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Rebecca A. Young
University of Nebraska-Lincoln

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

Nicolas A. Jelinski
University of Minnesota

Amber D. Anderson
Iowa State University

Kerry M. Clark
University of Missouri

See next page for additional authors

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Jumble judging: Cognitive and affective outcomes of intercollegiate collaboration at a soil judging competition

Rebecca A. Young[1] | **Judith K. Turk**[2] | **Nicolas A. Jelinski**[3] | **Amber D. Anderson**[4] | **Kerry M. Clark**[5] | **Ashlee Dere**[6] | **Colby J. Moorberg**[7] | **Kristopher Osterloh**[8] | **DeAnn Presley**[7]

[1]Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, Nebraska, USA

[2]Conservation and Survey Division, School of Natural Resources, University of Nebraska-Lincoln, Lincoln, Nebraska, USA

[3]Department of Soil, Water, and Climate, University of Minnesota, Saint Paul, Minnesota, USA

[4]Department of Agronomy, Iowa State University, Ames, Iowa, USA

[5]College of Agriculture, Food and Natural Resources (CAFNR), University of Missouri, Columbia, Missouri, USA

[6]Geography/Geology Department, University of Nebraska-Omaha, Omaha, Nebraska, USA

[7]Department of Agronomy, Kansas State University, Manhattan, Kansas, USA

[8]Raven Precision Agriculture Center, South Dakota State University, Brookings, South Dakota, USA

Correspondence
Judith K. Turk, Conservation and Survey Division, School of Natural Resources, University of Nebraska-Lincoln, Hardin Hall 607, Lincoln, NE 68583, USA.
Email: jturk3@unl.edu

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Abstract

Student–student interactions are influential parts of field experiences. While competitive judging events are a fun way to engage students in field-based learning, the focus on competition leads to an atmosphere that discourages collaboration between students. The objective of this study was to evaluate the cognitive and affective learning outcomes resulting from intercollegiate collaboration at a soil judging competition. Teams with students from two to three different universities were assigned and referred to as jumble judging teams. Jumble judging was held for the first time in the 2021 Region 5 Collegiate Soil Judging Contest. Learning outcomes were assessed using a pre- and postsurvey, as well as group and individual reflections completed in the field. Student responses were generally positive, with 70% of students expressing agreement or strong agreement that they would like jumble judging to be included in future contests, 54% citing jumble judging as one of the best parts of the contest, and 93% identifying learning outcomes or describing an affective learning experience resulting from jumble judging. Evidence of both cognitive and affective learning were identified through student surveys and reflections. Overall, the event created a collaborative and collegial atmosphere and increased interaction between students from different universities, while maintaining the competitive nature of the event that motivates many students to get involved with judging teams.

1 | INTRODUCTION

In cooperative learning activities, students work with peers in pursuit of a common goal. Through cooperative learning, students share knowledge and experiences. The active participation and communication between students lead to cognitive learning (i.e., understanding concepts and skills) (Macpherson et al., 2011) and influences students' affective response (i.e., attitudes, emotions, and motivations) (Kortz et al., 2020). Although lower performing students with less prior understanding of subject matter may be the strongest beneficiaries of cooperative learning activities (Johnson & Johnson, 1983; Macpherson et al., 2011; Mora, 2010), high-performing students may also benefit from cooperative learning through gains in self-esteem, confidence, and oral rehearsal of information (Johnson et al., 1985; Neber et al., 2001). In addition to improved learning around the subject matter, cooperative learning helps students learn to work with others, improves communication skills, and better prepares students to be productive members of workplace teams (Johnson & Johnson, 1983; Macpherson et al., 2011). These are important skill sets for students to practice, as many employers consider teamwork and collaboration critical competencies for prospective employees (Gosselin et al., 2016).

In the classroom, cooperative learning may be incorporated through peer instruction, think-pair-share questions, jigsaw activities, and tiered exams (Macpherson et al., 2011). Such activities lead to development of a deeper understanding of concepts through explanation and negotiation that takes place between students (Mora, 2010). Most students report that cooperative learning is both effective and enjoyable, suggesting a willingness to learn from and share knowledge with peers (Macpherson et al., 2011; Mora, 2010). Outcomes may be purely cognitive or affective, or combination of the two. For example, improved performance with tiered exams may reflect cognitive gains as students learn from their peers, or it may stem from the confidence that initially lower performing students gain from their experiences of success in group exams.

In designing field experiences, as in the classroom, it is important to consider the role of student–student interactions, which may go beyond cognitive gains to influence larger issues, including career decisions. Field experiences are critical to student retention within geoscience majors (Kortz et al., 2020). Presumably, this is also true in other majors within the natural sciences. Efforts to design field-based courses around affective learning objectives have also been shown to result in transformational experiences (Jelinski et al., 2020). Furthermore, the educational persistence of students is primarily related to affective factors, including increasing self-efficacy (e.g., from gaining mentors and getting to know peers) and developing a sense of identity within the profession (e.g., by being part of a community) (Kortz et al., 2020).

