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Assessing Student and Coach Learning Experiences with Virtual Collegiate Soil Judging Contest during COVID-19 Pandemic

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Abstract: Collegiate soil judging competitions are organized as annual face-to-face events both regionally and nationally in the USA. Soil judging provides a competitive platform for students to identify and describe soil characteristics in the field. However, the COVID-19 pandemic forced soil judging contests to find new strategies to maintain student engagement and provide competitive opportunities for students to apply their knowledge of soils. In response, Region IV in the USA hosted a virtual regional contest in October 2020. The objectives of this study were to quantify students' and coaches' perspectives on virtual soil judging contests and evaluate the role of virtual soil judging contests as either a complement or alternative to in-person contests. We conducted post-contest surveys of students (n = 31; 86% response rate) and coaches (n = 6, 100% response rate) to assess student learning outcomes and reflections on the virtual soil judging contest. Students responded most favorably to the virtual format, citing the flexibility it provided. Coaches were satisfied with the virtual format but still preferred an in-person contest. Coaches also expressed concern that the virtual soil judging format would not accurately measure the full range of student's skills typically measured during in-person contests. Overall, the coaches and students reported that the virtual soil judging contest was helpful to gain experience with soil descriptions and enhance skills related to soil assessment and pedology. We conclude that virtual soil judging contest formats can be an inexpensive way to provide students with additional soil judging experiences when field-based formats are not feasible (e.g., health restrictions such as COVID-19) or economical (e.g., budget constraints on soil site selection, contest development, and travel), and that hybrid formats may be a way to encourage greater participation among students in soil judging contests without losing the in-person benefits gained by judging soils in the field.

Keywords: virtual soil judging; soil interpretations; soil classification; soil morphology; Soil Science Society of America

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1. Introduction

Judging contests train students to conduct logical analyses, and enable them to develop independent thoughts and to apply them to the materials being judged [1]. Soil judging is an educational and practical, in-person, hands-on learning activity organized yearly at various levels [2,3]. Future Farmers of America (FFA) and 4-H (Americas' largest youth development organization) conduct programs for high-school-level soil judging, while the North American Colleges and Teachers of Agriculture (NACTA) association organizes a college-level contest. Likewise, the Soil Science Society of America (SSSA) and the American Society of Agronomy (ASA) organize separate college-level contests at regional (during fall) and national (spring) levels [4]. Under the SSSA-ASA format, states in the US are divided into seven regions (Region I to VII). Each region hosts a regional competition during the fall (the number of participating teams vary by region) to determine which teams will qualify to compete at the national contest held each spring [4]. Soil judging contests such as these

provide platforms for training undergraduate students to identify, describe, and interpret physical, chemical, hydrological, and biological characteristics of soils and how they are classified.

Participating in experiential learning activities such as soil judging is multi-faceted in helping students succeed. Studies have documented several benefits of hands-on and co-operative learning activities like soil judging contests. For example, soil judging contests motivate a student's learning process by working independently and collaboratively as a team with other students, promote student engagement due to coach–student interactions, and help explore, describe, and interpret soils in their in-situ state [2,5,6]. Rees & Johnson [4] (2020) reported that in-person soil judging contests help students understand location-specific soils and develop positive attitudes toward soil science. In addition, soil judging contests increase students' critical thinking, confidence, and interpersonal and problem-solving skills [3–5], each of which is essential to pursue soil-related careers [7]. Further, the team judging part of the soil judging contest and the opportunity to interact with other students and coaches from different universities can create a co-operative learning environment, which can help students to learn, and problem solve in real-time through working with their peers, improve their communication skills, and prepare students to work as a team member [8]. In essence, soil judging contests allow students to learn about various soil types in a given region and interact with students and peers from their university and other participating schools [3,5,6]. The framework of the SSSA-ASA regional and national contests is the same, but the format of individual soil judging contests may differ. For example, in the fall of 2019, Region IV organized an intensive week-long in-person soil judging contest with multiple days of field practice and a final day of competition at the end of the week. On the other hand, Region VII (limited by resources, long-distance travel, and potentially very remote contest sites) used virtual contests with physical soil samples used for competition mailed to participating teams.

