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How Will COVID-19 Change Forestry Education? A Study of US Forest Operations Instructors

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Abstract

The COVID-19 (COVID) pandemic affected nearly every aspect of higher education. It has been particularly disruptive to forest operations courses that rely heavily on field experiences. [Dodson and Blinn \(2021\)](#) surveyed US forest operations instructors at four-year institutions granting SAF-accredited forestry degrees to understand how they rapidly modified courses during spring 2020 to accommodate a move to fully remote instruction. Through an online survey and interviews, a follow-up study was conducted to understand how courses were modified when instructors had time to prepare and what, if any, of those modifications are likely to be retained upon a return to in-person instruction. Two main themes emerged from the survey and interviews: instructors will expand the range of tools and methods used to convey course content, and they have a renewed respect for the importance of field experience and personal interactions.

Study Implications: COVID-19 has affected academic instruction and workforce readiness. A broadening of instructors' digital skill sets and resources, pedagogical modifications, and a renewed appreciation of field experiences and interactions with students will have a positive influence on instruction in the future. The professional preparation of graduates suffered during the pandemic because of a marked decrease in field time and personal interaction between and among faculty and students. Employers need to anticipate that additional training in field methods and application of forestry concepts to real-world situations may be necessary for new employees who were educated during the pandemic.

Keywords: hands-on learning, pandemic, remote instruction, interaction, Zoom, flipped classroom

On March 11, 2020, the World Health Organization (WHO) formally declared COVID-19 (COVID) a pandemic ([World Health Organization 2020b](#)). The impacts of the pandemic were widespread, including livelihoods, health, and food systems ([World Health Organization 2020a](#)). The pandemic also affected nearly 1.6 billion learners in more than 200 countries with the closure of schools and a shift in the way that educators deliver their curriculum ([Pokhrel and Chhetri 2021](#)).

Transitioning from traditional face-to-face learning to online learning seemingly overnight reshaped the way in which education was delivered, requiring educators to adopt on the fly a system that they were generally not prepared to implement. For many university instructors, the online portion of their spring 2020 academic term was largely about survival ([Supiano 2021](#)). Once instructors knew whether their institution would continue with online learning for

their fall 2020 term, they were able to focus on intentionally redesigning their course(s) so that they could be taught more effectively. Fortunately, many universities expanded their professional development offerings over the summer of 2020 to assist their faculty in reimagining their course(s) for online delivery.

Forest operations is a subdiscipline of forestry that focuses on the methods, materials, and systems used to transform the forest during a timber harvest (Dodson and Blinn 2021). Courses within this field generally incorporate field and hands-on experiential learning opportunities to help students learn and apply course content. Those experiential learning opportunities build skills by connecting theories learned in the classroom to real-world situations (Eyer 2009).

A survey of forest operations instructors and their students at US universities in spring 2020 indicated that respondents struggled with the rapid, almost overnight, “just get it online” transition to online learning (Dodson and Blinn 2021). Instructors had limited previous experience with online instruction and were given limited assistance to learn their university’s video conferencing system and essentially no assistance in becoming pedagogically prepared to move to online learning. Instructors reported that they were generally unable to provide hands-on learning experiences. Despite that, there were some benefits reported: the ability to use guest speakers from afar, as they could be easily connected through video conferencing; online office hours made it easier for students to connect with their instructors; and recorded lectures allowed students to revisit material presented multiple times.

Heading into the 2020/2021 academic year (generally September 2020 through May 2021), forest operations instructors in the US had more time to plan for the delivery of their fall and spring term courses. At the end of the 20/21 academic year, those instructors were surveyed to understand how they may have redesigned their recently completed courses and what, if any, of those modifications are likely to be retained once classes return to in-person instruction. In addition, in-depth online interviews were conducted with instructors to learn more about their plans for incorporating any elements from their online teaching experience into their in-person classes.