Core Ideas

- An intercollegiate collaborative activity was implemented at a soil judging competition.
- Students responded positively to collaborating with their peers from other universities.
- Increased collaborative learning led to cognitive and affective outcomes.

Judging contests are a prominent and influential field experience in the education of many students in the environmental and agricultural fields. Collegiate soil judging contests have been held at a national level since 1961 (Cooper, 1991). However, a focus on competitive aspects of the field experience can lead participants to prioritize individual accomplishments over the benefits that can be gained through student–student interactions. In a typical soil judging contest, teams from various colleges and universities travel to a location selected by the host institution, spend 3–4 days in the field describing local soils, followed by 1–2 days of competition (Owen et al., 2021). Through such contests, students obtain practical, hands-on experience and gain confidence at making interpretations in the field (Cooper, 1991).

Cooperative learning was initially incorporated into soil judging with the addition of a group judging component to the contest. Group judging was first implemented in the 1990 Region 5 Collegiate Soil Judging Contest (Cooper, 1991), and subsequently adopted in most of the other regional and national soil judging contests. In the group judging portion of the contest, students from a single university or college work as a team to describe the soil and submit one score sheet for grading. As with other forms of cooperative learning, students benefit from discussions that take place as they work together and come to an agreement regarding how they describe and interpret the soil. In the first group judging contest, teams were limited to four individuals, a 1 hour time limit was imposed, and only one of the four contest pits was group judged. Student feedback was favorable, with 96% of students expressing a desire to continue this component of the contest (Cooper, 1991). However, students suggested that they would have liked extra time on group judging to allow for more discussion.

In the years since, group judging has become a larger component of the contest in Region 5, with three out of five contest soil pits being group judged. In addition, the size of teams is no longer restricted to four individuals, and in some cases, teams are exceptionally large (e.g., 17 individuals on a team). Interestingly, with larger teams the strategy has shifted, such that the division of labor to optimize efficiency is prioritized and the idea of allowing extra time to encourage discussion

during group judging has fallen lower in priority. Although this format of group judging leads to high scores and competitive teams, it raises concerns that some cognitive gains from collaborative learning are lost.

Beyond the student–student interactions that take place during the contest and practice days in the field, the contest as a whole provides opportunities for students to connect in ways that may promote self-efficacy and an identity within the profession (Kortz et al., 2020). Students attend group dinners, presentations by local soil experts, and an awards ceremony. In response to a survey given during remote soil judging contests, which were held by some regions during the coronavirus pandemic, 23% of students cited lack of social interactions within and among teams as one of the problems with the remote format (Owen et al., 2021). Earlier surveys conducted at soil judging events have also suggested that students benefit from the exchange of ideas between faculty and students from participating institutions (Post et al., 1974). Thus, this study considers how contests might be structured to increase such interactions.

Interestingly, in the earliest attempt at group judging, when teams were limited to four individuals, alternates were placed on mixed-university teams and were noted to benefit from the interaction with their teammates from other schools (Cooper, 1991). In this study, the idea of collaboration across institutions is revisited, not just for alternates in group judging, but for all student participants, as a third part of the soil judging contest (separate from single-university group judging). This part of the contest is referred to as "jumble judging" to reflect the mixed, intercollegiate composition of the teams. The objective of this study was to evaluate students' cognitive gains and affective responses associated with collaboration across universities through implementation of jumble judging at a regional soil judging contest.

FIGURE 1 Location of Crookston, Minnesota, and major land resource areas 56A and 56B within soil judging Region 5.

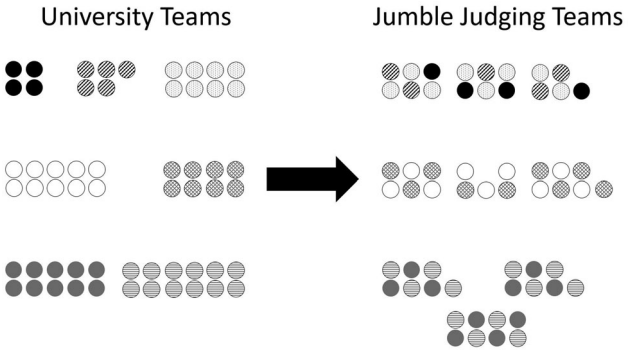

FIGURE 2 Illustration of how students were shuffled into jumble judging teams. Each pattern represents a different university. Teams on the same row of the illustration were assigned to practice sites in the same geographic area each day, making it possible to gather at the end of the day and work together on jumble judging.

2 | MATERIALS AND METHODS

The United States is divided into seven regions for collegiate soil judging and regional contests are held in the fall of each year. Teams from colleges and universities throughout a region travel to the contest location and spend 3–4 days in the field learning about the local soils prior to the contest, which takes place over 1–2 days. Most regions now include both individual and group judging in the contest. Region 5 encompasses the North Central part of the United States. In 2021, seven teams participated in the Region 5 contest—Iowa State University, Kansas State University, South Dakota State University, University of Minnesota-Twin Cities (host), University of Missouri, University of Nebraska-Lincoln, and University of Nebraska-Omaha. The contest was based in Crookston, MN, and focused on soils of the Lake Agassiz plain and surrounding beach ridges in Major Land Resource Region 56A and 56B (Figure 1) (USDA-NRCS, 2022).