Researchers have evaluated and made recommendations to improve soil judging competition formats such as these over time. For in-person competitions in the field, [9] recommended providing many horizons and depths during soil judging, including more learning experiences in conjunction with the contest to improve the students' learning experience. Cooper [5] tested group judging, implemented nationally in 2003 [10]. He reported that 96% of the students expressed their desire to continue group judging, which has become one of the most popular sections students enjoy in current competition formats. The authors of [6] indicated that soil judging concepts should be modified to expose students and teach observational, descriptive, and critical thinking skills to apply their learning to real-world experiences. Likewise, [6] reported that 70% of the participant students agreed or strongly agreed to make jumble judging (students were randomly assigned to teams containing members from different universities) a part of future contests, and 54% of students cited jumble judging among the best parts of the contest. Major challenges of virtual learning can be the inability to conduct traditional laboratory exercises and field trips, low student engagement, and less instructor interaction [11,12]. However, others have reported that virtual laboratories and field exercises can be as effective as traditional lab exercises and demonstrations [12–14]. More recently, evaluations of virtual soil judging contests indicate that this format can provide increased soil diversity seen by student competitors, and overall accessibility for students to be able to participate [15]. Furthermore, virtual soil judging contests and material can be adopted by smaller universities or those universities that lack traditional soil- or agriculture-specific departments in order to provide interested students with the necessary training and educational resources needed to prepare for competition in soil judging contests. In this way, incorporating new approaches to soil judging contests can expand the reach of soil science education and improve the field's ability to meet science-trained workforce preparation in the soil science discipline.

In 2020, the National Collegiate Soils Contest (NCSC) canceled the national soil judging contest scheduled at Ohio State University due to the COVID-19 pandemic. This cancellation forced many regions to either cancel, reschedule, or redesign their regular

soil judging contests for 2020. These decisions were critical for student learning and development, given that regional contests are often the first for many students [10], and cancellations of soil judging contests likely created delays in the students' learning process resulting from inabilities to apply and test their knowledge of soils in situ. Therefore, in response to the broad-scale shift to remote learning prompted by the COVID-19 pandemic, we developed a virtual soil judging contest using previously available soil profile data for soils in SSSA-ASA Region IV to keep students engaged in soil judging and continue their learning and engagement with soil science. The objectives of this study were (i) to quantify students' and coaches' perspectives on virtual soil judging contests and (ii) to determine if the virtual soil judging contest can be a viable alternative to in-person contests. The data were collected from the students and coaches that participated in the virtual regional (Region IV) contest.

2. Materials and Methods

The SSSA-ASA Region IV competition includes participants from the states of Texas, Oklahoma, Arkansas, Louisiana, and Mississippi. For the 2020 virtual soil judging contest, six universities agreed to participate (University of Arkansas, Texas A&M-College Station, Texas A&M-Kingsville, West Texas A&M University, Texas Tech University, and Tarleton State University).

2.1. Contest Preparation

Soil profile pictures used in the contest were obtained from Natural Resources Conservation Service (NRCS) archives, and were provided by Gary Harris (NRCS soil scientist). For the competition, we used 15 total soil profile pictures representing typical South Texas soils. Out of 15 archived soil profile pictures, 10 were used for practice, consistent with the historical in-person contest of the region. The remaining five were used for the official contest.

The soil profile pictures were compared with the National Soil Information System (NASIS) United States Department of Agriculture (USDA) pedon description to describe soil morphological, physical, and chemical characteristics and develop the keys for the competition. The NASIS information was used as a reference or baseline from which to develop the soil profile morphological characteristics used for the contest (https://nasis.sc.egov.usda.gov/NasisReportsWebSite/limsreport.aspx?report_name=WEB-Masterlist (accessed on 10 September 2019). For example, soil horizon depth, soil color, lower boundary, and boundary distinctness were modified based on the soil profile pictures (rather than simply copying and pasting the morphological characteristics from the NASIS pedon description). Several USDA-NRCS soil scientists assisted as independent reviewers to compare and revise the modified morphological characteristics. Likewise, for soil texture and soil chemical properties, such as soil pH, organic carbon, base saturation, sodium adsorption ratio (SAR), and calcium carbonate equivalent (CCE), the National Cooperative Soil Survey (NCSS) primary soil characterization database (https://ncsslabdatamart.sc.egov.usda.gov/ (accessed on 12 September 2019) was used. Actual landscape pictures were available for some soil profiles. If the landscape pictures were unavailable, we used Google Maps to assess the landscape for the 10 soil profiles used for the virtual practice round.