Methods

An online survey and interviews were conducted with forest operations instructors in the US. Potential participants selected were all faculty and instructors teaching

forest operations coursework at Society of American Foresters (SAF)-accredited four-year forestry programs within the US. Survey documentation received an exemption from review through the Institutional Review Boards at [University of Montana and University of Minnesota].

In March 2021, participation invitations describing the purpose of the survey were emailed to the 25 instructors identified. All individuals were known to the authors and the authors were included as participants in the online survey. When a positive response to participation was received, the faculty member was sent a link to the Qualtrics survey (Qualtrics 2021). The survey contained questions about COVID-related institutional restrictions on instruction, preparedness to return to in-person instruction, the number of courses taught during the academic year that contained planned modifications due to COVID, assistance received to prepare for the 20/21 academic year, background information about each course the respondent instructed during the academic year, modifications to course delivery to account for COVID, and descriptions of modifications to be retained. For the analysis of some questions, courses were separated into the topical areas of forest operations (e.g., harvesting systems, forest roads), other forestry (e.g., measurements, silviculture, planning), and general education for nonmajors.

Although surveys did not request any identifying information beyond course identifiers, respondents were known to the authors due to the small population that primarily included a single instructor at each represented university. The confidentiality of all survey respondents is maintained in reporting results.

One of the online survey questions asked respondents whether they were willing to participate in a one-hour interview to discuss their rationale behind decisions about what elements of their course delivery will be carried forward, as well as to provide additional details about online course activities that did and didn’t work well. Some questions asked respondents to specifically consider their forest operations courses in their responses. Unless specified otherwise, it can be assumed that all interview results apply to both forest operations and general forestry courses. Ten respondents agreed to participate in an in-depth, semistructured interview which was conducted and recorded via Zoom video conferencing (Zoom Video Communications 2021) during June 2021. Each interview included one participant and the two authors. Transcripts were manually coded and analyzed for

themes, and quotes were verified against interview recordings. Themes reported below were stated by multiple interviewees.

Results

From the 25 initial invitations, 16 agreed to complete the online survey with 15 completed responses, for a response rate of 94% among those who agreed to participate. Of the remaining nine invitees, either no response was received, or the individuals did not teach forest operations courses during the 20/21 academic year due to sabbatical or other release from teaching. A total of 10 interviews representing 10 different institutions were conducted, each lasting about an hour in length. Quotes from participants are used to help describe some of the key findings.

Respondent Demographics and Courses Instructed

Interviewees included four Assistant Professors, two Associate Professors, and four Professors with an average of 13 years of teaching experience. Online survey respondents taught a minimum of one and a maximum of eight courses during the 20/21 academic year, with a mode of three courses (Figure 1). Survey responses were received for 48 of the 56 forest operations, forestry, and general education courses (86%) respondents instructed over the 20/21 academic year. Only two respondents indicated that courses were canceled due to COVID restrictions; however, the classification of these canceled courses is not known. Of these 48 courses, the majority were upper-division undergraduate courses (81%), and fewer than half (37.5%) were classified as forest operations courses (Table 1).

Figure 1. Number of courses taught per online survey respondent during the 20/21 academic year ($n = 15$).

Institutional COVID Restrictions During the 20/21 Academic Year

Instructors reported a variety of restrictions imposed by their institution for all of their in-person courses based on public health measures. The most common restrictions included masking requirements, reduced capacity due to social distancing in classrooms, and restrictions on transportation capacity for field trips (Figure 2). Most institutions maintained these restrictions for the full 20/21 academic year. The majority of respondents reported that their institutions allowed instructors full to partial flexibility in selecting course modalities, which for some included full face-to-face instruction (Figure 3). The majority of interviewees reported that outside factors, such as family health and childcare concerns, had little to no impact on their choice of modality. Less than a quarter of all courses (23%) remained fully in-person during the 20/21 academic year with an additional 27% retaining at least the option of some in-person instruction (Table 2).

In preparation for the 2020 fall semester, all interviewees reported spending time outside of their contract teaching time to adapt their courses to these restrictions. Several interviewees took advantage of short courses and other training opportunities offered by their institution and reported these to be helpful in preparing their courses.

