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Evaluating student attitudes and learning at remote collegiate soil judging events

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Abstract

As with many aspects of teaching, the COVID-19 pandemic forced soil judging teams to attempt new strategies towards achieving student learning outcomes. Soil judging Regions IV and V hosted remote regional contests in October 2020 in place of traditional, in-person contests typically held each fall. We conducted pre- and post-contest surveys to assess student learning outcomes, attitudes, and reflections on the remote contest experience compared to past, in-person contest experiences. We received 108 total responses from students who participated in the Region IV and Region V remote soil judging contests (>80% response rate). In self-reported learning outcomes, there were no significant gains post-contest and there were minimal differences between students in Regions IV and V. Female students, students with more soil judging experience, and students who had taken more soil science courses agreed more strongly that soil science is important, that they planned to pursue careers in soil science, and that they gained important skills from soil judging. Finally, students who previously participated in contests reported that they gained more knowledge and enjoyed

Abbreviations: IRB, Internal Review Board; NCSC, National Collegiate Soils Contest; NRCS, Natural Resources Conservation Service.

in-person contests more than the remote contests held in Fall 2020. Thus, while it is possible to replicate some aspects of the soil judging experience in a remote contest, other aspects that are critical to student engagement are lost when teams are unable to gather at the contest location and examine soils in the field.

1 | INTRODUCTION

Instructors who participate in collegiate soil judging contests consider it to be one of the most valuable learning experiences that we can provide (Galbraith, 2012) and student participants show equal enthusiasm for the experience (Post et al., 1974; Rees & Johnson, 2020). As with many aspects of teaching, the COVID-19 pandemic forced soil judging organizers to attempt new strategies to achieve critical student learning outcomes while working within the context of restrictions necessary to protect the health and safety of instructors, students, and our communities.

Soil judging is a collegiate-level competitive event, rooted in the tradition of agricultural judging contests (Rees & Johnson, 2020). The first National Collegiate Soil Judging Contest was held in 1961 and the primary objective of soil judging since its inception has been for students, "to gain knowledge about the soil with particular emphasis on the practical experience of 'in field' training" (Post et al., 1974). In addition to hands-on field skills, modern contests also focus on developing students' ability to classify soils according to the USDA Soil Taxonomy and make interpretations for land use based on their field observations (Soil Survey Staff, 1999). The ability to make accurate morphologic descriptions and evaluate soils for various land uses are essential skills for many soil and environmental professions, to which a subset of student participants aspires (Ponte & Carter, 2000; Rees & Johnson, 2020). Soil judging teams have been formed at colleges and universities across the United States, with many students being introduced to field-based soil contests through similar high school programs run by organizations including 4-H, FFA, and the National Conservation Foundation. Collegiate soil judging contests are organized by the North American College and Teachers of Agriculture (NACTA) and the Soil Science Society of America-American Society of Agronomy (SSSA-ASA).

The contests organized by SSSA-ASA include seven regional contests held around the country in the fall and a national contest in the spring. The locations of both the regional and national contests rotate among participating colleges and universities. In most cases, the regional contests follow a format similar to the national contest, with students traveling to the contest location for several days and engaging in multiple days of practice leading up to a contest event at the end of the week (Galbraith, 2012; Rees & Johnson, 2020). Before attending the contest, students spend several weeks preparing for the contest through local field trips and classroom instruction to learn the basics of soil description, classification, and interpretations. During a typical regional contest, instructors and students spend approximately 50–60 hours together over the course of 5 to 6 days (Galbraith, 2012). In addition to daily field experiences, there are socials, dinners, and presentations that students attend in the evenings, review sessions with local experts and contest hosts, and an award ceremony at the end of the week. However, variations beyond this "typical" in-person regional contest format are allowed, and there is a precedent of remote contests, in which soil samples are mailed to participants. The remote format has been used previously in the northwestern region of the United States (Region VII) where distance between teams is great and resources available to support travel are limited.

Attempts to quantify the impact of soil judging competitions on student learning outcomes have produced varied results. Analysis of data from two national contests and one regional contest (1996–1997), showed little measurable improvement in the accuracy of students' soil descriptions between those who had participated in soil judging for 1, 2, and 3 years (Ponte & Carter, 2000). However, a recent pre- and post-assessment of student learning outcomes during a national soil judging contest demonstrated significant improvement in five out of seven learning outcomes, including specific soil description, classification, and interpretation skills identified as most important by the contest organizers (Rees & Johnson, 2020). The learning objective assessment and accompanying survey questions both highlighted location-based learning outcomes as an aspect of the contest that students valued the most.