For the newly added jumble judging portion of the contest, students were shuffled into randomly assigned jumble judging teams containing members from different universities (Figure 2). Due to time constraints during the contest day, jumble judging pits were judged by students during the practice days. These pits were included as part of the competition even though they took place prior to contest day. One jumble judging pit was included at the end of each practice day. Due to practice sites at widely distributed locations throughout the contest region, jumbled teams were limited to members from two to three universities who were assigned to practice sites that were in close proximity. This allowed teams that were in a jumble judging group to easily assemble at the end of the day. Students in each grouping of teams were split

into three jumble judging teams consisting of five to eight members (Figure 2). The teams were the same for all 3 days of practice. The jumble teams did not have any practice judging soils together before competing as a group at their first jumble judging pit. For jumble judging teams to be created efficiently, it was required that coaches submit the names of all student participants before the first day of practice so that the contest host could arrange the jumble judging teams and distribute this information to coaches.

During jumble judging, one coach was designated as moderator and was responsible for timing, distribution and collection of scorecards, and ensuring that contest rules were followed. At the first jumble judging, pit students were given 10 min before the start of judging to meet their teammates and discuss how they planned to work together. On the second and third days of jumble judging, this extra time was not provided. The teams were then given 80 min for judging, in which each jumble judging team worked together to complete one scorecard for grading. Teams were given access to the soil pit in three rotations of five minutes, three rotations of 10 min, three rotations of 5 min again, followed by 20 min of free time in which the pit was open to all students. Coaches were not allowed to interact with their students during jumble judging. Scorecards were collected at the end of the 80 min and held by the coach designated as jumble judging monitor until contest morning. After collection of the scorecards, coaches went over the key with the students, so that they could also use the jumble judging pits as a learning experience. Coaches were also permitted to meet with their university's team and talk about important features of the jumble judging soil pit after judging was complete.

Jumble judging was scored according to official contest rules and included as a part of the contest, with awards given to the top three jumble teams. Official grading of the jumble judging scorecards took place on contest morning and followed the same protocols as used for scoring regular contest pits (see Contest Guidebook in Supporting Information). Mean scores were compared between the three successive days of jumble judging using a one-way ANOVA test, and jumble versus single university team judging scores were compared using a *t*-test.

Students completed pre- and postsurveys on student learning outcomes during the contest, as well as daily reflections completed after each jumble judging pit. The precontest survey was completed by students during the welcome dinner held the evening that teams arrived at the contest site in Crookston, Minnesota. The postcontest survey was completed prior to the awards ceremony at the end of the week. Both surveys were conducted on paper and the questions on the surveys were based on those used in previous evaluations of student learning at soil judging contests (Owen et al., 2021; Rees & Johnson, 2020). Topics addressed in the presurvey included demographics, expectations for the week, self-assessment of how well students understood relevant soil concepts, and attitudes toward soil judging and soil science. Assessment of understanding questions were posed on a 5-point Likert scale: no understanding (1), little understanding (2), some understanding (3), good understanding (4), and master (5). Attitudes were also assessed using a 5-point Likert scale: strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), and strongly agree (5). Expectations for the week were posed in three open-ended questions: (a) What are you most looking forward to during the soil judging contest near Crookston, Minnesota? (b) What part(s) of the contest do you think you will least enjoy? (c) What do you expect will be the most educational part of the soil judging contest?

The postcontest survey included the same demographic questions, self-assessment of understanding of soil concepts, and survey of attitudes toward soil judging and soil science as the presurvey. The postsurvey reflection included three open-ended questions: (a) What was the best part(s) of this contest? (b) What was the worst part(s) of the contest? (c) What was the most educational part of the soil judging contest? The postcontest survey also included a set of 5-point Likert scale questions that assessed overall student attitudes about the jumble judging activity.

Daily reflections were completed in the field after each jumble judging pit. The reflections were completed by each jumble judging team as a group on the first 2 days. The third and final reflection was completed individually. For the group reflections, students were asked: (a) In a few sentences, describe what went well with today's jumble judging activity. (b) In a few sentences, describe what did not go well with today's jumble judging activity. (c) In a few sentences, describe how/what your group plans to do differently for tomorrow's jumble judging activity. Students were instructed to consider various aspects of the experience, such as techniques, group collaboration, problem-solving, communication, and overall group dynamic. In the individual reflection, students were asked: (a) Did you learn anything new from the jumble judging activity that you did not learn/do in your normal soil judging practice? (b) Suggestions for future jumble judging activities? The daily reflections were coded according to the theme of the response, using the categories of social, physical, cognitive, and affective (Kortz et al., 2020). Topics coded as social included communication and teamwork. Topics coded as physical included weather (e.g., heat), plants (e.g., thorns), and time (e.g., being tired at the end of the day). Any mention of skills, methods, and concepts were coded as cognitive. Topics coded as affective included self-doubt, moods, emotions, sense of belonging, confidence, networking, and bonding. Reflections that included multiple themes were assigned to all relevant coding categories. Coding was performed independently by two researchers and all disagreements were discussed and resolved by consensus.

