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Natural Sciences Education

SPECIAL SECTION

Enhancing Natural Sciences Education in Postsecondary Settings

Growing hearts and minds: Linking landscapes and lifescapes in a soils field course

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Abstract

Interacting with practitioners and understanding multiple, contradictory, and complex perspectives is an important skill for effectively managing terrestrial resources in the 21st century. Addressing these needs requires innovative approaches in higher education that elevate student learning outcomes and emphasize the affective learning domain through meaningful, place-based interactions with practitioners. We describe an approach taken to expand a traditional soils field course to include emphasis on higher-level student learning outcomes in the affective learning domain. Following the completion of a week-long field study course in which students gain skills in soil description, classification, and interpretation, the expanded second module of the course includes a traveling component in which students experience soils, landscapes, and "lifescapes" (i.e., the lived experiences of practitioners). This second module incorporates practitioners as the primary source of knowledge and is structured to encourage dialogue, understanding, and co-discovery centered around soils and land management. In unstructured narratives, students identified themes in the affective domain—deep collaboration, personal and professional development and sense of place, community, and joy—as transformational experiences in the course that influenced their personal and professional growth and future ability to interact with people from across the geographic, social, and political spectrum.

1 | INTRODUCTION

We live in an era seemingly "on fire" with increasing polarization through instantaneous streams of tailored information and myriad global environmental, social, and political crises. Innovative higher educational strategies are needed to prepare the next generation of professionals to deal with multi-dimensional complexity, long-term systems impacts, and an accelerating flow of data from competing sources (Basche et al., 2014; Duckworth, Andrews, Cubeta, Grunden, & Ojiambo, 2017; Francis et al., 2011). This is particularly pertinent for the discipline of soil science because soils are an integral component of land management and conservation efforts (Bouma & McBratney, 2013) and lie at the center of the global grand challenges of climate change, human health, water quality, and food security. As enrollment in soil science classes increases along with attention to the central role of soil management in

Abbreviations: SLOs, student learning outcomes.

addressing environmental challenges (Brevik et al., 2018), there are major opportunities for educators to increase student interest, engagement, and motivation through alternative teaching strategies.

Historically, soil science has focused on the acquisition and application of technical knowledge to meet workforce demands for these skills in both field and laboratory settings (Havlin et al., 2010). This learning occurs primarily in the psychomotor and cognitive domains (Anderson, et al., 2000). However, learning outcomes that address and emphasize the *affective* learning domain (i.e., feelings, attitudes, emotions, and values related to content learning; Anderson et al., 2000) in conjunction with technical skills can help prepare students for a diversity of roles as future professionals in resource-related careers. Strategies that enhance communication skills and challenge students' pre-existing attitudes and beliefs about environmental issues and their stakeholders can make them more accepting of differences and able to collaborate with others to find meaningful solutions. Developing students' abilities to respond appropriately to social cues, initiate self-reflection, and respect alternate ways of knowing is critical to cultivating more responsible community members and problem solvers (Fleischner et al., 2017).

Many teaching techniques may be employed to enhance student learning outcomes (SLOs) in the *affective* domain. One particularly effective strategy is to collaborate with practitioners to introduce pluralistic perspectives in which interests, objectives, values, and motives may conflict among stakeholders (Cannon, Feinstein, & Friesen, 2010). By engaging with practitioners, students are exposed to the challenges and drivers of land management decisions and become keyed into the multiple conflicting realities that coexist around a single issue. Introducing this pluralism into traditional soils field studies courses is paramount to preparing soils students to handle environmental, social, and political complexity (Peters & Wals, 2013; Welch-Devine, Hardy, Brosius, & Heynen, 2014; Williams & Patterson, 1996).

Multiple benefits and integrated, experiential learning can occur when students meet a variety of professionals in the field (Boyle et al., 2007; Mogk & Goodwin, 2012), accessing both the physical land (i.e., landscapes) and the people who work it, which we refer to as "lifescapes." Lifescapes are the intersection of events related to an individual's agency, emotions, health, socio-economic circumstance, cultural norms, and behaviors over their lifespan (Hadley & Hanley, 2011). First, learning becomes context-dependent, so theory may be applied in a variety of settings, and diverse landscapes can be used to connect science and societal challenges (Gosselin, Burian, Lutz, & Maxson, 2016). Additionally, this context-driven learning may invoke a sense of place in which land is imbued with meaning and emotion, either internally by the student or externally imparted by the practitioner's historic place relationship (Gosselin et al., 2016; Semken, Ward, Moosavi, & Chinn, 2017; Williams, 2014). Developing this sense of place can contribute to feelings of connection and responsibility in students (Kudryavtsev, Stedman, & Krasny, 2012). Finally, field settings improve the retention of theoretical knowledge learned in the classroom to real-world applications via tangible student experiences (Blanco-Canqui, Ruis, Speth, & Lee, 2018; Boyle et al., 2007). Students also often favor field work to classroom learning and consider it enjoyable, increasing the likelihood of knowledge recall for application and creativity in problem-solving (Blanco-Canqui et al., 2018; Levine & Pizarro, 2004; Zaragoza & Fraser, 2017).