A survey of instructor's perceptions of the educational benefits provided by soil judging at a traditional, in-person regional contest provides further insight on the value of soil judging (Galbraith, 2012). Many of the benefits reported in the survey responses have the potential to apply to a remote contest event: a small-class setting in which students train for the contest, student engagement promoted by the competition, exposure to new soils, learning from local experts, and practicing skills used by professionals (Galbraith, 2012). However, other aspects that were perceived as valuable by the instructors present a greater challenge to replication in a remote format. These include the week-long field trip, single-subject focus, immersive experience, and new social interactions (Gailbraith, 2012). The social aspects, including fellowship and exchange of ideas between faculty and students from participating universities, were also highlighted as one of the most important objectives of soil judging in earlier surveys of instructors and contest participants (Post et al., 1974). Research in geosciences education suggests that the social aspects of field experiences play an important role in development of self-efficacy, networks of mentors, and sense of belonging, leading to greater persistence in the geosciences (Kortz et al., 2020), further supporting the importance of these aspects of in-person soil judging contests.

In the face of the COVID-19 pandemic, two soil judging regions turned to a remote contest format as an alternate model for soil judging in Fall 2020. In this paper, we report the lessons learned from that experience. Our objectives were to assess student learning outcomes resulting from a remote soil judging contest, evaluate student and instructor perceptions of the remote contest experience, and compare these to previous data collected in response to in-person soil judging contests.

2 | MATERIALS AND METHODS

Regional soil judging contests typically take place in each of the seven regions across the United States. During regional contests, teams from colleges and universities across the region travel to locations selected by the host institution and spend 3 to 4 days in the field describing soils of that region before a 1- to 2-day contest, including individual and group judging portions. Due to the COVID-19 pandemic, in-person contests were not possible in the fall of 2020, following a canceled national contest in the spring of 2020. In lieu of in-person contests, Regions IV and V (Figure 1) held remote contests in two different formats.

In Region IV, six Universities (University of Arkansas, Texas A&M - College Station, Texas A&M - Kingsville (host), West Texas A&M University, Texas Tech University, and Tarleton State University) participated in the 2020 remote soil judging competition. Fifteen soil pits (profile pictures) from South Texas were used for the competition. Archived photos and soil characteristics from the USDA Natural Resources Conservation Service (NRCS) were provided by Gary Harris (USDA-NRCS Soil Scientist, Texas Soil Survey Program). Out of 15 archived soil pits, 10 soil pits were used for practice. The practice materials were sent 2 weeks before the competition to participating universities to ensure enough preparation time. Students were unable to describe

Core Ideas

- Remote soil judging contests are a viable alternative to in-person contests.
- Students gain more mastery of soil science concepts with hands-on practice.
- Soil judging participation results in more favorable attitudes toward soil science.
- Soil judging, regardless of contest format, is a precursor to a soil science career.