Coaches from each university (i.e., authors of this paper) were asked to complete a survey, which was distributed by email after the contest. The coach's survey included five open-ended questions: (a) What were some positive outcomes of the jumble judging part of the contest? (b) What were some negative outcomes of the jumble judging part of the contest? (c) Was there anything you found surprising about the jumble judging event? (d) Do you think we should continue this event? Why or why not? (e) Do you have any ideas for how jumble judging might be improved if we try it again?

3 | RESULTS AND DISCUSSION

3.1 | Student demographics

Fifty-seven students competed in the Fall 2021 Region V Collegiate Soil Judging Contest. Pre- and postcontest survey responses, as well as individual reflections of the jumble judging activity, were collected from all participants. Two percent of the students were freshman, 14% were sophomores, 26% were juniors, 53% were seniors, and 5% of the students responded as "other" for their undergraduate academic standing. Of the respondents, 58% responded that this was their first year of soil judging, 23% said that this was their second year of soil judging, and the remaining 19% that they had participated in soil judging for 3–5 years. Overall, 35% of students responded that their academic major was in environmental science, while 21% responded that they major in agronomy, 14% in geology, 10% in natural resources management and conservation, and the remaining students listed other majors such as plant science or agricultural education. Of the respondents, 32% indicated that they had taken one college-level soil science class, 21% had taken two classes, 21% had taken three or four classes, 17% had taken between five and ten classes, while 9% indicated that they had not taken a college-level soil science class.

3.2 | Jumble judging scores

The daily mean scores in the jumble judging contest ranged from 66.5% to 69.8% and showed no trend over time (Figure 3). Comparison of scores by ANOVA revealed no significant difference between the 3 days of the contest ($p = 0.46$). In addition, mean scores were very similar when students worked together on soil judging regardless of whether they were working with an intercollegiate jumble judging team (mean score = 68%) or their own university team (mean score = 70.1%) (Figure 4). No significant difference was found between jumble judging and team judging scores based on a two-tailed *t*-test comparison ($p = 0.30$).

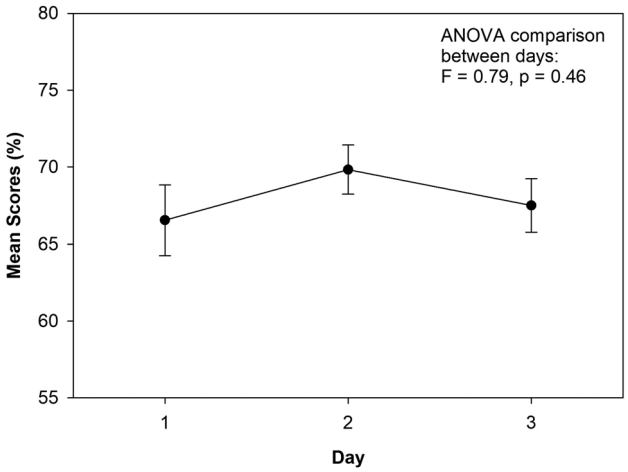

FIGURE 3 Mean scores on jumble judging over three successive days. Error bars depict the standard error.

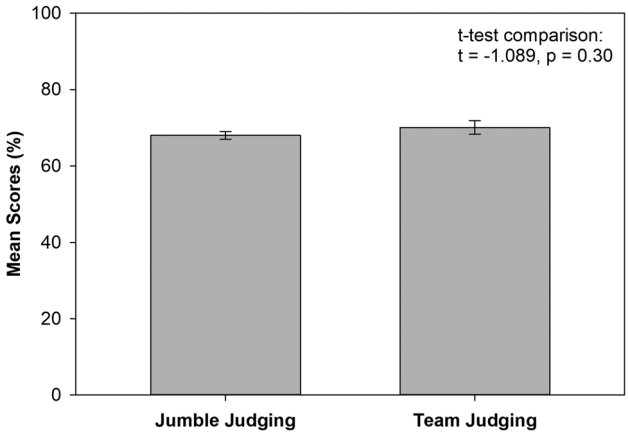

FIGURE 4 Comparison of mean scores on jumble judging and single-university team judging pits. Error bars represent standard error.

These results convey that student performance was neither improved nor lost when they were assigned to work with students from other universities. While we hypothesized that the score would improve as the jumble judging teams gained experience working together over 3 days, no such improvement was observed. Mental and physical fatigue may have played a part; practice days are long (8–10 h) and the jumble judging pits were at the end of the day.

3.3 | Group reflections

When reflecting on what went well during jumble judging, the majority of groups focused on social aspects of the experience on both day one and two, but often in combination with cognitive or affective aspects (Table 1). For example, one group wrote, "Forming a plan as a group; bounced ideas off each other well (boundaries!); learning new methods (texture!)."

