Transcript

[0:01] (music)

Derek Bruff: [0:06] This is Leading Lines. I'm Derek Bruff. Last year, when colleges and universities had to shift their instruction online, I kept hearing faculty and administrators worry about certain courses that would be particularly challenging to move online. Lab classes were usually at the top of that list. How do you conduct a physics lab on forces or electricity when you're teaching fully online? Well, we have an interview today with someone who has figured that out.

[0:32] Forrest Charnock is a senior lecturer in physics here at Vanderbilt University and the director of the undergraduate physics labs. Like other lab directors in 2020, Forrest had to get creative to adapt his labs to remote teaching and learning. We'll hear about his creativity in today's interview, which was conducted by Thayer Walmsley, a doctoral student in physics here at Vanderbilt, and a teaching affiliate at the Vanderbilt Center for Teaching. We employ about ten graduate students each year as teaching affiliates, mainly to help run our new teaching assistant orientation in August.

[1:06] We ask each affiliate to do a small project after the orientation, and Thayer jumped at the chance to conduct an interview for Leading Lines. In the interview, Thayer talks with Forrest Charnock about his teaching experiences, the role of introductory physics labs at Vanderbilt, and the ways he has been able to implement technology to effectively conduct labs remotely. (music)

Thayer Walmsley: [1:31] Thank you for being here, Dr. Charnock, and welcome to the Leading Lines podcast. Can you just start by saying who you are and what you do at Vanderbilt?

Forrest Charnock: [1:39] Well, as you observed I am the undergraduate laboratory director.

And basically, my job is to manage the introductory laboratories for the physics department. So that's, you know, Physics I, Physics II, laboratories where students who have to take the general physics classes, have to take a laboratory class. I'm in charge of these laboratories. There are also some other laboratories I'm in charge of. There's the laboratory for our majors, which I'm teaching, and also another laboratory for humanities majors that they often take.

Thayer: [2:21] Yeah, that sounds great. I was a TA and I saw a lot of those classes in action. A great thing about being a teacher is, you know, you really get to connect with people or be inspired. I was always interested in teaching because I could share what I learned and I always got excited seeing, you know, if you explain something once and they don't get it and then you try a couple more times and then a different explanation really resonates with someone. That's always something that really interested me.

[2:47] So I'm interested in if we just take a step back, kind of what got you into teaching or maybe what got you into physics or physics education. Or if there's a story or a moment you would want to share about, you know, when you realized you were a teacher. I'm sure our audience would love to hear it.

Forrest: [3:02] Well, much like you, I got into teaching when I had to teach, be a TA, as a graduate student at my university, and I found I was fairly good at it. But that said, I never had any real ambitions at the time to be a teacher. In fact, I can't say I even had any plans for what I was going to do with this degree that I was striving for. After graduate school, I went to a couple postdocs. And after I finished that second postdoc, I was just sort of fishing around, well, what am I going to do now?

[3:43] And my former advisor at Wake Forest said, well, we need somebody to teach for next year. And I said, okay, sure, I'll do that. And I sort of stumbled into it. So this whole teaching that I've been doing has been sort of like, ok, I'll do this gig for a bit and then I'm okay, now what do I do? Well, someone else needed a teacher and so I stepped into it. And so it's basically just something that's happened more than any plan or ambition of mine. And well, here I am.

Thayer: [4:20] I can definitely understand that. I know that seeing you work, I think you're maybe underselling your passion and your interests. I have to say, I do think you're a very good motivator, especially when it comes to inspiring our TAs and teaching our TAs how to teach. And so I think, you know, I think in life a lot of those things happen to us where we just

kind of stumble into the next thing we do and we're good at it and we like it, we make a difference and, you know, kind of go on from there.

[4:52] So kind of delving into the specifics of the undergraduate lab, could you briefly describe, so I know you talked about that there's a whole different set of labs. The kind of ones I want to talk more a little bit about are the ones that most students take. So could you talk a little bit more about those, not necessarily the major one, but maybe the ones for the humanities as well as the ones that are physics, quantum physics, and more broadly, could you describe those a little?