However, caution must be exercised in experiential learning alongside partner–practitioners to avoid the reinforcement of technocratic pedagogies and one-way knowledge transfer (Amador, Martinho, Bacelar-Nicolau, Caeiro, & Oliveira, 2015) or even previously held biases (Nairn, 2005) that may occur when students differ in their abilities to authentically receive the perspectives of others based on their previous socialization. Instead, these experiences should be carefully mediated by the instructor to prepare students for situational contexts and potential conflicts that may arise (Nairn, 2005), and to guide them through post-processing and reflection. When done well, field studies in natural resource education can invoke creativity, environmental literacy, and social responsibility (Fleischner et al., 2017).

In this article, we describe modifications made to an undergraduate soils field course in which we expanded and addressed SLOs in the affective domain by integrating pluralistic, practitioner-led learning during an intensive May term course. Our objectives are to describe the specific approach taken and to present the results of a thematic analysis conducted on 3 years of unstructured narrative reflections on the expanded version of the course. We focus on the interactions between the instructor, students, and

Core Ideas

- Student learning outcomes in the affective learning domain can provide critical skills for future professionals.
- A traditional soils field course was expanded to include learning through place-based, practitioner-led interactions.
- Thematic evaluation of unstructured narratives demonstrated transformational student growth.

practitioners involved in the field course, and explicitly align student narrative themes to high-level SLOs designed to address complexity in narratives and perspectives, the synthesis and application of technical information, and developing a sense of place, community, and joy.

2 | SETTING AND CONTEXT

The University of Minnesota–Twin Cities is located in urban Saint Paul, MN, and is a 4-year research and Ph.D.–granting institution. The University hosts soils-relevant majors in environmental science and plant science as well as a minor in soil science. The size of the undergraduate Basic Soil Science course at the institution averages approximately 100 students each semester, with approximately 30 students in the Soil Science minor each year. Students wishing to minor in Soil Science must take a total of 21 credits, including a mandatory, 2-credit, May Session, Field Study of Soils course to receive the soil science minor.

The state of Minnesota contains diverse soils, landscapes, and human lifescapes that are driven and shaped by diverse natural resources. Minnesota lies at the intersection of three major North American biomes—the grasslands of the Great Plains, the deciduous forests of the eastern United States, and northern boreal forest. Annual average temperature varies from 0 °C in the northern part of the state to more than 8 °C in the southern part of the state, while annual average precipitation exhibits a strong gradient across the state from the southeast (>34 inches per year) to the northwest (<18 inches per year). Continental glaciation dramatically shaped the landscapes and soil parent materials across the state of Minnesota; nearly all of the state lies inside of the Pleistocene glacial maximum, with the exception of the southeastern portion of the state, commonly known as the Driftless Area. These natural factors have led to the development of unique landscapes, soils, and lifescapes centered on industries that rely on the rich natural resources of the state. Agriculture, forestry, peat mining, and iron ore mining are the major resource-dependent industries in Minnesota. Generally, they are spatially separated in the state from south-central and western Minnesota (dominated by crop and animal agriculture) and north-central and northeastern Minnesota (dominated by forestry and mining).

3 | THE APPROACH

Until 2017, the Field Study of Soils course was taught as a field experience involving multiple day trips from the St. Paul campus of the University of Minnesota–Twin Cities. The course content focused primarily on developing psychomotor skills in soil morphology, soil classification, and field interpretation skills among the student participants. The SLOs associated with the pre-2017 "traditional" version of this course reflected the focus on tangible psychomotor and cognitive skills central to the study, inventory, and mapping of soils in the field.

Psychomotor domain:

- Accurately describe a soil profile, including horizon delineation and identification, soil texture, color, consistence, structure, coarse fragments, and pH.
- Accurately describe landscape characteristics affecting soil formation.
- Classify soils of this region to the Great Group level based on a soil profile description.

Cognitive domain:

- Make general land-use interpretations from soil profile and landscape descriptions.
- Define a soil catena and explain its importance in understanding spatial patterns of soil variability.
- Work effectively in a small group setting to describe soil profiles and landscapes and solve problems related to interpretations.