Reflections on Instruction During the 20/21 Academic Year

All survey respondents and interviewees reported using Zoom. Although most interviewees expressed feelings of “Zoom fatigue,” they also recognized several advantages to the platform. For example, interviewees universally recognized Zoom as a tool for incorporating a broader slate of guest speakers into classes:

[Zoom] allows the flexibility to bring people into the classroom you can't physically bring in... Students can hear from research colleagues internationally, and also you can bring in executives, CEO's, people like that, that it's hard to get to campus for a 50-minute lecture... [Zoom allows us] to bring in diverse speakers from remote locations.

Before 2020, 69% of all courses included a scheduled lab session, but this varied by course subject category (Table 3). Nearly all (89%) forest operations courses contained a lab as compared to only one (14%) general education course. Logistical modifications to lab activities in both forest operations and general forestry courses included selecting field sites that students could

Table 1. Categorization of courses taught by online survey respondents during the 20/21 academic year by target audience

Target audience	Forest operations (example: harvesting systems, forest roads)	Forestry (example: measurements, silviculture, planning)	General education or for nonmajors	Total
Freshman/ introductory	0	2	2	4
Sophomore	1	0	1	2
Junior	8	8	1	17
Senior	4	11	1	16
Combined senior and graduate	5	1	0	6
Graduate	0	1	2	3
Total	18	23	7	48

Figure 2. Summary of COVID restrictions reported by the online survey respondents during the 20/21 academic year ($n = 15$).

get themselves to, either by walking from campus or by driving personal vehicles. Many respondents reported increased use of videos to demonstrate concepts that would normally be presented in the field. All respondents indicated they intend to return to their pre-2020 lab delivery mode once their institution gives approval to do so and described the importance of field experiences in teaching forest operations courses:

There's no way to duplicate being in the forest where you could perhaps get lost. You don't know where the roads are, you have to use your map. You'll never learn how to use a compass unless you actually get in the field and have to rely on it. [Teaching through COVID] just reiterated to me how important it is for us to travel to places... How important it is to get out and meet people, and see things with your eyes, and smell things, and hear things, and experience the real world that you're signing up for as a professional. We can do a lot

Figure 3. Degree of flexibility afforded to online survey respondents to select course modalities during the 20/21 academic year ($n = 15$). Note that respondents could select more than one response. *All large classes (>100 students) were required to be offered remotely; permission from the university was required to deliver a class fully online.

of things on video, a lot of things online, but you can't do some of those things that are essential to building good skills and a well-rounded graduate. It just reiterated to me: I need to do this more. Not less. More. And the students feel the same way.

To make up for reduced field time during covid, many interviewees reported spending resources to purchase appropriate videography equipment and time developing videos to cover topics that would traditionally be presented in the field. One interviewee chose to invest not only time but funds into video production:

For the video field trips... I hired ex-BBC Nature film photographers and that's why I blew out my budget a bit. That was money well spent. I can't do that quality of filming and try to focus on talking about what we're seeing at the same time... If you're going to do something visual, quality is really important. Otherwise... if I try to do a shaky cell phone video of those logging operations... the students will lose

Table 2. Course delivery modes before 2020, during the 20/21 academic year, and in future years by course subject category

Timeframe	Course delivery mode				
	In-person	Online - synchronous	Online - asynchronous	Hybrid for all	Hybrid - student choice
Forest operations courses					
Before 2020	17	1			
20/21 academic year	3	7		2	6
Future academic years	17	1			
Other forestry courses					
Before 2020	22		1		
20/21 academic year	7	7	2	3	4
Future academic years	22		1		
General education courses					
Before 2020	5		2		
20/21 academic year	1	1	4		1
Future academic years	4		3		

Table 3. Lab frequency prior to the 20/21 academic year by course subject category

Course subject category	No lab	Travel to the field 1–2 times per semester	Travel to the field 3–8 times per semester	Travel to the field most weeks	Lab was held in an on-campus space	Other*
Forest operations	2	4	3	7		2
Forestry	7	3	2	6	3	2
General education	6		1			
Total	15	7	6	13	3	4

*Three of the four courses used concentrated multiday field experiences, the fourth required students to complete fieldwork on their own.

interest, they'll start looking elsewhere and not paying attention if it's not good enough quality.