Practice materials were sent to participating universities two weeks prior to the competition to ensure adequate team preparation time. Most students were given two weeks to review the practice materials. A coaches meeting was held via Zoom® to clarify any questions about the practice materials. Two representative soil profile pictures used in the virtual context are provided (Figure 1a,b).

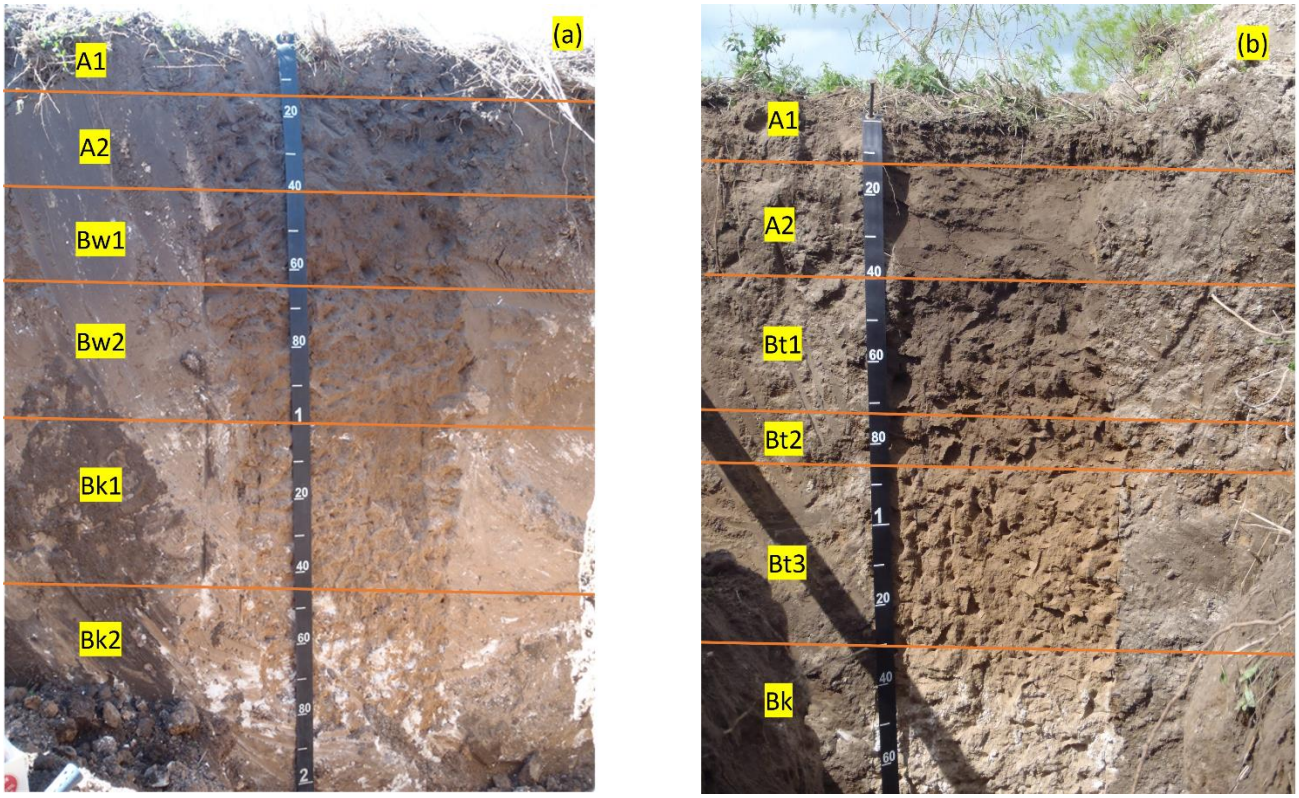


Figure 1. Typical examples of the South Texas soil profile pictures with soil horizons used for the competition: (**a**) example profile picture used for the practice; (**b**) example profile picture used for the final contest.