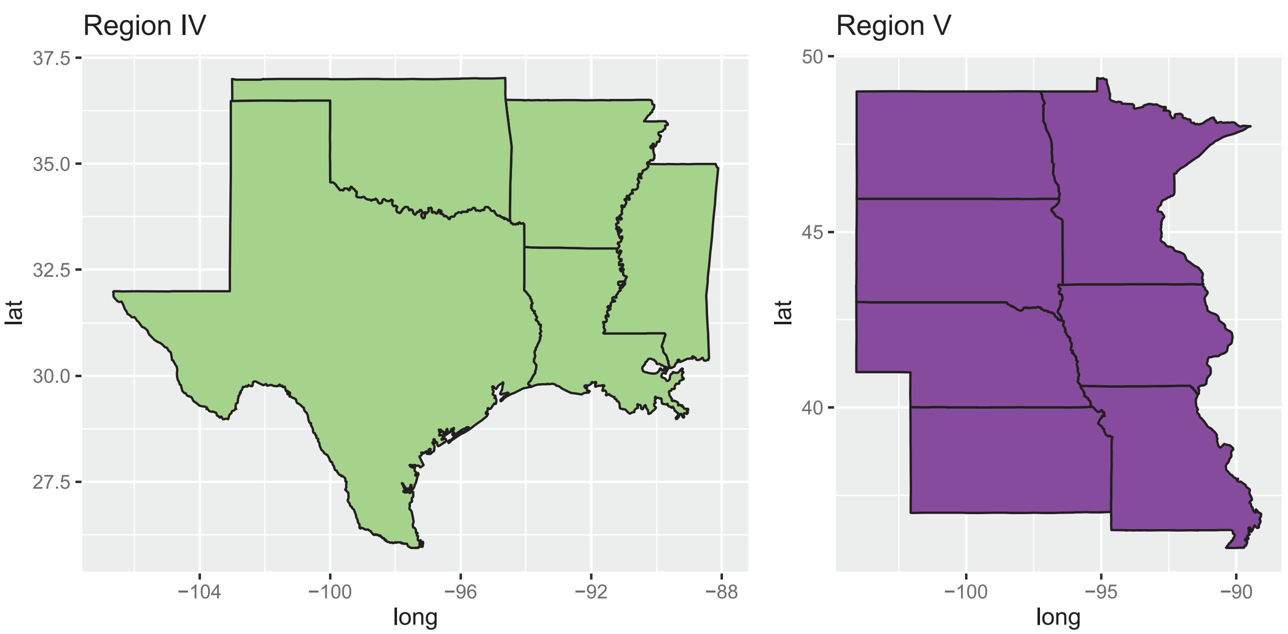

FIGURE 1 Map of the states included in Collegiate Soil Judging Region IV (Texas, Oklahoma, Arkansas, Louisiana, and Mississippi) and Region V (North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, and Missouri)

morphology from physical samples, thus, soil morphological and site characteristics were provided to students, including percent sand and silt, soil color, structure, and soil features (e.g., redoximorphic features, clay films, etc.) by horizon, and slope gradient, hillslope profile, and aerial landscape pictures for the site, in order for students to describe interpretations and to determine soil taxonomy.

The remote soil judging competition was hosted on Friday, 30 Oct. 2020 by Texas A&M University - Kingsville. Similar to a face-to-face competition, five soil pits were used for the contest (four individual pits and one group pit). The competition materials were sent by email to all coaches 2 hours before the competition to provide enough printing time. On the competition day, coaches and students were connected on a video call via Zoom, and students were allocated 45 minutes to complete each soil pit during the competition. The coaches sent their scanned scorecards immediately after each pit was completed. The final results were announced on 6 Nov. 2020.

In Region V, NRCS soil scientists and contest organizers collected soil cores using a Giddings probe and plastic liners, which kept the soil profile intact, and delivered the cores to each university the week prior to the contest. Students judged everything except slope, landscape position, and landform which were provided for each core and were not worth any points in scoring. Use of a hydraulic probe ruled out rocky soils and hard pans (e.g., fragipans), but several sites with lithic contacts were sampled and one core was able to penetrate a paralithic sandstone (Cr) horizon. Soil cores were collected from across the state of Missouri, rather than concentrating on one area, as is typically done in an in-person contest. Thus, students were able to see a wider variety of soils, but received less intensive practice focusing on specific soil types and features. Each team was provided with five practice cores and five contest cores.

Seven teams participated in the Region V remote soil judging contest – Iowa State University, Kansas State University, South Dakota State University, University of Minnesota - Twin Cities, University of Missouri (host), University of Nebraska - Lincoln, and University of Nebraska - Omaha. The contest took place during the week of 4–9 Oct. 2020, but many schools completed practice the week prior. Coaches were able to schedule the contest components at their discretion during the contest week with guidance to ensure a fair contest for all students. Students judged two individual cores and three group cores, and were given 60 minutes per core. Coaches scanned all scorecards and each scorecard was graded by coaches from two different teams. Results were announced during a Zoom gathering on Friday, 16 Oct. 2020.

For Region V, surveys to assess student learning outcomes and attitudes were distributed before the contest (pre-) and after the contest (post-). The pre-contest survey was open from 29 Sept. to 5 Oct. 2020 and the post-contest survey was open from 12—18 Oct. 2020. For Region IV, no pre-contest survey responses were collected (Region IV and V did not connect about the survey until after the Region IV contest had commenced) and post-contest survey responses were collected from 30 Oct. to 20 Nov. 2020. Survey questions were derived from a similar study conducted by Rees & Johnson (2020). The pre-contest survey contained 11 questions, including self-evaluation of current understanding, attitudes towards soil science and soil judging, expectations for the upcoming contest, and demographic information. The post-contest survey contained 15 questions, including self-evaluation of current understanding after the contest, attitudes toward soil science and soil judging, reflection on the contest, comparison to past in-person contests, and demographic information. Surveys were distributed electronically and conducted through the Qualtrics platform.