A majority of interviewees reported personal interaction with students as what they missed the most while teaching remotely:

What I missed most was actually the interaction before and after class... Learning what the students are doing, where they are getting jobs, what questions they have... somewhat unrelated information that just makes it nicer to know who you're dealing with. There's always examples coming up that I later on recycle in class. What they experience

in an interview. Things that then flow into "here's why you need to know this."

In addition to faculty-student interaction outside of formal instructional times, many interviewees also reported significant decreases in student interaction during class with the move to Zoom-based lectures:

It's only the self-starters, the good students, that seem to be really engaging online. It doesn't mean there aren't other students that aren't getting good grades, but they're not engaging. It's really draining on the professors... I found [it] was exhausting because I had to do all the talking. It was just awkward

silence, looking at the Brady Bunch faces... whereas when we're around a conference table.... you're right there in their face, you can get them to talk.

This lack of interaction extended to student-student interaction. Interviewees observed this lack of personal interaction and networking among students resulted in little to no development of student cohorts:

What I have seen is there is a huge disconnect between students during this covid time. The students that have moved from sophomore year into junior year in my classes, had no idea who they are actually in class with. There was no cohort building. They were all just individuals that worked, but no one knew each other. Which made it then difficult to connect them in groups because they just didn't know who they were working with, so they were all more quiet. So that changed my thinking about having summer classes where they all get together and build that really intense social structure that will... guide them through the next few years.

Many instructors reported recording their lectures for a variety of reasons (e.g., for students to go back to review later, students missing the original presentation). Many interviewees described this experience as talking to a blank screen. Beyond job satisfaction, the lack of interaction during remote-live or recorded lectures was also seen as a major limitation to student learning:

Some [students] said they liked to listen to [recordings] on double speed so they could get through them quicker... But, you know, what does that give you in the end? It gives you snippets of information that you might write down and memorize. If you want someone to be thinking and problem-solving, that's a little different. It might be you're giving some information that helps them understand some way of doing things so they can go on to problem solve, so that may be a good way to link things together. But if it's just giving people an easier way of getting some bullets to write down to get a better mark on an exam, that's not really learning.

Several interviewees described the consequences of remote instruction and lenient attendance and late work policies (as described in [Dodson and Blinn 2021](#)) as allowing students to do other things, such as work or recreate, that they would not be able to do under normal circumstances. Interviewees questioned the long-term impacts of this flexibility on student learning, retention, and professional preparation as these other pursuits distracted students from their

studies. An additional way that flexibility was provided to students was through hybrid course offerings where students were able to choose to attend class meetings in-person or remotely, either synchronously or asynchronously. Several interviewees reported frustration with the work involved with providing multiple avenues for students to interact with course material but not seeing that work translate to better student outcomes:

Basically, for us, a hybrid course devolved into online only; students won't come to class... In the fall, I started out with three-quarters of my class coming, but by the end of the semester I had four students coming regularly. Because the rest of them figured out it was synchronous... or else it was recorded and I put it on YouTube so they could sleep in and watch it at 2 pm instead of doing it at 8 o'clock in the morning. But they never did! And that's the problem. It was like "Holy crap, the exam's on Thursday and I've got three weeks' worth of videos to watch. But wait a minute; I've got three other exams on Thursday!" A lot of stress and underachievement, I think. I'm not a fan of recorded lectures unless there's a real justification for doing it.