Forrest: [5:19] So these are the laboratories that if you're in engineering or a science major here at Vanderbilt University, you take Physics I and II. And so these are the laboratories associated with that. So Physics I, mechanics. It's where you learn about velocity, acceleration, pressure. And we have a variety of labs associated with these principles. Measuring the speed of a cart, acceleration, trajectories. Physics II, emphasizing optics and electricity and magnetism. And we have a series of laboratories based on optics, polarization, electrical circuits, et cetera.

Thayer: [6:05] I think those are all very interesting interval physics concepts. But I know from talking with you and being a TA that these labs, a lot of different majors take them. And that beyond learning the mechanics, the mechanics of mechanics I guess you could say, or electricity and magnetism. And I think it also brings a different skill set. I know there's a big emphasis on data and interpreting results. And could you talk a little bit about, you know, what role do you think kind of either teaching science or teaching physics or the lab courses helps in making well-rounded students? Or why would the university have a mandatory class like this for a lot of students?

Forrest: [6:53] Yeah, and this is the question, of course, a lot of students themselves have. They're taking a lab course. They have to take the lab. Of course, my ambition is for them to, well, several things. First off, to see in practice the physics that they're learning about in the classroom. So if you just take physics or any science course in a classroom, it can be a lot like theology. You're talking about a lot of things, but if you don't see it, you don't feel it. It's like ok whatever, this is the way Newton said it was. Therefore, this must be true.

[7:28] And the goal in the laboratory is to show them that this isn't just stuff people, the professor talks about. This is real stuff. You could see it in your life surrounding you every day.

There's also the broader notion of just, you know, learning how to experiment and how to think critically about the world around you. And it almost doesn't matter what you do to learn these skills. It can be in physics class, it could be a chemistry class. In our purpose for say, Physics I, a process of doing a mechanics experiment is just a forum for which we can explore the notions of rigor and experimental error and thinking through a problem critically to find your own solution.

Thayer: [8:25] I definitely have seen that in action and seen students experience that. And kind of turning to the challenge that has faced us this year, one of the big things you said at first was getting students hands-on experience and hands-on experience when your hands are not allowed to pawn is a very difficult thing to do and it's a very big challenge. I couldn't, I couldn't even envision how I would've gone about teaching physics labs remotely, let alone just the physics lecture course. But, you know, let's just kind of walk through maybe the timeline of how this happened or the thought process.

[9:04] So this kind of hit us in spring, where the classes for the spring semester weren't over. So kind of what happened at that time when you heard, you know, more or less, the world was not, I don't want to say ending, but things weren't going too well, particularly for human-to-human interaction. So what were your initial thoughts when you started to hear about what was going on or when Vanderbilt made the call to close things down or just kind of early onset of the pandemic?

Forrest: [9:32] So I'm trying to recall the timeline myself. It's been so long. So I think this happened the weekend before, the announcement was set out saying that the students may have to move remote. And I'm just still barely getting my mind around the notion. And I think at the time I thought, well this is so ridiculous, I'm not even going to think about it. (laughs) And then on Monday, I think it was we had just finished one laboratory session and we had just started another one and the call went out, classes are ending, send everyone home.

[10:14] And it basically happened so suddenly, I just sort of stared blankly at the wall for a while trying to figure out ok what's happening here. And we sent our students home. And it was a mad dash for a week to figure out what the heck we were going to do. So the result of that was I referred to it as building the aircraft while you're flying it. We spent the rest of that semester, week by week coming up with labs that were viable, that could be suddenly done over this bizarre thing that they called Zoom, that I was just now finding out about and muddling through.

[11:05] I think for the most part we did as well as could be hoped. And that got us through the spring. Then immediately it was like ok, we had several weeks and then summer happens. And it was clear at that point that summer wasn't going to be in person. And so at that point I'm fooling around. I feel very strongly about the notion that this is a laboratory. It should, I imagine the students actually doing experiments. And I needed to have some way of having students physically do an experiment.

[11:50] And that cast my mind back to this conversation I'd had a couple of years earlier with a representative from one of the big companies about this iOLab device. And it's basically a physics lab in a box. So it consists of this part, talks to your computer via Bluetooth and there are a number of sensors on it. These are basically the same sensors you would find on a high-end cell phone. It's got a temperature sensor, a magnetometer, pressure sensor, all the things that you find on your expensive iPhone, it's just sort of packaged in a somewhat cheaper device, a bit more rugged, and a software interface that's appropriate for a physics lab.