Students were asked to evaluate their understanding of various concepts and skills associated with soil judging (Table 1) on a 5-point Likert scale - no understanding (1), little understanding (2), some understanding (3), good understanding (4), and mastery (5). Student attitudes (Table 2) were also evaluated on a 5-point Likert scale - strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), and strongly agree (5). The questions regarding student learning outcomes and attitudes were the same on the pre- and post-contest surveys. Contest expectations were captured in three open-ended questions in the pre-contest survey: (a) What are you most looking forward to during the virtual soil judging contest?, (b) What part(s) of the contest do you think you'll least enjoy?, and (c) What do you expect will be the most educational part of the soil judging contest? Similarly, students were asked to reflect on the contest in three open-ended questions on the post-contest survey: (a) What was the most enjoyable part of the contest?, (b) What was the least enjoyable part of the contest?, and (c) What was the most educational part of the contest?

In the post-contest survey, students reflected on the virtual contest compared to past, in-person contests by responding to three questions about their experiences. First, students reflected on their knowledge gained and enjoyment of virtual and in-person contests by responding to statements (Table 3) on a five-point Likert scale - strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), and strongly agree (5). Additionally, they reflected on their experience by answering two open-ended questions: (a) What was the greatest benefit(s) of participating in the virtual contest, compared to past, in-person contests? and (b) What was the worst part of the virtual contest, compared to past, in-person contests? The following demographic and personal information was collected on the pre- and post-contest surveys: gender, soil judging experience, number of college-level soil science classes taken, university, major, and academic level.

After compiling responses from Region IV and V, we compared the distribution of responses from pre- and

TABLE 1 Perceptions of student mastery of various concepts or skills related to soil judging learning outcomes. The pre-contest survey was administered to Region V soil judging contestants (n = 44) and the post-contest survey was administered to Region IV (n = 25) and Region V (n = 39) soil judging contestants. Mean response is described on a 5-point Likert scale from no understanding (1) to mastery (5). Responses were compared using Fisher's exact test between Region V pre- and post-contest responses and separately, between Region IV post-contest and Region V post-contest responses

Concept/skill		No understanding	Little under-standing	Some under-standing	Good under-standing	Mastery	Mean response	*P*-value
		%						
Identifying depth to high water table*	Pre (V):	0	11.4	36.4	47.7	4.5	3.45	.2367
	Post (V):	0	5.1	23.1	69.2	2.6	3.51	.0081
	Post (IV):	4.0	12.0	48.0	28.0	8.0	3.24	
Estimating clay % by feel*	Pre (V):	0	6.8	36.4	56.8	0	3.50	.1553
	Post (V):	0	2.6	20.5	76.9	0	3.37	.0001
	Post (IV):	8.0	28.0	36.0	28.0	0	2.84	
Classification of local soils	Pre (V):	9.1	38.6	40.9	11.4	0	2.55	.0585
	Post (V):	2.6	17.9	51.3	25.6	2.6	3.08	.9331
	Post (IV):	4.0	12.0	52.0	32.0	0	3.12	
Describing soil structure	Pre (V):	0	6.8	34.1	59.1	0	3.52	.1956
	Post (V):	0	7.7	17.9	69.2	5.1	3.63	.1056
	Post (IV):	4.0	0	40.0	52.0	32.0	3.52	
Identifying Mollic vs Ochric epipedons	Pre (V):	4.5	9.1	25.0	45.5	15.9	3.59	.3300
	Post (V):	2.6	5.1	10.3	64.1	17.9	3.80	.5002
	Post (IV):	8.0	0	20.0	52.0	20.0	3.76	
Identifying E horizons in the field	Pre (V):	0	15.9	56.8	27.3	0	3.11	.4444
	Post (V):	5.1	20.5	46.2	25.6	2.6	3.05	.3945
	Post (IV):	8.0	8.0	40.0	44.0	0	3.20	

Note. Asterisks represent statistically significant results at $p < .05$.

TABLE 2 Student attitudes towards soil science and soil judging contests based on soil judging contest experience (1st Year or > 1st Year), number of soils courses taken (≤ 2 or ≥ 3), and gender (male or female). Mean values represent responses from 1 to 5 (strongly disagree to strongly agree). Significant differences between categories ($p < .05$) are emphasized in bold. Responses were compared using Fisher's exact test