Inspired by the late Dr. Fred Madison's (1937–2019; University of Wisconsin-Madison Professor of Soil Science) Soil Science 601, Soils of Wisconsin: Landscapes and Uses course, which emphasized interaction with practitioners in the places where they live and work and intentionally introduced students to a diversity of social and political perspectives, the University of Minnesota's Field Study of Soils course was expanded to include an 11-day statewide camping trip that engages practitioners from across the state of Minnesota in collaborative soil investigations. This expanded portion of the course (affectionately entitled Minnesota Soils and Land Use, in honor of Dr. Madison's legacy) is taught as an optional component in conjunction with the traditional Field Study of Soils course, immediately following the completion of the first part of the course. Each year from 2017 to 2019, the second portion of the course drew approximately 10 to 15 students from the pool of 18 total students signed up for the Field Study of Soils course, and utilizes the foundational skills in soil morphology, classification, and landscape analysis built in the first portion of the course. Students opting out of the second part of the course (typically due to work or scheduling conflicts) complete a 40-hour online report on the soils and landscapes of a specific portion of the state to receive full credit for the course.

In order to better reflect the intention and objectives for the second part of the course, which emphasizes both landscapes and lifescapes and meets practitioners on their own

properties, novel, higher-level SLOs were articulated in the syllabus that emphasized the affective domain.

Psychomotor domain:

- Application of technical skills: Master a body of knowledge and mode of inquiry. Develop technical skills by applying classroom concepts to field activities such as describing soils and identifying geomorphic features.

Cognitive domain:

- Appreciating difference: Appreciate and articulate the value of interacting with individuals whose backgrounds and/or perspectives differ from their own.
- Synthesis of soils/land use impacts: Formulate connections between soils and land use. Demonstrate tolerance of ambiguity by navigating in complex environments where clear-cut answers are absent.

Affective domain:

- Deep dollaboration: Develop interpersonal skills, including effective communication, logistical coordination and planning, mutual support, and teamwork.
- Personal and professional development: Develop personal and professional skills for effective citizenship and life-long learning.
- Sense of place, community, and joy: Reflect on personal connection to the land, sense of place, pride or appreciation of the University's role in society, experience happiness, fun, and engagement.

Students taking the second part of the course begin their journey by co-planning logistics with the instructor and collaborating on gear and equipment inventory for camping and fieldwork. The instructor impresses upon all students that (a) a transition will occur from having a primary instructor delivering course content to a team atmosphere needed to achieve "deep" collaboration to honor practitioner time (some of whom may be farmers in the midst of planting season) and that (b) the majority of the subsequent content will be delivered by practitioners, with the instructor acting as mediator and connector.

This second portion of the course takes students across the state of Minnesota to meet with 20 to 24 practitioners in the varied landscapes and lifescapes of the state (Figure 1). Students have an opportunity to see firsthand the major ecoregions (Figure 1a), land uses (Figure 1b), soil parent materials (Figure 1c), and soil diversity (Figure 1d) across the state of Minnesota in the context of the people who live in those areas and manage the land. These practitioners represent the major land-based industries in the state and include forest managers (U.S. Forest Service, Tribal Entities), peat harvesters (for-profit companies), farmers (conventional, organic, crop-based, and animal-based agronomic systems), and researchers (U.S. Forest Service, USDA–Agricultural Research Service, University of Minnesota). Relationships with these practitioners are carefully cultivated by the instructor through personal contacts, collaborative work, and intentional relationship building. These foundational relationships pay dividends as practitioners understand that students may ask difficult questions but trust that these questions come from a place of achieving understanding and advancing shared experiences. In the current iteration of the Minnesota Soils and Land Use module, students are assessed by the instructor primarily based on their level of engagement in interactions with practitioners and ability to lead discussions of soil and landscape investigations. Graded diaries or nightly reflective journals are not required due to time constraints; days begin before sunrise by breaking camp and end well after sunset by setting up camp, leaving students little time to write structured reflections. Notetaking and reflection is encouraged, however, and is practiced by the vast majority of students in the class.

Practitioners also gain from this process. Without the stressors of travel, practitioners are delivered a captive group of future professionals that is primed for listening and understanding. The sharing of technical soils knowledge by the instructor and students in combination with an emphasis on relationship building allows this class to avoid extractive interactions. The goal is to provide a *transformational* rather than *transactional* experience for both the students and the practitioners. In addition to enhancing student learning, meeting practitioners in the field contributes to building trusting relationships between the practitioner, instructor, and students. These relationships are built on the trust that practitioners' time, knowledge, and decisions will be respected and valued, and that the practitioner will gain knowledge from the interaction. Academic, and specifically scientific, knowledge is often prioritized over experiential knowledge in Western cultures, but being on someone else's turf —literally —where their expertise reigns contributes to the development of a horizontal relationship where reciprocity is a natural outcome.