TABLE 1 Themes identified in student reflections on jumble judging.

Reflection prompt and day	Response themes (count)			
	Social	Physical	Cognitive	Affective
Group reflection prompt 1: In a few sentences, describe what went well with today's jumble judging activity (N = 9)				
Day 1	9	1	5	1
Day 2	8	0	4	5
Group reflection prompt 2: In a few sentences, describe what did not go well with today's jumble judging activity (N = 9)				
Day 1	4	4	5	2
Day 2	2	2	3	4
Group reflection prompt 3: In a few sentences, describe how/what your group plans to do differently for tomorrow's jumble judging activity (N = 9)				
Day 1	5	1	8	0
Day 2	2	2	6	3
Individual reflection prompt: Did you learn anything new from the jumble judging activity that you did not learn/do in your normal soil judging practice? (N = 57)				
Day 3	16	0	40	8

This was considered social (i.e., how they worked together) and cognitive (i.e., methods and skills) in theme. Another group wrote, "We had really good teamwork, great mixture of the schools working together on the same things. Everyone jumped in and got dirty and had fun. We all have really good communication and know how to be social and not be afraid to ask the hard questions." This was considered as social and affective because they discussed teamwork and communication, but also their emotional responses of "having fun" and being "unafraid." More affective statements were identified on day 2 compared to day 1, reflecting increased use of emotional language on the reflections as the teams spent more time working together.

In their reflections on what did not go well, there was an even distribution of social, physical, and cognitive themes on day 1 (Table 1). For example, one group focused on social and cognitive themes in their reflection, "Slope was hard to choose from. Group overall communicated but lost track of responsibilities." Another group reflected only on physical challenges, "I sat on a thistle, too many thistles; took a minute to find footing." On day 2, the responses had more cognitive and affective themes. For example, "Figuring out landform; overthinking."

When reflecting on what to do differently the next day, most responses focused on cognitive themes on both days, but often combined these with social or affective themes (Table 1). Affective themes were again found to increase on day 2. For example, on day 1, one group reflected, "Split color and texture. More checks and balance." This includes both cognitive and social aspects. On day 2, one group included social, cognitive, and affective elements in their reflection, "Take representative samples after boundary discussion; be more open to double checking and respect."

In general, students reflected that social aspects of jumble judging went well, while their reflections on how to improve tended to focus on cognitive themes. When reflecting on what did not go well themes were nearly equally divided between the social, physical, cognitive, and affective domains. Across all parts of the reflections, affective themes emerged more on the second day.

3.4 | Individual reflections

The majority (82%) of students indicated that they learned something new from jumble judging that they did not learn in their normal soil judging practice. Another 11% indicated that they did not feel they learned anything, but did describe an experience related to affective outcomes. Cognitive learning outcomes made up 70% of responses (Table 1). These responses focused on new field techniques, strategies, resources, or soil concepts. Techniques for soil texture were mentioned in more than half of the responses focusing on cognitive themes. This reflects the diversity of approaches that instructors take toward teaching this skill and the challenge that it presents to many students (Turk & Young, 2022). Students mentioned a variety of texture techniques that were shared during jumble judging, including feeling for grit with the teeth, visual assessments for sand, and the wire method for clay. Social learning was included in 28% of responses. These included statements such as, "Having new groups helped in discovering new group cohesion techniques" and "I learned how to work with people I don't know." Affective aspects of learning were brought up within 14% of responses, with students describing their experiences dealing with compromise, gaining comfort at speaking one's mind, teaching others, and having fun. However, many of these affective responses

conveyed that the students did not view these experiences as a form of learning. They made statements such as "No [I did not learn anything], but did teach others."

Most suggestions for improvement of the jumble judging activity focused on increasing the diversity of the teams and changing the timing of the event. Regarding the diversity of the teams, students expressed that they would like to be on teams with one student from each university, rather than a few individuals from two or three universities. With regard to timing, students expressed that they had extra time during jumble judging and the time allotted could be shortened. Many students also expressed that they would rather do jumble judging earlier in the day when they are less tired and have more energy to work with other people. Upon reflection on these suggestions, it seems possible to structure jumble judging in a way that would accommodate both increased team diversity and moving the event earlier in the day. One way to accomplish this could be to designate one field site with three soil pits, located centrally in the contest area, where all teams could meet each morning for jumble judging. The central location and common meeting place would make it possible to create jumble teams with members from more than two or three universities. The jumble judging pit would be the first pit of the day, after which teams could disperse to separate field sites around the region for the rest of the day. Moving jumble judging to the start of the day would reduce waiting if a team is running late in their practice schedule.

Another common suggestion was to incorporate an ice-breaker or social activity during the welcome dinner, which would allow the jumble judging team to get to know each other better before working together. Depending on the conventions of the contest (i.e., if a welcome dinner is typically held), this is a suggestion that could easily be accommodated. The ice-breaker could be a generic activity that helps the groups get to know each other personally and build community. However, ice-breakers in higher education are thought to be more effective when they are relevant to the class subject and designed around the interests of the targeted group (Eggleston & Smith, 2004). Therefore, a better approach may be to design an ice-breaker that encourages students to share their experiences in soil judging, why they are at the contest, and their values around competition and collaboration.