Since students would be unable to describe morphology without physical samples, we modified the typical face-to-face scorecard and provided students with a minimum level of soil morphological and site characteristics (e.g., percent sand and silt, soil color, structure, slope gradient, hillslope profile, and aerial landscape pictures) needed to describe their soil interpretations and complete the sections pertaining to soil taxonomy. A sample scorecard developed for the event, which could be used as a reference for similar virtual contests in the future, is provided (Figure 2).

The remote soil judging competition was hosted on Friday, 30 October 2020, by Texas A&M University-Kingsville. We held a 90 min coaches meeting on Wednesday, 27 October, to discuss the logistics of the contest. On competition day, we used five soil profile pictures for the contest: four individual profile pictures and one as a team profile picture, consistent with a face-to-face competition. The competition materials were emailed to all coaches two hours before the competition to provide enough time to print and share materials with student competitors. We then connected coaches and participating students on a video call via Zoom. Students were given 45 min to complete each soil pit, consistent with an in-person contest. The coaches then scanned and returned their student's scorecards immediately after students completed each virtual soil profile. Coaches from one university graded the scorecard of another university to avoid coaches grading their own students. A coach from a non-participating university helped to verify the final scorecard. The results were announced on 6 November 2020, via a Zoom meeting.

REGION IV VIRTUAL SOIL JUDGING CONTEST, 2020 TAMU-Kingsville Kingsville, TX

Contestant I.D. _____
Site No. __1_____
MLRA _____
Horizons_6_____
Describe to a depth of ____200__cm.
Virtual Nail in third horizon at __50__

Horizon Data

#	OC (%)	pH	BS (%)	CCE	SAR
1	0.8	7.7	97	-	-
2	0.6	7.2	100	-	-
3	0.4	7.1	100	-	-
4	0.2	7.6	100	-	-
5	0.1	8.5	100	9	-
6	0.1	8.4	100	15	-

I. _____ _____
II. _____ _____
III. _____ _____
IV. _____ _____
V. _____ _____
Total: _____ _____

Properties highlighted will be provided.

I. Soil Morphology Score: ____

Horizonation				Boundary		Texture					Color (Moist color)			Structure		Effer-vescence	Redox Features		Score
Prefix (2)	Master (3)	Sub. (2)	No. (2)	Lower Depth (3)	Dist (2)	Clay films	Sand %	Silt %	Clay% (2)	Class (4)	Hue (2)	Value (2)	Chroma (2)	Grade (2)	Shape (2)	(2)	Con/Dep (2)	Abund (2)	Possible (24)
						-	84	10			10 YR	3	2	1	SBK	N			
						-	81	9			10 YR	2	1	2	SBK	N			
						-	75	9			10 YR	3	2	2	SBK	N			
						-	75	9			10 YR	4	3	2	SBK	N			
						-	66	13			10 YR	4	4	2	SBK	ST			
						-	56	21			10 YR	5	5	2	ABK	V			

II. Soil Profile Characteristics Score: ____

Hydraulic Conductivity (10)		Effective Soil Depth (5)	Water Retention Difference (5)	Soil Wetness Class (5)
Surface (5)	Limiting Layer (5)			
___ High	___ High	___ Very shallow (< 25 cm)	___ Very low (< 7.50 cm)	___ Very shallow (< 25 cm)
___ Moderate	___ Moderate	___ Shallow (25 to 49 cm)	___ Low (7.50 to 14.99 cm)	___ Shallow (25 to 49 cm)
___ Low	___ Low	___ Moderately deep (50 to 99 cm)	___ Medium (15 to 22.49 cm)	___ Moderately deep (50 to 99 cm)
		___ Deep (100 to 149 cm)	___ High (22.5 to 29.99 cm)	___ Deep (100 to 149 cm)
		___ Very deep (≥ 150 cm)	___ Very high (≥ 30 cm)	___Very deep (≥ 150 cm)

III. Site Characteristics--- Score: ____

Parent Material (5 each)	Landform (5)	Slope Gradient (5)	Hill Slope Profile (5)	Surface Runoff (5)	Erosion Potential (5)
___ Aeolian	___ Drainageway	___ 0 to 1 %	___ Summit	___Ponded	___ Very low
___ Alluvium	___ Dune	___ 1 to 3 %	___ Shoulder	___Very slow	___ Low
___ Residuum	___ Depression	__X__ 3 to 5 %	___X_ Backslope	___Slow	___ Medium
___ Fluvo-Marine Sed.	___ Uplands	___ 5 to 8 %	___ Footslope	___Medium	___ High
		___ 8 to 12 %	___ Toeslope	___Rapid	___ Very high
			___ Channel	___Very rapid	
			___ None		