A typical sequence of events upon arrival at a host practitioner's site is as follows:

- The instructor prepares students the night before their meeting with the practitioner, including basic information regarding their livelihood and practice, followed by a geographic and ecological awareness briefing the morning of the meeting.
- Upon arrival at the host site, the instructor introduces the practitioner, at which point the practitioner is given the "floor." Practitioners are encouraged to discuss their

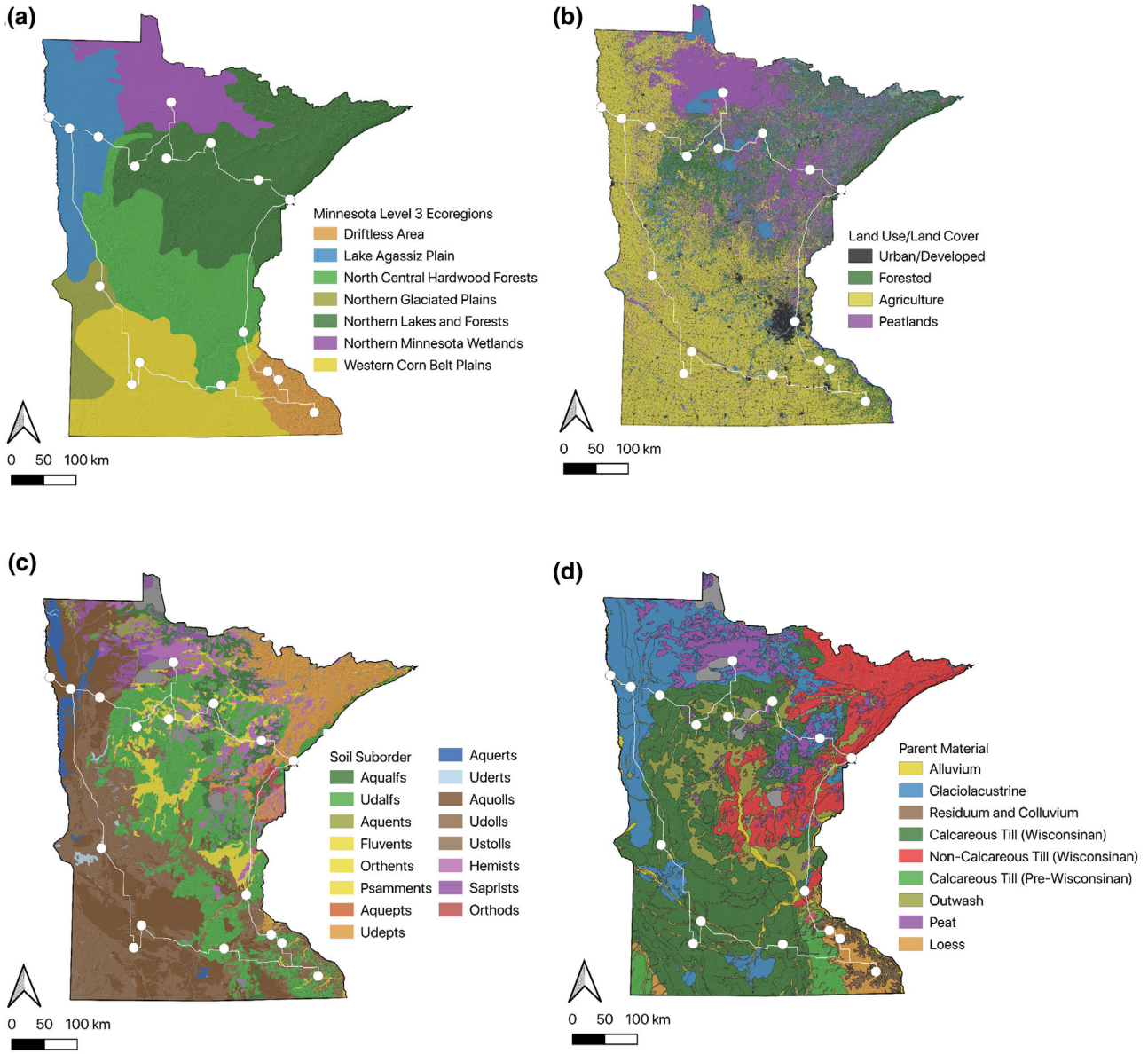

FIGURE 1 Route of travel and stops (white lines and dots) for the expanded Minnesota Soils and Land Use module of the traditional Field Study of Soils course, in relation to (a) U.S. Environmental Protection Agency Level III Ecoregions (USEPA, 2003), (b) modern land use and land cover (Knight, 2016), (c) soil suborders (Soil Survey Staff, 2019), and (d) soil parent material groupings (Hobbs & Goebel, 1982) across Minnesota

lifescapes (i.e., their lives, livelihoods, families, and resource management decisions) and the connection of their livelihoods to the landscapes they live in. They are presented as the primary vessels of knowledge by a mediating instructor (Figure 2a, Figure 2b).