3.5 | Attitudes survey

In response to Likert scale attitude statements, students showed agreement (i.e., mean significantly greater than three) for all statements (Table 2). This included attitudes related to cognitive, social, and affective outcomes of jumble judging. Attitude statements that focused primarily on affective outcomes received some of the highest ratings. This included the impact of jumble judging on helping students feel like a valued member of the regional soil judging community (3.72) and if they had fun jumble judging (3.98). Regarding cognitive gains, students generally agreed that the activity improved their problem solving skills, but this was among the lowest scoring attitudes, with an average rating of 3.6. This was also the only attitude for which significant differences were identified between first-year students and those with past soil judging experience. The average score for first-year students was higher (3.82) compared to the experienced judgers (3.23) ($p = 0.017$), indicating that the cognitive gains from jumble judging were greater among students who were new to soil judging. This finding is similar to other cooperative learning studies, which reveal the students who benefit the most are those with the least prior understanding of the subject matter (Johnson & Johnson, 1983; Macpherson et al., 2011; Mora, 2010). Students' attitudes related to social aspects of the contest varied. The highest scores (4.04) were given to the attitude statement that the activity improved their skills to collaborate with more diverse teams and backgrounds. This high score is likely related to students' literal interpretation of the statement, which is a direct description of what took place during jumble judging (i.e., they had to collaborate with different groups of students). Scores were also high when students rated the impact of jumble judging for strengthening their social network (3.82), which suggests broader and more affective impacts (i.e., sense of community). However, lower scores were given for the impact of jumble judging for strengthening their professional network (3.53). There was a large gap between first year (3.38) and returning soil judgers (3.72) for this attitude statement. Although this difference was not significant ($p = 0.138$), it is reasonable to hypothesize that returning soil judgers are thinking more seriously of soil science as a career path and therefore see more professional benefits of forming connections within the soil science community. Importantly, students also showed an agreement that they would like jumble judging to be included in future soil judging contest, with an average Likert score of 3.84.

Overall, the surveys convey positive attitudes toward the jumble judging activity. More specifically, students felt benefits from jumble judging in the social and affective dimensions. These aspects of field experiences may increase student motivation and engagement with the subject matter (Jelinski et al., 2020) and are critical to student persistence within a field of study (Kortz et al., 2020). Cognitive outcomes were rated somewhat lower, especially among students with past soil judging experience. This is an interesting contrast to the reflections, in which students primarily focused on cognitive outcomes when asked what they learned from jumble judging. This may reflect the greater focus on cognitive learning outcomes in higher education, leading students to default towards this type of response when asked what they "learned."

TABLE 2 Student Likert-scale ratings of attitudes statements.

Group	Response (%)					Mean	*p*-Value
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
The jumbled judging activity improved my problem solving skills.							
All (N = 57)	1.8	7.0	35.1	42.1	14.0	3.60	<0.001
First year (N = 34)	0.0	3.0	29.4	50.0	17.6	3.82	0.017
2+ years (N = 23)	4.3	13.0	43.5	30.4	8.7	3.26	
The jumbled judging activity improved my skills to collaborate with more diverse teams/backgrounds.							
All	0.0	1.8	22.8	45.6	29.8	4.04	<0.001
First year	0.0	3.0	23.5	44.1	29.4	4.00	0.683
2+ years (N = 23)	0.0	0.0	21.7	47.8	30.4	4.09	
The jumble judging activity helped me to feel like a valued member of the regional soil judging community.							
All	0.0	10.5	22.8	50.9	15.8	3.72	<0.001
First year	0.0	11.7	23.5	50.0	14.8	3.68	0.652
2+ years (N = 23)	0.0	8.7	21.7	52.2	17.4	3.78	
The jumbled judging activity strengthened my social network.							
All	0.0	5.3	28.1	45.6	21.1	3.82	<0.001
First year	0.0	8.9	29.3	41.2	20.6	3.74	0.326
2+ years (N = 23)	0.0	0.0	26.1	52.2	21.7	3.96	
The jumbled judging activity strengthened my professional network.							
All	0.0	12.3	36.8	36.8	14.0	3.53	<0.001
First year	0.0	20.6	32.3	35.3	11.7	3.38	0.138
2+ years (N = 23)	0.0	0.0	43.5	39.1	17.4	3.74	
The jumbled soil judging activity was fun.							
All	3.5	5.3	12.3	47.4	31.6	3.98	<0.001
First year	3.0	5.9	8.9	52.9	29.3	4.00	0.873
2+ years (N = 23)	4.3	4.3	17.4	39.1	34.8	3.96	
If I participate in another soil judging contest, I would like it to include a jumble judging component.							
All	3.5	10.5	15.8	38.6	31.6	3.84	<0.001
First year	3.0	14.7	14.7	44.1	23.5	3.71	0.259
2+ years (N = 23)	4.3	4.3	17.4	30.4	43.5	4.04	

Note: The *p*-value in rows labeled "All" was determined from a two-tailed *t*-test with the hypothesized mean of 3. The *p*-value between rows labeled "first year" and "2+ years" was determined from a two-tailed *t*-test comparing these two groups.

