. alternative styles. No difference between LG/NLG and Carnegie Categories

2. WHAT are we teaching? – Topics

Are performance objectives from the SSSA or your state board of professional soil scientists "Fundamentals of Soil Science" exam incorporated into the learning objectives of the class?

Yes: 49% No: 51%


GOPHERS

3. HOW are we teaching it? – Lab Manuals

What type of laboratory manual is used?

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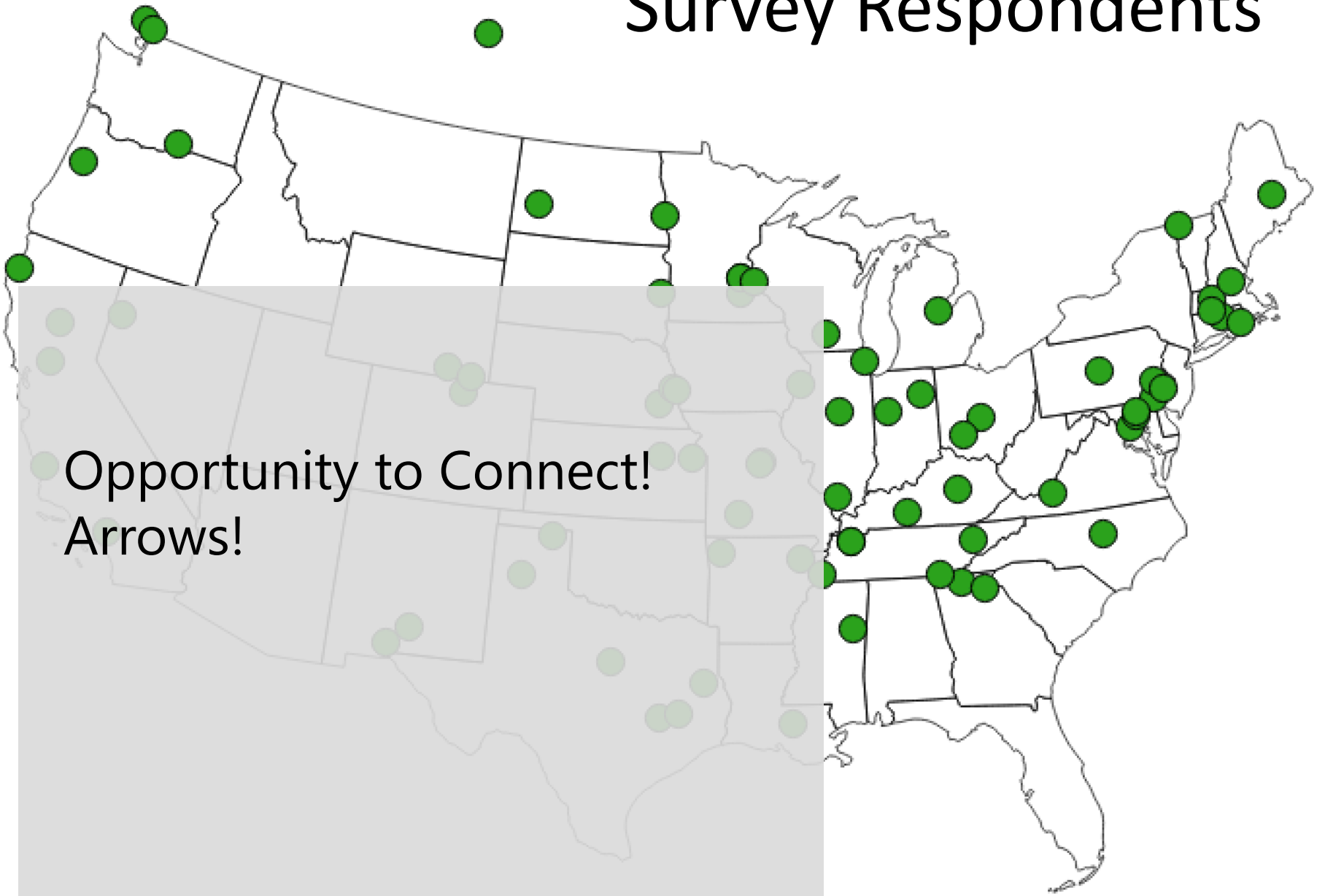


Opportunity to Connect!
Arrows!