- Students are encouraged to engage the practitioner in dialogue and discussion. These unstructured discussions occur in outdoor settings and often lead to unexpectedly deep, meaningful topics.
- Practitioners are asked to identify a site of interest for afternoon soil investigations. Even for the same practitioner, these sites often vary from year to year as their needs and interests change.
- Students and practitioners eat lunch together. Students set up lunch as a team activity and invite practitioners to share in class provided food.
- The instructor mediates soil investigation activities based upon the desires of the practitioner. These soil investigation activities typically entail re-constructing soil profiles along hillslopes or between contrasting sites using soil augers and gutters. The class is split into groups and set out on the landscape. The practitioner is free to interact with students as they conduct soil investigations (Figure 2c).
- These groups then re-assemble following independent investigations and share the results of their

FIGURE 2 Practitioner-led, place-based learning as a critical component to addressing student learning outcomes (SLOs) in the affective learning domain: (a) Keith Karnes (forester, Leech Lake Band of Ojibwe, Cass Lake, MN) demonstrates use of an increment borer to students; (b) Brad Myers (farmer, Middle Creek Sheep, Redwood Falls, MN) discusses crop management and soil and landscape variability with students; (c) Dave Morley (hydrologist, U.S. Forest Service) examines a soil core with students; (d) gutters filled with representative soil profiles from independent investigations are placed together while the landscape is conceptualized by students and practitioners; (e) students and practitioners on the Leech Lake Reservation (Chippewa National Forest); (f) students and practitioners (Grant and Dawn Breitkreutz) on the Breitkreutz family Stoney Creek farm near Redwood Falls, MN. Photo Credits: S. Perrone

investigations. Gutters containing reconstructed soil profiles are placed adjacent to each other and a white board is used to synthesize observations across hillslope positions or sites. These lead to broad, interactive discussions between the practitioner and students (Figure 2d).

- If the practitioner has additional questions requiring laboratory analysis, physical samples are taken, and data and interpretation is later returned to the practitioner by the instructor.
- The instructor mediates a synthesis and wrap-up of the discussion, and the practitioner is given an opportunity

to share last words and parting thoughts with the students. The students express their appreciation to the practitioner with a raucous round of applause and emotional gratitude (Figure 2e, Figure 2f).

4 | THEMATIC ANALYSIS OF UNSTRUCTURED NARRATIVE EVALUATIONS

4.1 | Approach

In conjunction with the novel second portion of the course Minnesota Soils and Land Use, from 2017 to 2019, students were prompted to write narrative, unstructured reflections of the course, being told that these would be used to support future improvement and continuation of the class. Without guiding questions or length requirements, these evaluations genuinely encapsulate the meaning and importance of the course for students. The length of these unstructured reflections ranged from ∼400 to more than 1,500 words. A limitation of analyzing unstructured, narrative evaluations is the potential for students to underreport learned skills and experiences; without directed questions about their development throughout the course, students may inadvertently omit some outcomes. However, writing unstructured narratives also allows students to express thoughts, emotions, and reflections without the burden of instructor guidance and may also reflect more accurately a range of lived experiences and important perspectives.

We reviewed all evaluations ($n = 38$) from the 3 years of course offering (2017, 2018, and 2019) to gauge the impact of the course. All evaluations remained anonymous and were transcribed into digital form by a departmental staff member not involved in the teaching of the course or the research process. We employed "thematic analysis," a method for organizing and describing qualitative data based on the identification of patterns or themes, on these narrative evaluations (Braun & Clarke, 2006; Peasland, Henri, Morrell, & Scott, 2019). This approach involves generating codes for qualitative data based on the students' reflection of their experience and self-identification of skills they learned. The goal of this analysis was to identify what students learned in the context of course objectives and learning domains. To facilitate data organization, we used the SLOs from the expanded version of the course to generate major themes expressed by students. The SLOs and major themes overlapped nearly seamlessly and thus were combined (Table 1).

The coding of the evaluations required identifying themes based on keywords or phrases in student writing that related to a defined theme and assigning them to that SLO. During the coding process, a sentence could be assigned multiple SLOs. However, a single SLO could not be counted multiple times for an individual course evaluation. The final assignment of sentences to themes required a consensus of the authors. The purpose of this was to conduct a semantic approach (Braun & Clarke, 2006) and, thus, avoid reading into the writing beyond what was intended by the student. After coding the qualitative data, total counts of student responses corresponding to each theme were calculated and compared to the total number of evaluations. This yielded the percentage of students who identified each SLO in their writing (Table 1).