3.6 | Pre- and postcomparison

When asked what they were most looking forward to on the precontest surveys, only 21.1% of students mentioned jumble judging (or related topics) (Table 3). However, in the postsurveys 53.5% of the students included jumble judging (or related topics) in their reflections on the best part(s) of the contest. This result suggests that jumble judging was an impactful part of the contest that exceeded student expectations. However, when asked about the most educational part of the contest, the number of references to jumble judging decreased from 22.8% on the presurvey to 10.3% on the postsurvey. This is surprising considering the numerous examples of cognitive learning that students described in their individual reflections on jumble judging (Table 1). However, it is similar to the Likert scale attitudes survey, which showed relatively lower scores for student impression of their cognitive gains during jumble judging and higher scores for social and affective outcomes (Table 2). In answering the question about the "most educational" part of the contest, students seem to have focused on cognitive learning above other educational aspects of the experience. A minority of students (less than 10%) conveyed that they were not looking forward to jumble judging on the presurvey and that jumble judging was among the worst part(s) of the contest on the postsurvey. In most cases, these students felt that the collaborative nature of jumble judging detracted from the competitive aspects of the contest.

TABLE 3 Percentage of pre- and postsurvey responses making reference to jumble judging or related themes. Related themes included peer-learning, team/group collaboration, and networking.

Survey type	Survey prompt	Percent of responses including jumble judging or related themes
Pre	What are you most looking forward to during the soil judging contest near Crookston, Minnesota?	21.1
Post	What was the best part(s) of this contest?	53.5
Pre	What part(s) of the contest do you think you will least enjoy?	5.3
Post	What was the worst part(s) of the contest?	6.8
Pre	What do you expect will be the most educational part of the soil judging contest?	22.8
Post	What was the most educational part of the soil judging contest?	10.3

3.7 | Coaches' reflections

The coaches of the soil judging teams (i.e., authors of this paper) appreciated that the jumble judging activity increased peer learning and led to more and varied student–student and student–instructor interactions. One downside that they noted was that it took up time on practice days, so they had less time for instruction and training activities with their own students. Similar to the students, the coaches felt that the activity would benefit from a structure that allows for more diverse teams (i.e., more universities represented on a single jumble judging team) and noted that the time allotted for jumble judging was more than what was required. The coaches also noticed that some students were hesitant to share ideas and methods, and were afraid that sharing team "secrets" would harm their university team's competitive edge. Designing an ice-breaker for opening night that encourages students to think about the broader outcomes of soil judging (i.e., long-term career goals over short-term contest goals) may be one way to overcome some of this hesitation. Aside from this issue with some students, coaches were overall surprised at the collegial atmosphere that jumble judging created, and the positive and respectful collaborations that took place between students from different university teams. The coaches also appreciated the interactions with their peers from other universities, which resulted from being put in the position to teach together in the field. Overwhelmingly, the coaches expressed that they would like to continue jumble judging as a way to promote collaborative learning within soil judging, and subsequently incorporated jumble judging at the 2022 Region 5 Soil Judging Contest in northwest Iowa.

4 | CONCLUSIONS

Overall, responses to implementing jumble judging in the 2021 Region 5 contest were positive. Among the students, 70% agreed or strongly agreed that they would like jumble judging to be a part of future contests. In their reflections, 54% of students cited jumble judging (or related topics) among the best parts of the contest and 93% either indicated they learned something new from jumble judging or described something that could be categorized as an affective outcome. All coaches agreed they would like to continue including jumble judging as part of the regional contest.

Assessment of cognitive learning yielded mixed results. Scorecard grades show no evidence of improved student performance related to jumble judging, with average scores remaining the same over three successive days of jumble judging and no significant difference between jumble judging and single-university team judging scores. However, cognitive learning was found to be the major focus of group reflections on how the students planned to improve, as well as individual reflections on what was learned through jumble judging. On the Likert-scale attitudes survey, students conveyed agreement in regard to cognitive learning (i.e., jumble judging improved my problem-solving skills). However, the agreement was not as strong as those related to affective outcomes, especially among students who had previously participated in soil judging.

Social themes were the most common topic of group reflections when jumble judging teams were asked what went well. In the individual reflections of what was learned through jumble judging, these themes were not as common as cognitive learning. However, attitudes related to affective learning (e.g., jumble judging improved my skills to collaborate with more diverse teams/backgrounds) received the strongest agreement on the Likert-scale survey.

Students and coaches both suggested that jumble judging could be improved by organizing the activity in a way that allows each jumble judging team to have representatives from more universities. While logistical concerns related to travel between field sites may present a barrier, this may be an achievable goal in some contests. A precontest

ice-breaker was also suggested to help jumble judging teams get to know each other. A well-designed ice-breaker could also help students reflect on the benefits of collaboration versus competition during soil judging, which could increase buy-in among students who expressed negative attitudes toward jumble judging.