IV. Soil Classification Score: ____

Epipedon (5)	Subsurface Horizons (5 each)	Other Characteristics (5 each)	Order (5)	Suborder (5)	Great Group (5)	Particle Size Control Section	
							Class (5)
___ Mollic	___ Argillic				___ Argi	Starting depth (5)	__ Sandy
___Umbric	___ Calcic	___ Lithologic discontinuity	___ Alfisol	___ Aqu	___ Hapl		__ Loamy
___Ochric	___ Cambic	___ Lithic contact	___ Entisol	___ Fluv	___ Natr		__Coarse-Loamy
___ None	___ Gypsic	___ Slickensides	___Inceptisol	___ Orth	___ Pale		__ Fine-Loamy
	___ Petrocalcic	___ None	___ Mollisol	___ Psamm	___ Psamm		___ Coarse-Silty
	___ Natric		___ Vertisol	___ Ust	___ Ust(i)	Ending depth (5)	__ Fine-Silty
	___ Salic				___ Epi		__ Clayey
	___ None						__ Fine
							__ Very Fine

V. Interpretations Score: ____

Dwellings with Basement (5)	Septic Tank Absorption Field (5)	Local Roads and Streets (5)
_____ Slight	_____ Slight	_____ Slight
_____ Moderate	_____ Moderate	_____ Moderate
_____ Severe	_____ Severe	_____ Severe
Reason # (2): _____	Reason # (2): ____	Reason # (2): _____

Figure 2. Example score card used for virtual soil judging contest for morphological and soil profile characteristics, site characteristics, classification, and interpretations. The soil texture, color, and structure; slope gradient; and hill slope profile (shaded with color) were provided to students during the competition.

2.2. Data Acquisition and Analysis

Post-contest survey questions were designed to assess both student learning and the coaches' experiences in a virtual soil judging contest. The post-contest student survey contained 15 questions, reflecting on the contest's quality and format, students' self-evaluation of their understanding after the contest, and the feasibility of virtual contests in the future (Tables 1 and 2). The survey for coaches included 16 questions, reflecting on the quality of the contest, their student's ability to apply their knowledge, the student learning experience, the coach's experience in preparation for the virtual compared to past face-to-face in-person contests, and time (Tables 3 and 4). The surveys were distributed electronically via Survey MonkeyTM from 30 October to 15 November 2020. All responses were evaluated on a five-point Likert scale [16]—strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), and strongly agree (5). Sample sizes of n = 31 and n = 6, respectfully, for students and coaches were attained, representing 86% and 100% response rates.

Table 1. Students' response on virtual soil judging event satisfaction, 2020.

Quantitative Questions	M	Mode	SD
The clarity of instruction during the event	4.35	4	0.66
The overall quality of event	4.17	4	0.69
The pre-event communications	4.07	4	0.84
The format of the event	3.97	4	0.79
The accuracy in which the event measured my actual knowledge	3.94	4	0.77
The accuracy in which the event measured my skills	3.84	4	0.93
Overall satisfaction	4.06	4	0.78

Table 2. Students' response on level of agreement on virtual soil judging contest, 2020.

Quantitative Questions	M	Mode	SD
If I had the choice of doing this event online or face-to-face, I would definitely choose the face-to-face option	4.35	5	0.79
I really enjoyed the flexibility that the online components of the event provided	3.97	4	0.94
The online format allowed for an accurate measure of my knowledge	3.58	4	0.88
The format of the event really allowed me to demonstrate my skills in soil science	3.55	4	0.92
The online nature of the event caused me to prepare even more for the contest	3.19	3	1.16
I learned more than I normally would have as a result of the online format	2.97	3	1.25
The online components made it difficult to stay focused	2.35	2	1.01
The online components made it difficult for me to understand the directions of the event	2.32	2	0.87
If I had the choice of doing this event online or face-to-face, I would definitely choose the online option	2.16	1	1.18
Overall agreement	3.16	3	1.00

We estimated mean, mode, and standard deviation (SD) of the collected data. By providing mode and standard deviation, we believe we are adequately covering the nature of the responses. Range, or simply the difference between high and low values, is less informative given the scale of the survey (1 to 5), so that any one outlier in the respondents will generate a large range, but such responses will have less impact on the standard deviation and no impact on the mode.