	Soil judging experience			Soils courses taken			Gender		
Attitude	Category	Mean	*P*-value	Category	Mean	*P*-value	Category	Mean	*P*-value
I plan on pursuing a career in soil science	**1st Year**	**3.15**	**.0053**		**2.86**	**< .0001**	**Male**	**3.20**	**.0027**
	> 1st Year	**3.60**			**3.78**		**Female**	**3.55**	
I plan on pursuing graduate education in soil science	1st Year	2.80	.2712		**2.67**	**< .0001**	Male	2.89	.3523
	> 1st Year	2.85			**2.94**		Female	2.79	
Soil science is important	**1st Year**	**4.67**	**.0318**		4.72	.2542	**Male**	**4.70**	**.0042**
	> 1st Year	**4.88**			4.84		**Female**	**4.85**	
Soil science is overly technical	1st Year	2.83	.8409		**2.84**	**< .0001**	Male	2.84	.7707
	> 1st Year	2.70			**2.70**		Female	2.69	
Soil science has broad applications	1st Year	4.30	.0829		4.37	.0504	Male	4.36	.2720
	> 1st Year	4.57			4.51		Female	4.52	
More people should study soil science	1st Year	4.07	.5041		**4.07**	**.0005**	**Male**	**3.93**	**.0387**
	> 1st Year	4.28			**4.27**		**Female**	**4.37**	
This contest will be a highlight of my undergraduate education	1st Year	3.24	.6351		**3.40**	**.0151**	**Male**	**2.91**	**.0444**
	> 1st Year	3.36			**3.24**		**Female**	**3.59**	
Given the chance, I would compete in another soil judging contest in the future	**1st Year**	**3.78**	**.0008**		**4.12**	**.0015**	**Male**	**3.91**	**.0027**
	> 1st Year	**4.50**			**4.24**		**Female**	**4.39**	
Soil Judging builds teamwork skills	1st Year	4.26	.0705		4.56	.2838	**Male**	**4.19**	**<.0001**
	> 1st Year	4.63			4.40		**Female**	**4.66**	
Soil Judging builds professional skills	1st Year	4.12	.1115		4.33	.0626	**Male**	**4.14**	**.0012**
	> 1st Year	4.48			4.32		**Female**	**4.45**	
Soil Judging strengthens my social network	**1st Year**	**3.96**	**.0345**		4.21	.1953	**Male**	**3.98**	**.0175**
	> 1st Year	**4.33**			4.14		**Female**	**4.31**	
Soil Judging strengthens my professional network	1st Year	3.98	.2294		4.09	.1198	**Male**	**3.91**	**.0002**
	> 1st Year	4.19			4.10		**Female**	**4.23**	
Participation in Soil Judging improves my resume	1st Year	4.09	.1171		4.23	.1162	**Male**	**4.00**	**<.0001**
	> 1st Year	4.50			4.38		**Female**	**4.55**	
Soil Judging is too competitive	1st Year	2.54	.2062		**2.51**	**< .0001**	**Male**	**2.70**	**.0014**

(Continues)

TABLE 2 (Continued)

Attitude	Soil judging experience			Soils courses taken			Gender		
	Category	Mean	*P*-value	Category	Mean	*P*-value	Category	Mean	*P*-value
	> 1st Year	2.23			**2.27**		**Female**	**2.13**	
Soil Judging has been critical for developing my understanding of soils	**1st Year**	**3.93**	**.0001**		**4.21**	**.0029**	**Male**	**4.05**	**.0018**
	> 1st Year	**4.67**			**4.44**		**Female**	**4.56**	
I care a lot about protecting soil health	**1st Year**	**4.39**	**.0408**		**4.40**	**.0063**	**Male**	**4.32**	**<.0001**
	> 1st Year	**4.68**			**4.67**		**Female**	**4.73**	
I intend to tell others about the importance of soils throughout my life	1st Year	4.11	.0534		**4.16**	**.0092**	**Male**	**4.02**	**<.0001**
	> 1st Year	4.62			**4.46**		**Female**	**4.56**	

post-contest using contingency table analysis and Fisher's exact test. For student learning outcomes, we compared pre- and post-contest responses for Region V and separately, post-contest responses from Region IV and V. Statistical differences were also evaluated for combined pre- and post-contest responses based on gender, major, soil judging experience, and soil science courses completed. Gender was categorized as male, female, or other. We categorized majors as predominantly 'environmental', 'agronomic', or other (e.g., agricultural education, geology, etc.). Soil judging experience was divided into two categories: 1st year and > 1st year. Similarly, the number of soil science courses taken were divided into two categories: ≤ 2 classes and ≥ 3 classes. To complete the statistical analysis, we used the fisher.test function in R statistical software (R Core Team, 2019).

Open-ended questions were coded into categories to describe common themes among responses. Categories identified by Rees and Johnson (2020) were used as the initial keys, but categories were added and adjusted based on responses specific to this study. For example, several responses were focused on different aspects of the virtual contest, such as lack of traveling and social interaction and describing cores rather than being in pits. All responses with > 10% response frequency were reported below.