4.2 | Results

Upon the conclusion of the coding process, there were six total SLOs framed under three learning domains from Bloom's taxonomy: psychomotor, cognitive, and affective (Table 1) (Anderson et al., 2000). Interestingly, the three most popular SLOs happened to each fall under a separate learning domain. The most popular SLO identified by students was personal and professional development (82%), which pertains to the affective learning domain. Although students expressed accruing passion and curiosity for soil science, some even felt confident and excited to bring their gained skills to the professional workforce. Additionally, students linked taking this course to personal growth and developing into a more well-rounded community member ($n = 17$, 45%)

The second most identified SLOs were application of technical skills (71%; psychomotor) and synthesis of soils/land use impacts (71%; cognitive). In their evaluations, students overwhelmingly expressed that this course built upon the foundational technical soils knowledge from basic soil science and the first portion of the Field Study of Soils course. Getting out of the classroom, into the field, and participating in this hands-on work with practitioners helped solidify student understanding and retention of concepts. Overall, students left with greater confidence in hand texturing, describing, and classifying soils. Pertaining to synthesis of soils/land use impacts, students expressed their ability to better comprehend the relationship between soils and land use. Students further pointed out that they could now identify the relevance of soils on a wider scale, specifically how soils relate to management and how management relates to environmental and political issues.

More than half of student narratives (58%) articulated experiences related to the SLO sense of place, community, and joy. Students routinely stated that this course cultivated a sense of place and community that led to a greater appreciation for the University of Minnesota and the state as a whole. Moreover, students' recognition of

TABLE 1 Student learning outcomes, thematic evaluation, and representative quotes from unstructured student narrative reflections on the expanded version of a traditional soils field course, emphasizing learning in the affective domain

Learning domain	Student learning outcome	Percentage of narrative responses ($n = 38$)	Representative quote from student evaluations
Psycho-motor	**Application of technical skills**: Master a body of knowledge and mode of inquiry. Develop technical skills by applying classroom concepts to field activities such as describing soils and identifying geomorphic features	71%	"Not only do I understand formation of soils in MN better, but I have a practical understanding of what the different soils mean in actual useful ways. I am far more confident in my understanding of this material and find myself able to recognize and identify characteristics of the land just by looking at it."
Cognitive	**Appreciating difference**: Appreciate and articulate the value of interacting with individuals whose backgrounds and/or perspectives differ from their own.	45%	"I got to see how the land that people live on directly shapes their lives. I would have never met these farmers, researchers, agronomists, peat harvesters. And others–and importantly, likely never understood their way of life–had I not taken this class. These peoples' stories were really important to hear."
	Synthesis of soils/land use impacts: Formulate connections between soils and land use. Demonstrate tolerance of ambiguity by navigating in complex environments where clear-cut answers are absent.	71%	"Complex, multi-stakeholder situations that are normally talked about in a hypothetical way on campus come to life in this course… The policies and decisions made in our Twin Cities have far-reaching implications. I didn't understand this until looking in the eyes of farmers and landowners whose businesses and livelihoods depend on people like us making the correct ones."

(Continues)

TABLE 1 (Continued)

Learning domain	Student learning outcome	Percentage of narrative responses ($n = 38$)	Representative quote from student evaluations
Affective	**Deep collaboration**: Develop interpersonal skills including effective communication, logistical coordination and planning, mutual support, and teamwork.	47%	"…I also think it's important to note how much learning on this trip happens between students from different academic backgrounds sharing their knowledge with the group. Our [class] quickly transformed from a group into a team…"
	Personal and professional development: Develop personal and professional skills for effective citizenship and life-long learning.	82%	"This may also be the most applicable class to the real world that I have taken. I have gained a new insight into careers in Minnesota that I could pursue. I am already considering places to apply after I graduate next year. I am extremely optimistic about my future in soil science and natural resources and can't wait to graduate next year and move into another stage of my life."
	Sense of place, community, and joy: Reflect on personal connection to the land, sense of place, pride or appreciation of the University's role in society, experience happiness, fun, and engagement.	58%	"But what I took to heart most was hearing how connected to the earth all of the land managers were–whether forester, sugar beet farmer, peat harvester, or organic farmer. Through this unique personal learning experience I realized that people are inherently tied to the land."…"I would recommend this course to anyone who wants to be out in the field face to face with some soils while having a blast…"

their institution as a leader in research led to enhanced pride. In addition, students discovered Minnesota in a different way by experiencing new parts of the state's landscape, which led to connection with the land and appreciation for the beauty and uniqueness of the state of Minnesota. From our thematic analysis, it became apparent that students also experienced joy in many ways. Joy could be found in several different aspects of the course experience, including but not limited to teamwork, friendship building, learning, and traveling, or even in "every second of [my time in] the class."