Table 3. Coaches response on virtual soil judging soil contest event satisfaction, 2020.

Quantitative Questions	M	Mode	SD
The format of the event	4.00	4	0.71
The clarity of instruction to students during the event	3.67	3	1.21
The overall quality of event	3.50	3	1.05
The accuracy in which the event measured student knowledge	3.50	3	0.84
The clarity of instruction to coaches during the event	3.50	2	1.38
The accuracy in which the event measured student skills	3.33	3	0.82
The pre-event communications	3.17	2	1.17
Overall satisfaction	3.52	3	1.03

Table 4. Coaches' response on level of agreement on virtual soil judging contest, 2020.

Quantitative Questions	M	Mode	SD
If I had the choice of doing this event online or face-to-face, I would definitely choose the face-to-face option	5.00	5	0.00
The online format allowed for an accurate measure of student knowledge	3.33	3	1.03
The format of the event really allowed my students to demonstrate their skills in soil science	3.17	3	0.75
The students really enjoyed the flexibility that the online components of the event provided	3.17	3	0.75
If I had the choice of attending this event hybrid (some online + face-to-face practice), I would definitely choose the hybrid option	3.00	3	1.41
The online components made it difficult for students to understand the directions of the event	2.33	3	0.82
The online nature of the event caused me to prepare even more for the contest	2.00	2	1.10
The online components made it difficult for students to stay focused	1.83	2	0.75
If I had the choice of doing this event online or face-to-face, I would choose the online option	1.50	1	0.84
Overall agreement	2.81	3	0.83

3. Results

3.1. Students' Responses

Survey results indicate that student event satisfaction was satisfied to neutral, with an overall mean score of 4.06 (Table 1). The highest mean scores were found within the individual responses to "The clarity of instruction during the event" (M = 4.35, SD = 0.66) and "The overall quality of the event" (M = 4.17, SD = 0.69) (Table 1). This suggests that students felt satisfied about the clarity of instruction provided during the event, and the overall quality of the event. The lowest mean scores were found within the individual areas related to "The accuracy in which the event measured my actual knowledge" (M = 3.94, SD = 0.77) and "The accuracy in which the event measured my skills" (M = 3.84, SD = 0.93) (Table 1). These results show that students felt more neutral about the ability of the virtual format to allow students to express their knowledge of soils as well as the ability of the format to appropriately capture student performance on soil-judging-related tasks.

Regarding contest modality, students felt neutral with the format of the event, with an overall mean score of 3.16 (Table 2). The highest mean score to questions pertaining to the elements or characteristics of the event was in relation to the flexibility that the online event provided (M = 3.97, SD = 0.94), suggesting that students most enjoyed those components of the contest that were either asynchronous or less sensitive to in-person meeting (e.g., studying practice material) and required less travel, thereby reducing time lost on other responsibilities (e.g., fewer absences from class and work).

In addition, the lowest mean scores to questions pertaining to the elements or characteristics of the event were found within the areas of event direction (M = 2.32, SD = 0.87)

(Table 2). This suggests that students did not perceive or easily intuit the online components or directions of the soil judging contest. Inability to easily follow the instructions could have reduced real or perceived student performance in the contest itself given the greater cognitive load needed to simply complete the exam. For the summative preferential questions (i.e., "If I had the choice of doing this event online or face-to-face, I would definitely choose the face-to-face option" (M = 4.35, SD = 0.79) or "If I had the choice of doing this event online or face-to-face, I would definitely choose the online option"), the responses showed that students would still prefer a face-to-face option (M = 4.35 compared to M = 2.16; Table 2) if it were offered.