[12:38] So myself and I think about a couple other thousand laboratory directors suddenly converged on the publisher, producer of this thing saying, oh, we need about a couple of 100 of these by the way. And by the way, I've got to say kudos to Macmillan. They ramped up from a rare kind of boutique device that they were selling to a few home schoolers and a few schools to being a nationally demanded thing that was produced in quantity. And it's been a real struggle. But kudos to them for stepping up to that and actually getting these things made where it was accessible.

[13:28] So we're able to get, you know, enough to teach the summer schools. And in the process, we also had to come up with laboratories that were appropriate for this device. And then basically applying the lessons we learned during the summer as we entered into the fall. Of course, we also had to learn how to use Zoom with a bit more rigor than we had done in the spring. And yeah, it's been a learning process. Every week is getting ready for the next thing. Completing the last lab, getting ready for a new lab, catching mistakes before they go out, often missing them, and a whole new experience for everyone.

Thayer: [14:26] I understand how I remember in the spring that everything felt very sudden, very immediate. The world felt upended. And I lied to myself and said, oh, two weeks, I'll be back in the lab and I'll be doing experiments. And then a month goes by, two months goes by, I have difficulty getting to the lab. I couldn't imagine for students trying to do classes. But it sounds like you certainly did work getting the spring, getting through the spring and then

setting up in the summer, getting the devices that you needed, as you mentioned.

[15:02] And so I kind of want to speak or ask kind of two things. One, about how the Zoom teaching went or how you integrated kind of the lab experience that students would have for their everyday lab. Because it sounds like in some degree this IOU or iOLab was able to really has just as good or just as many types of sensors or monitors that a lot of the lab experiment equipment had. And so my question is about, how, could you kind of walk us through, you know, what a day in a traditional lab setting looked like, maybe your favorite lab that we teach or that has been taught? And then contrast that with to a similar lab in the day experience for the iOLab.

Forrest: [15:56] Ok. So back in the before time, a student would come to laboratory at a regularly scheduled time, come into a room with 18 other students and a teacher. And it would be a brief introduction into the material that we'll be covering today. They would also have hopefully completed a pre-lab material then a little bit of study about the material that we're going to talk about. Answered a few questions. Then we start the lab. And we'll have a laboratory about some topic, a pendulum, gravity, whatever the topic of the day is. They'll work through some exercises answering some questions, making their measurements, commenting on the accuracy and precision of the measurements. Do those measurements agree with what a theory says those experiments should be? And completing your report on the lessons learned.

[17:03] So that suddenly of course turns into an online version. And I've tried as much as possible with what we've been doing this last semester, to keep it as much a laboratory experience as possible. So now we're gathering together in a Zoom session. We have some pre-lab material that I asked the students to complete, answer some questions, read about the theory so that they're prepared to deal with the physics that we'll be entering. And then we break them into groups. And so in the physical lab, we have them at groups in a table of two or three. Over the Zoom sessions, we break them into breakout sessions of groups of about three people. And so that makes each student in a place where they can openly talk. And if there are only three or four people in the room, it doesn't turn into cacophony. They still have, I hope, the experience of talking through a problem, solving the problem on their own.

[18:18] And that really is the goal of the lab. The best lab is where the teacher or the TA actually ends up doing relatively little. His job is to point them in the right direction and have

the students themselves figure out the problems. And when necessary, explain things a bit more or ask a question that would guide the students to understanding a principle that we're shooting for. And I think the breakout sessions, when you only have a few students in a Zoom session serves most of that purpose.

[18:56] So, ordinarily of course, they'd be at the table together. They'd be sharing the exact same equipment. They'd be looking at the same screens. Now they're apart. But nonetheless, they're dealing with same problem. They're each facing the same questions because they're doing, it's actually the exact experiment separated by several miles. And they're coming to the same questions. And they can share those questions, share those problems we're facing in the breakout session.

[19:28] So in that breakout session they do a lab and they answer the questions, they submit a report, hopefully explaining what they've learned. All the while, our teacher is sort of hopping from breakout session to breakout session, making sure that things are going well, that they're not completely lost. Spending more time than I wish on solving computer problems. I think basically at this point we're all, we all know way more about Windows and Macintoshes than I ever wanted to know. But this is where we're at.

Thayer: [20:15] It's like a special certificate you get during a pandemic. You get a mini IT license.