5 | DISCUSSION

5.1 | Psychomotor domain: Application of technical skills

Field courses offer ample opportunities to apply technical knowledge to real-life situations, and they are generally valued across scientific disciplines for their ability to help students acquire hands-on skills relevant to future professional careers (Hartemink et al., 2014; McPhee & Przedpelska, 2018). Therefore, it is not surprising that 71% of students in our course mentioned an increase in their confidence for independently carrying out tasks such as describing soil profiles, estimating soil texture, and identifying landscape characteristics affecting soil formation. It is likely that the teaching format of the course, with a mix of instructor-led and student- and practitioner-driven investigations, contributed to students' sense of competency in these technical skills (Peasland et al., 2019).

There are typically major differences in the types of tasks students are asked to carry out in the classroom environment and the types of tasks they will carry out as professionals. Field courses help bridge that gap through the application of technical concepts to real-world environments (McPhee & Przedpelska, 2018). It is our experience that building confidence in technical skills during the field course can also motivate students to seek out additional ways to hone their skills, such as enrolling in additional soil science classes or joining the campus soil judging team.

5.2 | Cognitive domain: Synthesis of soils/land use impacts and appreciating difference

Cognitive skill development is the primary goal of many efforts in higher education, and there is evidence that field courses in particular provide cognitive gains measured as higher final exam grades for participating students (Easton & Gilburn, 2012). Although grades may represent the instructor's definition of successful skill acquisition, we took the approach of using student unstructured narrative language to understand the cognitive skills students believed they gained from the course (Peasland et al., 2019). In these unstructured narratives, students consistently identified synthesis, or the ability to integrate knowledge into new concepts and understanding, as a valuable outcome. The evaluations presented examples of making integrative connections across situations and environments connecting soils and land use. They also highlighted the value of seeing real-life examples of the interdisciplinary connections between the fields of soil science, agricultural management, hydrology, ecology, and forestry. In alignment with other studies, we attribute some of the success in reported cognitive skill development to the rich, varied environments provided by a field course and the opportunities for active problem solving in small groups (Clary & Wandersee, 2013; Durrant & Hartman, 2015).

Incorporating the expertise of more than 20 practitioners from diverse professional and personal backgrounds primed students for synthetic thinking on the interconnected nature of soils and land use because they heard the same issues, such as food security, climate change, and sustainability, discussed by different practitioners in varied settings. The ability to integrate different perspectives and sources of information is relevant not only to synthesizing knowledge, but to recognizing and articulating the unique value that diverse people, perspectives, and experiences bring to the process of knowledge creation. We highlight the ability to "appreciate difference" as a distinct learning objective that involves recognizing the value and contributions of diverse actors. Students have few opportunities to practice this type of skill without the direct involvement of community members in higher education, and we are indebted to participating practitioners for the contributions they made to student learning and motivation in this course.

5.3 | Affective domain: Deep collaboration

Students built relationships with one another and the instructor through formal and informal interactions during camping, small-group work, and sharing meals. These opportunities for direct interpersonal interactions truly fostered a "field learning community" composed of students, the instructor, and practitioner experts (Jolley, Kennedy, Brogt, Hampton, & Fraser, 2018). The development of this fellowship is typically not available in traditional courses, and we feel that the combined experiences of a residential field course and interpersonal interactions with practitioners substantially enhanced

student experience (Hope, 2009). Our data and experience also support the idea that field courses enhance social relationships between students which may contribute to increased student motivation and engagement (Jolley et al., 2018; Stokes & Boyle, 2009).

It is important to note that positive affective states vary by student and over time throughout a field course, and negative affective states may also arise, such as anxiety and uncertainty in unfamiliar environments (Stokes & Boyle, 2009). The instructor can play a key role in mediating these negative experiences by setting expectations, developing a culture of trust and open communication from the onset of the course, and providing a safe space for students to ask questions and express concerns about various aspects of the field experience.

5.4 | Affective domain: Personal and professional development

Incorporating a diversity of perspectives throughout the course allowed students with different professional goals to interact with role models in many fields. In evaluations, many students expressed a sense of increased inspiration and confidence related to their future careers as a result of these interactions. In the 2019 cohort, two students committed to soil science minors by the end of the course, whereas another decided to pursue a forestry minor. We also found it notable how many students referred to a sense of personal development, or becoming a better person and community member, as a result of the course. We attribute this experience of personal fulfillment to the authentic interpersonal experiences of trust and communication students were able to have with one another and with diverse practitioners outside of the typical campus context.