3.2. Coaches' Responses

Coaches' event satisfaction scores were neutral, with an overall mean score of 3.52 (Table 3). The highest mean scores of coaches were in response to the individual question "How satisfied were you with the format of the event?" (M = 4.00, SD = 0.71) (Table 3). This shows that coaches felt satisfied about the format of the event to serve its purpose as an alternative contest format given the current restrictions at the time, but were less satisfied with other aspects of the virtual contest approach (e.g., the clarity of instruction to coaches and students, overall contest quality, ability to evaluate student knowledge; Table 3). The lowest mean scores for the summative questions about the event (M = 3.33 for the accuracy in which the event measured student skills and M = 3.17 for pre-event communications) show that coaches felt more neutral or less satisfied about the ability of the virtual contest form to accurately evaluate soil science knowledge and skills and the communications leading up to the event. Such a low score may have been expected given the hands-on nature of soil science and the novelty of crafting a first-of-its-kind virtual event in the midst of the pandemic.

Coaches strongly agreed that they would choose to participate in the event face-to-face rather than online, if the option of face-to-face was offered (M = 5.00, SD = 0.00 compared to M = 1.50, SD = 0.84; Table 4). Coaches responses to individual questions pertaining to the elements or characteristics of the event either departed from or corroborated those responses from students regarding the ability to follow the contest directions. For example, in response to whether the online components made it difficult for students to stay focused, coaches mostly disagreed (M = 1.83, SD = 0.75), showing that coaches believed that the virtual soil judging event did not impact the students' focus, whereas students agreed more strongly that the format reduced their ability to stay focused (M = 2.35, Table 2). Similarly, students more strongly agreed that they liked the flexibility of the event, whereas coaches were more likely to disagree about the flexibility of the event to student satisfaction (M = 3.17 of coaches, Table 4, compared to 3.97 of students, Table 3). On the other hand, coaches agreed or disagreed at nearly the exact rates of students about the clarity of directions (M = 2.33 and M = 2.32; Tables 2 and 4). In response to the summative preferential question ("If I had the choice of attending this event hybrid, some online + face-to-face practice, I would definitely choose the hybrid option"), coaches responses indicate that they are neutral to adapting any hybrid soil judging contest (M = 3.33, SD = 1.03) (Table 4).

4. Discussion

In this study, we tried to understand the potentiality, feasibility, and benefits of virtual soil judging contests during the COVID-19 pandemic using a survey instrument administered to both students and coaches. Because of the high response rates (86% of students and 100% of coaches), we were able to complete statistical analyses of the surveys, but small sample sizes (n = 31 and n = 6) may limit the interpretation of the results or extrapolation to other regions or soil judging contexts. Region IV students gained valuable soil judging experience based on the survey responses. They were satisfied with the contest's quality, clarity of the instruction, format, pre-event communications, and accuracy in measuring their actual soil judging knowledge and skills (Table 3). Interestingly, students enjoyed the flexibility of the contest compared to the traditional in-person contest, which is typically

intense and conducted for a whole week (Table 4). Web-based, online, and virtual learning opportunities have been shown to provide desired flexibility to students [17,18], indicating that innovations and virtual learning platforms are emerging and will potentially continue to grow even after the COVID-19 pandemic. Thus, the virtual soil judging contest we used in this study has the potential to continue in some form in the future (e.g., providing additional training, judging, and contest interpretation experiences prior to in-person regional and national contests).

However, there were some challenges with the format and testing of students' skills with virtual soil judging. For example, soil morphological characteristics, such as soil texture, color, structure, and effervescence, and site characteristics, such as slope gradient, etc., were challenging to describe in the virtual soil judging contest. Thus, we provided this information to the students during the contest. Owen et al. [3] also indicated that virtual soil judging contests did not allow students to gain significant learning experience in describing and identifying soil texture, soil structure, recognizing indicators of high-water tables, etc. Further, students mentioned that staying focused, understanding, and demonstrating their skills in the virtual soil judging contest was challenging.

The study indicates that students prefer face-to-face in-person contests to virtual soil judging contests (Table 2), perhaps due to difficulties identifying some soil characteristics with profile pictures, lack of interaction with peers, and ability to demonstrate their skills during the virtual contest. In an upper-division pedology class, [18] reported similar results, where students favored in-person field experiences over remote delivery options. In addition, in-person and hands-on learning is difficult to replicate virtually [2,19], which might limit students' hands-on field experience and learning opportunities [4]. Perhaps, digging fresh soil pits and providing a fresh soil profile picture (3-D pictures, if possible) with better qualities may have improved the students' experience with the virtual contest. Further, Ref. [3] recommended that providing filmed videos for the profile descriptions as an example during the contest preparation may help partially replicate and enhance the hands-on experience.