Forrest: [20:21] Basically, yeah. We're all computer support now. (laughs) In ways, of course we had to deal with it before, but now it's well, how do I install the software? I've got a Mac. Ok, I don't have a Mac, how do you do this on a Mac? So there are a lot of bizarre questions and it's a pain. On the other hand, it sort of goes into the whole, goal of the lab anyway. The point is sort of okay, you're in this situation, whether it's a physics laboratory in your college or it's the laboratory of the company you're working for. Whatever it is you're here and you've got a problem to solve, and you've got some tools to solve it. So in some sense, this is very much a real-world situation. You've gotta make this measurement and you've gotta get your iOLab device to communicate with your computer. Okay, there's job one.

[21:24] Now you've gotta download the data from the iOLab device into Excel so you can do the analysis. Ok, now you've got to learn how to do that. And your TA, your teacher can't answer all those questions. You've gotta figure this out on your own to some extent. We'll be here. We'll help you if we can. But the problem remains. So in a sense, this still works as a

laboratory because it's still about problem-solving. If it's not quite the problem that we wished it to be, it's still a problem and you're still having to learn some physics in the process.

Thayer: [22:05] I think it's really just remarkable how you've been able to, you know, just the ingenuity of I think physicists, you know, personally I think has, has that for sure, showing that here's a problem, here's the solution. This is how we're going to do it. And then we're going to add a couple little things that you need to learn along the way to get it done. And I think that's just very thematic of the lab experience and very helpful to the students I think for learning a lot of it, which is really great.

[22:35] One of the things that you talked about was the data that students have. And so I just think that's really very interesting that, you know, in the lab setting, you'd have maybe one set of data between three students and they're having to problem-solve that. Do you think it helps the students to, since they each have their own device that they're getting their own data and are having to compare things? I don't want to say that, you know, doing the lab courses remotely made them better because there's certainly obviously different challenges and different things are going on. But is there any silver lighting that you felt?

[23:13] You've already kind of talked about the IT certificates that you get and the extra problem-solving that you get on top of a lab. But, you know, I'm really fascinated by the data because the carts that we had in the lab, you know, sometimes, you know, you'd have to bounce them. Sometimes you'd have to push them just right, or problem-solve in the lab. In replicating that at home, I think that's one of the biggest or the most interesting things about doing the lab at home with having real data. Not like tables or not, you know, oh, somebody did this experiment in this textbook, in a textbook problem and found this momentum, which you're actually doing it with your data in your cart. And so I guess do you see any silver lining in the data or anything like that, that have maybe more hands-on?

Forrest: [24:00] There are lot of silver linings in the this and in many ways it's sort of pushing me in a direction that I'd been wanting labs to take for a long time. One of the biggest problems of having the labs in the past is that you have a group of students, they're working together at the table. And working together is much of the point of a lab. You have to talk with someone. You've got to think through this orally to really learn physics, the best way to learn physics is to explain it to someone else. And so I want those conversations going on.

[24:31] But in the past it was like there were three students at a table. One of them is looking at the computer, one of them is looking at the cart, one of them is reading the text. And it means that someone never learns how to use a computer is the problem. And someone never learns how the cart works because well, Tim did all that. And now everyone has to do everything. Everyone has to do a measurement. Everyone has to learn how to use the computer. They can't just copy out what someone else did. This is pushing us in that direction in a very good way.

[25:12] Another benefit of this is in the past the labs that I'd written were pretty recipe driven. And that is, it was step one, step two, step three. And it's really a logistics problem of how do I put a lab together that works for a lot of people and the time allotted. Necessarily, we had to loosen up the laboratory reports that we had the students write because of the whole situation. And to some extent this makes the students think a lot more critically about what they should be doing. That they're not told explicitly measure this ten times, it says measure it. And in the process, I think the students are being forced to be a bit more independent in how they're approaching the problem-solving they're doing. Which is, like I said, a direction I'd been wanting to take the lab for some time.