5.5 | Affective domain: Sense of place, community, and joy

The Minnesota Soils and Land Use course module is explicitly place-based in the sense that it gives attention not only to the scientific meanings of diverse landscapes in Minnesota but also the cultural and social meanings of landscapes through the lens of environmental issues, indigenous land management, and other topics (Jolley et al., 2018). Place-based learning is a useful way to connect science and societal challenges (Gosselin et al., 2016) and instill a sense of place that can make students more likely to care about what they are studying by activating their psyche (Kudryavtsev et al., 2012). One instructional approach in this course that likely contributed to students' sense of place was the encouragement of independent exploration and investigation at the field sites (Jolley et al., 2018). Students worked together in small groups and came together with the larger group to share their findings and hypotheses about the phenomena they observed, giving them ownership and a sense of connection to the landscape.

One of the tensions in place-based natural science education is the fact that science typically aims to find universal, generalizable truths, whereas a sense of place relies on personal identification and connection to a particular, unique place and the intertwined ecological and social factors that create it (Van Eijck, 2010; Williams, 2014). Some non-Western pedagogies offer a solution by highlighting the value and imperative of recognizing and drawing from one's own positionality in scientific work (see, e.g., Wilson, 2008). In their narratives, students articulated personal experiences of connection to the landscape and the university community as a result of course activities. They also commented on an increased sense of empathy and understanding for the way that diverse practitioners relate to the land. There is evidence that students associate positive emotional states—both their own and that of the instructor—with effective teaching and learning (Moore & Kuol, 2007). We also highlight joy to emphasize the role of positive emotions in student perceptions of the discipline of soil science and their abilities as future professionals (Hartemink et al., 2014). The experience of joy and fun throughout a field course can serve as an entry point to deeper engagement with the scientific material and landscape.

5.6 | Transferability

We believe that the approach taken here is readily transferable to institutions that have already formally developed practitioner relationships integrated into the curriculum (Verma et al., 2016). However, there may be limitations to this approach as well. First, this approach requires significant continuous investment by the instructor in relationship-building throughout the year with practitioners who often live far from campus. These relationships can be built and maintained by mail or email correspondence and sharing of class pictures or laboratory data on soils specific to their site. Second, logistical challenges due to the additional course time, cost, and student and academic schedules could result in barriers to adoption. This version of this course is taught as a May session course, immediately following spring semester final exams. Although the timing is advantageous for students who may be starting summer internships or employment in June, it can be challenging from the perspective of some practitioners, particularly for farmers who may be in the midst of planting season. Despite these specific constraints

on logistics and resources, and increased requirements on instructor preparation time for maintaining relationships with practitioners, we believe this approach can be successfully adapted in part or whole across a diverse range of soils field courses.

6 | CONCLUSIONS

Today's students of natural resources face a dynamic professional future defined by complex environmental, political, and social environments. Soil science as a major environmental discipline can play an important role in preparing students for this contemporary professional landscape. In the described course, we found that integrating SLOs in the affective domain to a traditional soils field course can (a) improve student teamwork, communication, and interpersonal skills; (b) inspire deep reflection for students on their roles as a citizens and a professionals; and (c) develop a sense of community, connection, and joy in students that anchors learning with self discovery. This learning is achieved by inspiring confidence through iterative small group work, centralizing the roles of practitioners as the primary sources of knowledge, building reciprocal relationships, and implementing place-based curricula. The outcome is a group of students that have grown and changed through the course and continue to move forward in the world with a diverse set of skills and a new perspective on problem identification and management.

Looking forward, we are excited by opportunities to continue to expand this course in useful and innovative ways that may broaden learning and accessibility. Specifically, the expansion of what is considered to be "the field" to include urban and suburban environments (Fleischner et al., 2017) could serve to increase diversity of practitioners, types of stakeholders, and challenges faced by land managers. Further, opportunities for the integration of new technologies, such as incorporating augmented or virtual reality approaches to learning (Vaughan, Vaughan, & Seeley, 2017), could improve access for students prevented from taking the class due to personal responsibilities or students of various abilities that may be unable to access field sites. New forms of content delivery and modes of interaction are especially pertinent in a world halted by global crises, such as the COVID-19 pandemic, which is current as of this writing.

The approach that we outline here is one specific example of how a traditional soils field study course can be adapted and expanded to meet high-level learning outcomes in the affective domain and grow the hearts and minds of students and practitioners through shared discovery and place-based interactions. We hope it inspires others to integrate similar SLOs into field soil science courses to better equip students with lifelong skills to explore soils and landscapes with people from all walks of life.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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