3 | RESULTS

Seventy-eight students competed in the Fall 2020 Region IV ($n = 30$) and Region V ($n = 48$) soil judging contests. In total, 108 survey responses were collected from the participants. Of the responses, 44 were collected pre-contest (92% response rate) and 64 were collected post-contest (82% response rate). The pre-contest responses were collected from Region V students. The post-contest survey responses were collected from students in Region IV ($n = 25$) and Region V ($n = 39$). Demographics are described based on combined results from the pre- and post-contest surveys. The students who responded to the surveys represented Freshmen (6%), Sophomores (11%), Juniors (17%), and Seniors (66%). Forty-three percent of students responded that this was their first year of soil judging and 57% of students responded that this was not their first year of soil judging. For the latter group of students, the number of years in which they had participated ranged from two to four years. Broadly speaking, 41% of students responded that they major in an environmental discipline, 31% responded that they major in plant science or agronomy, and the remaining students listed other majors, such as agricultural education or geology. Of the respondents, 41% identified as male, 57% as female, no students identified as non-binary or other and 2% of students did not respond. Students from all participating universities were included in the responses.

TABLE 3 Quantitative and qualitative responses regarding student views on in-person ($n = 60$) and virtual ($n = 63$) soil judging contests

		Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)	Mean response	*P*-value
Quantitative questions		%						
I gained significant knowledge about soil at the contest*	In-person contest	3.3	0	33.3	20.0	43.3	4.00	.0071
	Virtual contest	3.2	4.8	19.0	44.4	28.6	3.90	
I enjoyed the contest*	In-person contest	1.7	0	35.0	15.0	48.3	4.08	<.0001
	Virtual contest	11.1	6.3	12.7	46.0	23.8	3.65	
Open-ended questions	**Theme**			**Response rate, %**				
What was the greatest benefit(s) of participating in the virtual contest compared to past in-person contests? ($n = 36$)	Not missing classes/work			44.4				
	Not traveling			16.7				
	New experiences			13.9				
	Contest flexibility			13.9				
	Other			22.2				
What was the worst part of the virtual contest compared to past in-person contests? ($n = 39$)	Not seeing the pit/landscape			59.0				
	Lack of social interaction			23.1				
	Scheduling			17.9				
	Not traveling			17.9				
	Other			5.1				

Note. Asterisks represent statistically significant results at $p < .05$.

In self-reported learning outcomes, mean response increased from Region V pre- to post-contest survey for all skills except identifying E horizons (Table 1), and there were no significant increases in mastery. When comparing the post-contest responses between Region IV and Region V, students in Region V reported greater mastery of identifying the depth to high water table (p = .0081) and students in Region IV reported greater mastery of estimating clay % by feel (p = .0001). Overall, there were no differences in student learning based on major, but the number of soil science courses completed and soil judging contest experience did influence self-reported learning outcomes. With combined responses from the pre- and post-contest surveys, students who had completed three or more soil science courses reported an increased mastery of identifying depth to high water table (p = .0160), describing soil structure (p = .0204), and identifying Mollic vs. Ochric epipedons (p = .0227) compared to students who had completed fewer courses or participated in fewer soil judging contests. Additionally, students who responded that they had competed in soil judging for more than one year reported an increased mastery in all of the measured learning outcomes ($p < .05$) except identifying E horizons. Finally, mastery differed between genders for the learning outcome of estimating clay percentage with males reporting more mastery than females (p = .0419).

Students were also asked to respond with their degree of disagreement or agreement to several attitudes about soil science. There were no statistical differences between pre- and post-contest responses; however, there were several differences based on contest experience, number of soils courses taken, and gender (Table 2). Students who had attended multiple contests were more likely to have favorable attitudes towards soil science and felt that they gained more from soil judging contests (e.g., 'participation in soil judging improves my resume') compared to students who had not competed in the past. Students who had completed more soil science courses (≤2) agreed more strongly that they planned to pursue a career or attend graduate school in soil science and that they cared about promoting and protecting soils more broadly (e.g., 'I intend to tell others about the importance of soils throughout my life'). Students who had taken fewer soil science courses (≥3) agreed more strongly that soil science is overly technical (p < .0001) and that soil judging is too competitive ($p < .0001$). Students who identify as female were more likely to have favorable opinions of soil science than male colleagues (e.g., 'soil science is important'), and they were also more likely to respond that they plan to pursue a career in soil science (p = .0027) and that they gained valuable skills from soil judging (e.g., 'soil judging builds professional skills'). Comparing attitudes by major, students majoring in an environmental discipline most strongly agreed that they plan to pursue a career in soil science (p = .0005) and that they plan to attend graduate school in soil science (p = .0040), followed by students majoring in agronomy or plant science and other disciplines, respectively.