Participants in the Region IV virtual soil judging contest indicated that they enjoyed the flexibility of the virtual contest. Students in Region V also reported similar results, and indicated that they enjoyed the scheduling flexibility during their virtual contest [3]. Participants in the study reported that the virtual soil judging contest format did not affect their focus. This corroborates the results that [3] reported, where students reported fewer distractions and disturbances during the virtual compared to typical in-person contests, creating a favorable learning environment.

This study also includes the coach's perspective on the virtual soil judging contest, the first-ever virtual soil judging contest hosted in Region IV. Therefore, coaches' experience and feedback on this new soil judging format will benefit future virtual contests. The study indicates that coaches were satisfied with the format of the event, clarity of instruction to students, and quality of the instruction given to students during the virtual soil judging contest. However, coaches were slightly skeptical or neutral about the accuracy of the virtual soil judging contest to measure student knowledge and skills on soil judging (Table 4). Like the students, the coaches preferred face-to-face to virtual soil judging contests. The coaches also indicated that they prepared more for the virtual contest than in-person, which might be due to their first-time participation in the virtual soil judging contest in Region IV, spending more time to familiarize themselves with the online logistics, and understanding newly developed specific guidelines for the virtual contest. Hill et al. [20] documented a significant benefit of workshops to coaches in terms of familiarizing them with the soils near the contest site and the descriptive techniques used in the contest area. Thus, coaches (especially those not familiar with the virtual contest) might need workshops or other platforms to familiarize themselves with the new format of the virtual soil judging contest to be more effective in helping the students better prepare for the future.

The coaches also indicated that they might select a hybrid option (some virtual and some face-to-face practice) if it could be implemented with well-developed guidelines.

This question was not included in the student survey, as some participants needed to be more familiar with the face-to-face contest and were first-time participants in the soil judging contest. Thus, the hybrid option can be a way forward, as it may help save travel requirements and economically benefit the universities. For instance, the traditional format of regional soil judging, which takes place face-to-face for a whole week, can be shortened to three days of face-to-face meetings (two days of practice and one day of contest) if we can incorporate some virtual practices.

Further, the virtual soil judging contest can provide increased accessibility to participants. For example, the guidelines we used in the contest could be replicated using available profile pictures to develop practice materials to train students on soil science in the future. It can be an opportunity to establish a cost-effective learning platform for future generations of soil scientists and communities with limited resources as an alternative to face-to-face in-person training. The virtual soil judging format we developed can also be adapted to help students in small schools that lack soil- and agriculture-specific departments, and thus lack student familiarity with soil judging, but are interested in starting a soil judging program, as stated by [21], and to provide students with the necessary skills and experience. Virtual reality field trips to soil judging sites and online videos could help provide future remote learning and soil judging opportunities.

5. Conclusions

The overall results show that virtual soil judging using archived profile pictures might be used as an alternative to help train students. However, coaches preferred face-to-face contests due to the lack of hands-on activities in the virtual format for soil texture, color, and other soil characteristics, including landscape information. Because of the COVID-19 pandemic, this is one of the first virtual soil contests of its kind, and it offers a completely new approach to soil judging for both coaches and students. Components of the virtual competition approach (e.g., soil profile pictures and associated data; landscape photographs) can still be used to augment the training resources for students (including new students from universities without a history of soil judging) who often are limited geographically to the type and diversity of soil pits they can practice on prior to competition, especially if coaches from varying universities share example soil profile data (illustrated above). Given the neutral responses of coaches to potential hybrid soil judging events, such material may continue to be improved and used to design hybrid contests for instances when face-to-face events are impossible (due to a pandemic) or become uneconomical (limited university resources or restrictions, long-distance travel, limited time availability, and remotely located and spread-out regions) due to the length of face-to-face contests, which generally last four to five days. Hybrid contests may also offer an economical way to gain additional judging contest experience prior to face-to-face contests. The design and implementation of hybrid events is therefore a fruitful area of future soil science pedagogical research (e.g., development of virtual reality 3-D soil pits).

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