Based on the peer sharing reported in [Dodson and Blinn \(2021\)](#), the majority of interviewees reported using resources shared among instructors, including the professionally-produced videos and other videos developed during the 20/21 academic year, curriculum, and pedagogy. Videos were used to replicate field time for those courses unable to visit the field, to give students examples of forest operations outside their region, and as make-up assignments when an individual student was unable to attend a field trip. Nearly all interviewees indicated that these videos will be used similarly in the future.

Interviewees expressed concern for the workforce preparedness of this year's graduates based on a lack of hands-on field skills developed during field labs:

[A credible education is] a really hard thing to measure; you measure it with grades, assignments, how you think... When I was working in industry and hiring people, you get them out in the field and you're working with them and you're starting to try to get them to think and problem solve, you start to understand... in a way that's a little different than I think they get in university.

Faculty are called on to serve many roles for students beyond instructors, particularly within applied disciplines such as forest operations. One of those roles is as

career advisors and mentors. Several interviewees reported they were uncomfortable giving internship and job references for students they had only interacted with remotely:

It's almost impossible to know people's names, put faces and names together, especially when you have a lot of students... And in our profession, you have to get to know people. Can you imagine going through life this way, and interacting with someone three years from now, and they're like "I was in two of your classes" and I'm like "I don't know you. I never talked to you personally." You don't get to learn people's mannerisms, you don't get to see their behaviors, how they interact with other people. You get an employer calling you "I need a reference on this person." I can't really tell [them] much about this person because I don't know this person. I never got to talk to them. I didn't get to spend a week in a van with this person. I didn't get to go to the woods with this person. I didn't get to learn this person. That's just so important. You take these things for granted until they're taken away from you. A lot of these things are the reason I chose this profession.

Curriculum Modifications

Survey respondents reported making more modifications to assignments in forest operations courses as opposed to other courses (Figure 4). They indicated that assignments were changed for two main reasons: to increase student engagement and to accommodate for the loss of field and in-person time. At least some modifications will be retained for 10 (21%) of the surveyed courses.

One example of a new assignment that likely would not have been created if it had not been for the COVID pandemic was a collaboration between instructors at two universities residing in two different regions of the US. These instructors had students in junior-level harvesting systems classes develop group presentations describing forest operations and best management practices in their state. The presentations were delivered to students from the other university via a student-led, joint Zoom meeting. Students at both institutions rated the assignment highly because it forced them to teach the topic to someone else while learning about forest operations in another region where topography and resources were different. The instructors plan to continue

Figure 4. Responses to the question "Did you modify assignments during the 20/21 academic year?" reported by course subject category. Note that respondents could select more than one response.

this assignment after the return to full face-to-face instruction and to expand the assignment to include classes from other institutions. In addition, instructors at other institutions plan to conduct a similar assignment between their institutions during a different semester.

Another example of a change to an assignment reported by two interviewees, and that is likely to be retained, is the use of videotaped operations for a harvesting system production estimation assignment. Historically in these courses, students had conducted a time-and-motion study on a live forest operation. When COVID restrictions made this an unworkable option, the instructor collected video recordings of operational elements. This revised assignment allowed students to safely observe all aspects of the operation and ensured students had access to all necessary operations.

Instructors were more likely to change how exams were administered in forest operations courses than either forestry or general education courses (Figure 5). An equal number of forest operations courses moved to online exams administered through a learning management system (LMS) as those that eliminated exams altogether, replacing them with projects or other demonstrations of student learning. For example, one instructor replaced an exam with a project that asked students to select a road management topic and create a video that was shared with the class during the final exam period. Another instructor replaced all exams with weekly writing assignments where students had to (1) summarize key learnings from the week, (2) identify the most confusing point(s) from the week, and (3) pose at least one question related to timber harvesting or forest roads. The instructor provided an individualized written response to each student, which frequently resulted in additional interaction between faculty and students. In over half of all courses (57%)

that had modified exams, instructors plan to retain at least some portion of these modifications. In making this decision, several interviewees discussed weighing the balance between grading workload, pace of student feedback, exam rigor, and concerns about cheating during an online exam:

Used to be my exam was like 12 pages long, handwritten, and I had to grade this thing... But now it's graded for me, or mostly graded for me... That's freed up a lot of my time. The exams are not as good, I'll admit that... [They're] not as challenging... There's a balance there... [However, students] get their feedback so much faster instead of waiting on me.