Responses to open-ended questions revealed specific likes and dislikes about the remote contests and the transition between traditional and remote contests. First, students (n = 100) reported the aspects of the contest that they were most looking forward to or the best part of the contest after it took place. The most common responses were the people (e.g., teammates - 48% of responses), learning about soils in Missouri or Texas (27%), the actual competition (19%), and in general, learning more about soils (17%). Next, students (n = 93) reported the aspects of the contest that they were least looking forward to or least enjoyed about the contest. Students reported that they least enjoyed the virtual contest format (84% of responses), specific aspects of the contest (e.g., determining structure - 12.9%), and the competition itself (10.8%). Specifically, of those who reported that the virtual format was what they least enjoyed, the most common reasons why were due to judging cores rather than soil pits (48.1%), not traveling (32.9%), and inconsistencies between the practice samples and contest samples (10.1%). Lastly, students (n = 96) identified the most educational part of the contest. Of these responses, the most common were learning about Missouri or Texas soils (25.0% of responses), learning from the coaches or NRCS judges (20.8%), learning about a specific soil feature (e.g., soil horizonation - 19.8%), the competition (18.8%), and the practice samples (15.6%).

Finally, students were asked to share their views on the virtual contest compared to past in-person contests they may have attended (Table 3). The majority of students somewhat or strongly agreed that they gained significant knowledge and enjoyed both past in-person contests and the virtual contest; however, students agreed more strongly that they gained significant knowledge at in-person contests compared to the virtual contest (p = .0071) and that they enjoyed in-person contests more compared to the virtual contest (p < .0001). Students reported that the advantages of a virtual contest included not missing school or work (44.4% of responses), not traveling (16.7%), gaining new experiences (13.9%), and having flexibility with the contest schedule (13.9%). Other reported benefits included avoiding bad weather, the opportunity to spend more time practicing and preparing, and less tediousness. The greatest downfall of the virtual contests was reported to be judging based on cores and photos, rather than by being in the pit (59.0% of responses). Other reported downfalls included the lack of social interaction within and among teams (23.1%), complications with scheduling the contest around school and work (17.9%), and not having the opportunity to travel (17.9%). The two responses classified as 'Other' (5.1%) included criticism of the contest time limits and time spent waiting for results to be announced.

4 | DISCUSSION

In this study, we aimed to better understand the potential for remote soil judging contests to provide students with hands-on educational experiences as a substitute to in-person soil judging contests. Based on survey responses from students in Regions IV and V, students gained significant knowledge of the local soils in South Texas and Central Missouri, respectively, but the remote contests did not allow students to make significant learning gains in other concepts, such as describing epipedons, recognizing indicators of high water tables, and correctly identifying texture or structure. Students who had also competed in past, in-person competitions reported that they gained significantly more knowledge and enjoyed in-person contests more than the remote contests that took place in Fall 2020. The most influential factors for these differences seem to be in describing soils from cores or photos instead of from field soil pits, and the lack of social interaction with students across the region. Though it was not a primary objective of this study, survey responses also revealed differences in student attitudes towards soil science and soil judging based on gender, soil judging experience, number of soil science courses completed, and major.

Based on this study and compared to similar surveys conducted before and after in-person contests, students did not learn as much at the remote contests compared to past, in-person contests. Rees and Johnson (2020) found that student learning outcomes increased from pre- to post-contest for five of seven soil concepts at the 2019 National Collegiate Soils Contest (NCSC). In comparison, students reported increased learning for only one of seven soil concepts at the Fall 2020 remote regional contests. We expected that students competing at a national contest may have more soil judging and soil science experience than students competing at a regional contest; however, many participants in the 2019 NCSC were first-year soil judging students (52%), similar to first-year participants in the 2020 regional contests (43%). Thus, while the first-year participants in the 2019 NCSC had participated in at least two soil judging contests (regional and national), they did not have substantially more soil judging experience than students participating in the 2020 regional contests. The lower knowledge gains reported after the virtual regional contests may be due to students coming into the contest with experience, but not learning as much from the contest due to the remote format. Indeed, students reported more significant knowledge gains at past, in-person contests (Rees & Johnson, 2020). Field-based and hands-on learning are valuable components of soil science education, and it is difficult to fully replicate these experiences virtually or in remote settings (Vaughan et al., 2017; Galbraith, 2012). Some of these experiences may have been partially replicated if contest organizers could have filmed videos of profile descriptions to be used as examples during contest preparation.