AUTHOR CONTRIBUTIONS

Rebecca A. Young: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; writing—original draft. **Judith K. Turk**: Data curation; formal analysis; funding acquisition; investigation; methodology; project administration; writing—original draft. **Nicolas A. Jelinski**: Project administration; writing—review and editing. **Amber D. Anderson**: Writing—review and editing. **Kerry M. Clark**: Writing—review and editing. **Ashlee Dere**: Writing—review and editing. **Colby J. Moorberg**: Writing—review and editing. **Kristopher Osterloh**: Writing—review and editing. **DeAnn Presley**: Writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data are available upon request from the corresponding author.

ORCID

Rebecca A. Young https://orcid.org/0000-0003-1066-5885
Judith K. Turk https://orcid.org/0000-0001-6132-9166
Nicolas A. Jelinski https://orcid.org/0000-0003-3348-6900
Ashlee Dere https://orcid.org/0000-0003-3931-0893
Colby J. Moorberg https://orcid.org/0000-0002-1168-1839
Kristopher Osterloh https://orcid.org/0000-0002-9234-8746

REFERENCES

Cooper, T. H. (1991). T.E.A.M. soil judging—An experiment. *Journal of Agronomic Education*, *20*(2), 123–125. https://doi.org/10.2134/jae1991.0123

Eggleston, T., & Smith, G. (2004). *Building community in the classroom through ice-breakers and parting ways*. Office of Teaching Resources in Psychology. http://teachpsych.org/resources/Documents/otrp/resources/eggleston04.pdf

Gosselin, D., Cooper, S., Lawton, S., Bonnstetter, R. J., & Bonnstetter, B. J. (2016). Lowering the walls and crossing boundaries: Applications of experiential learning to teaching collaboration. *Journal of Environmental Studies and Sciences*, *6*(2), 324–335. https://doi.org/10.1007/s13412-015-0312-2

Jelinski, N. A., Perrone, S. V., Blair, H. K., & Fabian, M. L. (2020). Growing hearts and minds: Linking landscapes and lifescapes in a soils field course. *Natural Sciences Education*, *49*(1), e20018. https://doi.org/10.1002/nse2.20018

Johnson, D. W., Johnson, R. T., Roy, P., & Zaidman, B. (1985). Oral interaction in cooperative learning groups: Speaking, listening, and the nature of statements made by high-, medium-, and low-achieving students. *Journal of Psychology*, *119*(4), 303–321. https://10.1080/00223980.1985.9915450

Johnson, R., & Johnson, D. W. (1983). What research says about student-student interaction in science classrooms. In M. Rowe (Ed.), *Education in the 80's: Science*. National Education Association, 25–37.

Kortz, K. M., Cardace, D., & Savage, B. (2020). Affective factors during field research that influence intention to persist in the geosciences. *Journal of Geoscience Education*, *68*(2), 133–151. https://doi.org/10.1080/10899995.2019.1652463

Macpherson, G. L., Lee, Y.-J., & Steeples, D. (2011). Group-examination improves learning for low-achieving students. *Journal of Geoscience Education*, *59*(1), 41–45. https://doi.org/10.5408/1.3543930

Mora, G. (2010). Peer instruction and lecture tutorials equally improve student learning in introductory geology classes. *Journal of Geoscience Education*, *58*(5), 286–296. https://doi.org/10.5408/1.3559693

Neber, H., Finsterwald, M., & Urban, N. (2001). Cooperative learning with gifted and high-achieving students: A review and meta-analyses of 12 studies. *High Ability Studies*, *12*(2), 199–214. https://doi.org/10.1080/13598130120084339

Owen, R. K., Anderson, A., Bhandari, A., Clark, K., Davis, M., Dere, A., Jelinski, N., Moorberg, C., Osterloh, K., Presley, D., Turk, J., & Young, R. (2021). Evaluating student attitudes and learning at remote collegiate soil judging events. *Natural Sciences Education*, *50*(2), e20065. https://doi.org/10.1002/nse2.20065

Post, D. F., Miller, F. P., & Allen, B. L. (1974). The collegiate soils contest—A report and analysis. *Journal of Agronomic Education*, *3*(1), 82–86. https://doi.org/10.2134/jae.1974.0082

Rees, G. L., & Johnson, D. K. (2020). Impact of a national collegiate soil judging competition on student learning and attitudes. *Natural Sciences Education*, *49*(1), e20007. https://doi.org/10.1002/nse2.20007

Turk, J. K., & Young, R. A. (2022). A novel approach for teaching soil texture estimation: Replacing standard protocols with directed self-calibration. *Journal of Geoscience Education*, *70*(1), 40–55. https://doi.org/10.1080/10899995.2021.1891402

USDA Natural Resources Conservation Service (USDA-NRCS). (2022). Northern great plains spring wheat region. In *Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin* (Agricultural Handbook 296, pp. 157–179). USDA-NRCS.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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