Lessons Learned

Although all respondents are looking forward to a return to in-person teaching, the majority (73%) indicated that they plan to retain at least some of the modifications made to one or more of their courses during the past year. Interviewees reported that a number of concepts and teaching techniques learned while being forced to adapt to covid public health measures will influence how they deliver their courses in the future.

A perennial issue faced by all forest operations instructors is the conundrum of what to do when students are unable to attend a field lab, either because of logistical constraints (e.g., the operation to be visited is down unexpectedly; unsafe road or weather conditions) or personal circumstances for individual students. Interviewees reported that videos and alternate lab assignments that were created during COVID will continue to be used as make-up assignments. Additionally, periodic meetings of forest operations instructors and the sharing of ideas, assignments, and

Figure 5. Changes to exams by course type.

digitally recorded content has allowed instructors to include resources, such as videos, from outside an interviewee's region.

Interviewees reported that short videos (10–20 minutes) were more engaging and effective in conveying course content. Several interviewees stated they will retain the same concept on the return to in-person teaching by breaking up lectures with discussions, problem sets, and other activities that engage students. Additionally, some interviewees reported retaining elements of a “flipped classroom” (Millman 2020) by, for example, requiring students to watch an instructional video before class, freeing up lab and lecture time for hands-on activities and more in-depth discussion.

Platforms such as Zoom were universally recognized by interviewees as greatly expanding communication options. Nearly all interviewees expressed the belief that Zoom is an excellent way to efficiently incorporate more guest speakers into a class by allowing for the participation of professionals outside the immediate geographic area and minimizing the time commitment requested. Similarly, Zoom allows students from multiple institutions to collaborate on joint assignments. Multiple interviewees reported they will continue to use Zoom for small-group meetings, both with students and professional colleagues, reducing travel and increasing the flexibility to meet beyond typical office hours.

Zoom allows for the recording of live lectures, which can allow instructors to efficiently share material with students who must miss a class meeting or when instructors must miss a class because of travel or illness. The majority of interviewees who indicated they would use this strategy in the future also discussed not advertising this capability and only providing recordings to students with legitimate absences. Only one interviewee indicated they would post these recordings for all students to review.

Interviewees expanded their use of their institution's LMS to administer and automatically grade on-line quizzes and exams, run plagiarism checks on student work, share digital content, and engage students outside of class meeting times through linked resources. Through increased use of true/false, multiple choice, and matching questions, the LMS was able to quickly grade those question types, which freed up instructor time while also providing quantitative assessments of the fairness of each question. Use of a plagiarism-checking application allowed instructors to assign more written work while assessing the originality of

each. The expansion of digital content is expected to continue.

Although not a new concept, interviewees were reminded just how important interactions with students outside formal class meetings are for career mentoring, networking, and faculty job satisfaction. Similarly, the importance of field experience in the teaching of forestry and forest operations was reinforced. Interviewees indicated that, moving forward, they will be more intentional in the design and inclusion of field experiences, interactions with students, and student cohort building outside of formal instruction.

Discussion

Classes that are purposefully designed for an online environment rely on careful and systematic instructional design, learner support, and provision of methods for multiple types of interactions between students and course content from student to student and from student to instructor (Means et al. 2014, Johnson and Barr 2021). The development time to achieve high-quality online content can take months and may require an instructor to teach the course at least twice to feel proficient with the new design (Hodges et al. 2020). As all respondents indicated they will be returning to in-person instruction as soon as their institution allows them to, it is unlikely this repetition of online course delivery will be achieved.