The COVID-19 pandemic forced coaches and teams to prepare for the regional soil judging contest differently than previous contests. Coaches followed university guidelines and also prioritized personal safety for high-risk individuals when determining the best practice and contests formats for their teams. Many coaches reported students being in quarantine and unable to participate in practice sessions prior to the contest. When practice sessions were held, they often took place in abnormal locations and many teams were unable to travel together to field sites, or to practice group judging. Prior to the contest, many students did not have the opportunity to describe all practice cores due to scheduling difficulties and conflicts with classes, work, home responsibilities, and the need to quarantine. Further, students had less access to the NRCS contest coordinators when questions arose about morphology and interpretations in the practice samples. During the contest, students in Region V reported that they enjoyed the scheduling flexibility to complete individual contest cores, but several students in Region IV reported that the virtual contest timing was not ideal. During the virtual contest there were fewer distractions and disturbances during the individual and group contests compared to typical in-person contests where students rotate in and out of pits, which may have provided a more favorable learning environment for students with learning accommodations. Overall, several aspects of a traditional soil judging contest were replicated in these remote contests; however, students were likely less prepared than normal, despite efforts by coaches to get students ready for the contest.

In this study, student characteristics didn't play a large role in learning outcomes, but attitudes varied significantly based on gender, soil judging and soil science experience, and major. Rees and Johnson (2020) found that female students were more likely to consider soil judging to be the highlight of their undergraduate education, but other attitudes did not differ by gender and they did not report differences based on major and soils experience. Women are currently underrepresented in soil science careers, but a growing majority of undergraduate and graduate students in soil science are female (Hartemink et al., 2008; Vaughan et al., 2019) Female students competing in the Region IV and V soil judging contests were more likely to agree that they planned to pursue careers in soil science, but there may still be significant barriers that prevent women from advancing to higher-level positions (Vaughan et al., 2019). This survey also mimics a trend towards more interest in environmental-based soil science compared to agronomic soil science (Havlin, et al., 2010).

While it is not possible for students to physically describe soil profiles in place during a remote contest, many aspects of an in-person soil judging contest can be replicated to enhance student learning. Based on student responses, it may be most effective to combine elements of the Region IV and V contests by providing students with intact soil cores (or soil horizon samples if students cannot gather at their universities) to describe soil morphology and photos and maps to describe landscape characteristics. From this information, students can complete almost all portions of the traditional, in-person scorecards and make interpretations based on the soil characteristics. Region V found that it was also helpful for coaches to have some portions of the official description (e.g., soil structure, horizon boundaries, etc.) so that they could identify any discrepancies in their team's cores. For instance, the upper depth of an argillic horizon in an individual core received by a university may have differed from the official description – providing the coaches with portions of the official descriptions before the contest allowed them to identify such discrepancies which may have greater impacts on the scorecard. Intra- and inter-team interaction is more difficult to replicate in a remote setting. Region V was first to implement a group judging portion of their regional contest (Cooper, 1991), and it has become a favorite for soil judging participants (Rees & Johnson, 2020). If possible, coaches and contest organizers should maintain a group judging portion for remote contests. Finally, students also expressed that they look forward to interacting with students from other teams at soil judging contests. In the Fall 2020 Region V soil judging contest, students from the host institution coordinated a virtual trivia night during the contest week where students could gather with students they had met at previous contests from other universities.

5 | CONCLUSIONS

While it is possible to replicate some aspects of the soil judging experience in a remote contest, other aspects that are critical to student engagement are lost when teams are unable to gather at the contest location and examine the soils in the field. Student learning outcomes varied by soil judging experience and number of soil science courses taken. Female students, students with more soil judging experience, and students who had taken more soil science courses agreed more strongly that soil science is important, that they planned to pursue careers in soil science, and that they gained important skills from soil judging. Finally, students who previously participated in soil judging contests reported that they gained more knowledge and enjoyed in-person contests more than the remote contests held in Fall 2020. Based on remote regional contests in Fall 2020, remote soil judging contests and remote learning opportunities may be most effective when students can still gather safely at their schools and work with actual soil samples; however, students can still experience place-specific learning through photos and maps. Soil judging provides a pathway into soil science careers and in general, improves students' attitudes towards soil science; thus, it is important to continue contests, despite the COVID-19 pandemic.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

R. K. Owen: conceptualization, data curation, formal analysis, project administration, writing - original draft; A. Anderson: formal analysis, writing - review & editing; A. Bhandari: data curation, writing - original draft; K. Clark: resources, writing - original draft; M. Davis: supervision, writing - review & editing; A. Dere: writing - review & editing; N. Jelinski: conceptualization, writing - review & editing; C. Moorberg: writing - review & editing; K. Osterloh: writing - review & editing; D. Presley: writing - review & editing; J. Turk: conceptualization, writing - original draft; R. Young: writing - review & editing.

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