Results will be published in Natural Sciences Education (Journal)

42% of surveyed instructors interested in connecting with other introductory soils instructors, and exploring new pedagogical techniques.

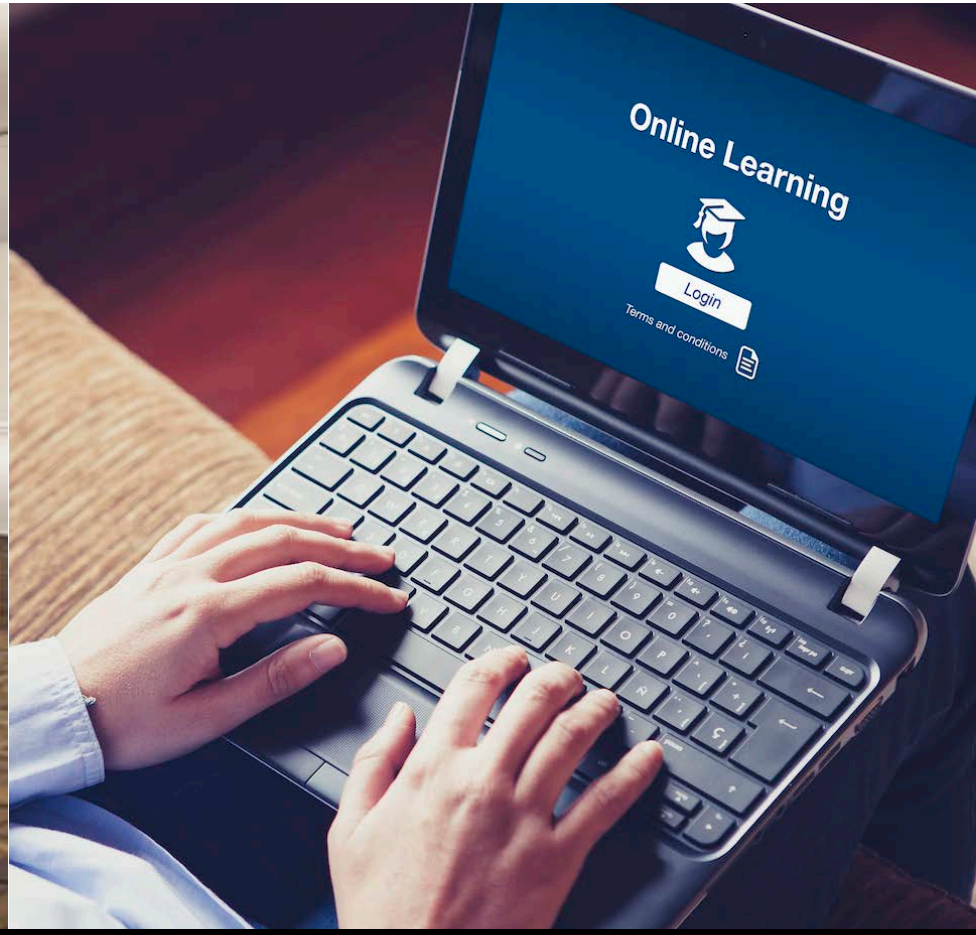
First step in understanding state of soil science education and potential high-payoff collaborative tasks. Move to open source.

3. How are we teaching it? - Delivery

Hybrid: 16%

Classroom: 87%

Classroom: 8%



Images: (L)? (R): University of South Florida-Manatee

2. How are we teaching it?

Average Number of Primary Instructors: 1.4 ± 0.9 (1-6)

Outline/Agenda

1. Survey Goals and Objectives
2. Respondent Statistics
3. **Who** Are We Teaching?
4. **What** are We Teaching?
5. **How** are We Teaching It?
6. Opportunities for X

1. WHO are we teaching? – Class Size and Pre-Reqs

Class Size

- Average (All) 65 ± 29 students per course offering (Min – Max)

Pre-Requisites

- Chemistry (63%)
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- Biology/Plant Science/Crop Science (9%)
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