The rapid onset of the COVID pandemic in March 2020 forced forest operations instructors to transition their content delivery to online in a matter of days (Dodson and Blinn 2021). However, as they approached the 20/21 academic year, those instructors who knew that their classes would be online had additional time to rethink their curricula and learn new strategies for delivering their courses. Although the effort was challenging, it appears to have sparked some new strategies for delivering courses that will last beyond the 20/21 academic year.

Three frequent concerns expressed by interviewees about their experience being online during the 20/21 academic year were their lack of (1) interaction with students, (2) cohort building among students, and (3) workforce preparedness of this year's graduates based on a lack of hands-on field skills. Most individuals have a fundamental motivation to socially interact (Baumeister and Leary 1995). In academia, this interaction frequently occurs through small group discussions and working on projects together both inside and outside of a classroom. Additionally, the field labs included in most forest

operations courses provide extensive opportunity for informal interaction while riding in shared transportation, walking through the woods, and observing active forest operations. Elmer et al. (2020) reported that the shift to COVID protocol for students negatively affected the social integration of some individuals, leaving them isolated. That isolation meant that some students likely spent more time inside of their apartment or home than normal and generally rendered them unable to meet with classmates because many were no longer located on campus or even within the state. Similarly, Ramane et al. (2021) reported that online teaching and learning during COVID wasn't as effective as face-to-face instruction because of the lack of peer-to-peer communication. All interviewees who scaled back or eliminated in-person teaching reported similar findings after the 20/21 academic year.

Similar concerns about the lack of workforce development have been expressed about graduates within many academic areas, including the medical profession (e.g., Böckers et al. 2021, Masterton et al. 2021), zoology (Davis-Berg and Kocot 2021), and engineering (Asgari et al. 2021, Johnson and Barr 2021). In some disciplines (e.g., medical), successful workarounds have been developed to adapt hands-on laboratory courses to online learning through use of recorded video demonstrations, virtual reality, and augmented reality simulations (e.g., Allen and Barker 2021, Masterton et al. 2021). In some cases, it was reported that although successful, those alternative lab approaches made learning more challenging for students and required more effort for them to engage with the material while leaving them with the feeling that they still lost some of the experience that comes with hands-on learning (Allen and Barker 2021). Forest operations instructors reflected similar sentiments; they were able to develop learning materials that marginally worked to deliver content, but these work-arounds were not nearly as effective as hands-on field experiences.

Although it may be possible to partially or completely replicate hands-on lab situations in fields where conditions can be relatively easily controlled, forest operations instructors may have felt that they need field-based experiences because of the high degree of variability in operating conditions within the forest. For example, there is variability in site and stand conditions, landowner objectives, weather, equipment, and preexisting infrastructure that makes it impossible to have one-size-fits-all prescriptions. Learning to recognize and integrate these multiple, often conflicting, factors is a main objective of many of these field experiences.

Current graduates of US forestry programs have not been exposed to as many hands-on experiences as they otherwise would have; therefore, they may not be able to bring in as many new skills and ideas to their employers. Employers of recent forestry graduates may need to revise the field portions of their interview process and supplement new employee training in field skills to account for the loss of field time due to COVID-related restrictions. Ideally, students who were early in their academic career during the 20/21 academic year will have an opportunity to "catch up" on these field skills later in their program of study; however, this will depend on the progression of covid-related restrictions and the design of individual forestry programs.

Time in the field with students, helping students develop integration and problem-solving skills, and fostering personal relationships with future natural resource managers are key contributors to forest operations faculty job satisfaction. Interviewees indicated they will be returning to these activities with a renewed appreciation for their importance to faculty, students, and the forestry profession.

Conclusions

The 20/21 academic year was stressful and draining for both faculty and students, with public health measures necessitated by the covid pandemic altering the ways in which forest operations courses were delivered. This experience, however, did force faculty to innovate and develop new tools and teaching methods, some of which will be incorporated into future in-person courses. This pedagogical expansion will benefit students and the profession, as forest operations faculty have more options to choose from when selecting delivery approaches that will best serve students. Additionally, forest operations faculty will be more intentional in developing field experiences and engaging students with course material, instructors, and each other.

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