Thayer: [26:16] I was just gonna say I remember the simple harmonic motion lab was during my tenure as a TA is one of those labs that you revamp in that capacity. It started out as, you know, this is simple harmonic motion. This is the thing that makes it not simple harmonic motion. Do this and see that that's true. And then, you know, kind of what you've been talking about when you rewrote that lab. It's like here is the general concept of simple harmonic motion. And then the students have to discover for themselves, oh, this is what makes it not simple harmonic motion. Because they were introduced to a pendulum instead of a spring. And there was something slightly different about it. And they had to suss that out of the data in, you know, kind of work in that direction. So I think that's really interesting. Was there a specific lab that you had in mind with the iOLab that followed that maybe more open ended, you know, they had to figure it out themselves., method of doing the lab?

Forrest: [27:20] Yes. So one of the problems that I had the students work on, let's say, some electronics lab where they had to build a circuit. Before when I had a circuit and I had very explicit instructions in the laboratory. Connect the resistor from here to here, connect the capacitor from here to here. And very explicit pictures of what that circuit's supposed to do. And I did that because it was practically easier and everyone had the same board and it was just the easiest thing, to have it setup.

[27:59] Now the students are home. So in the kit that the students are asked to acquire, they have a circuit board, but it works in a different way. And so they have to figure out how to build that circuit without the hand-holding instructions that I was providing before. And that's been really difficult in getting the students to learn how to do this. On the other hand, that whole pain is part of why this, in some ways I think might be working better. And that they have to figure out, ok, here's this very idealized diagram that I've been given. But that's not the same thing as resistors and capacitors on a circuit. I've gotta figure out how to go from this idealized version to a real circuit. And I've pretty much got to do this on my own. My TA's there. I am holding the circuit up to the camera. But still I'm on my own in a way that wasn't true when they were in the classroom, which has changed the whole tone I think, of the lab. Rather than doing exactly what you're told, you very much more have to figure it out.

[29:25] Similarly with the pendulum lab of the initial question was here is a theory. This is what pendulums are supposed to act like. Do the experiment and verify that this is true. And now that's been turned into something more like, okay, here's what the theory says. You come up with an experiment using the tools that you have to verify if it's true or not and I'm not going to tell you how to do it because I don't know what equipment you have. Ok, you have an iOLab device. But maybe that's not the best way to do the experiment. It is sort of like a MacGyver problem almost in a sense that, okay, I want you to do an experiment here. And you're in your apartment, home, whatever. You don't have the equipment, all the equipment that we would usually have in a laboratory setting.

[30:22] Nonetheless, you have equipment, you have experimental apparatuses. You have the iOLab device that you asked to receive. You also have your dad's stopwatch. You have measuring tape. You have other items that you can use to build an experiment. And physics is very much about the real world. It's not confined to the classroom. It's not confined in laboratory. It's all around you. And I want you to learn to open up your eyes and see things not just as that's measuring tape, that's what we used to do carpentry. No. It's a measuring tape. You use it to measure distances. That's the basis of physics. That stopwatch, it's not there to time how quickly you could run the 100-meter dash. It measures time. You can measure lots of things with it. And we can apply those measurements to the basic underlying principles that Newton talked about. It's all there, it's all the same. And the fact that it doesn't have Vanderbilt printed on the device or that it doesn't say physics on the device. It's still the world we live in. And this is the world I want you to experiment in.

Thayer: [31:44] Because the beauty of physics or the beauty of problem-solving and certainly centers around being given a challenge, I think that's really interesting for the way that they're having to do that lab in particular at home of maybe having to come to the realization themselves that, oh, this fancy tool that, you know, is, you know, an iPhone light in terms of the sensors they have, is not the best way maybe to do this lab. And so I think it's really interesting that the presence of kind of this very sophisticated technological apparatus is actually forcing the students to rethink what goes into fancy technologies? Or what goes into how we go about our daily lives or how do we use the thing that we have in our daily lives? That sounds like certainly a big silver lining of the types of experiments that are going on.

Forrest: [32:43] I recall last spring, I was, we did a pendulum lab for one of the offline labs or online. And there was a student who sent me an email saying, I can't do the lab because I don't have a pendulum. I had to encourage them, yes, you do. You can make a pendulum. I don't care if you're locked in your apartment in New York City. It's the simplest device in the world. You've just got to open up your imagination a bit more and see things that you ignored in the past and say, oh, no, that's a pendulum that you need something heavy, you need a string. So what have you got? Well, your dad's tie can be the string and your old toy from when you were five years old can be the bob. There's a pendulum. It obeys the same physics that that fancy lead device that we have in the lab does. It's just a weight and a string. Physics is physics no matter what you're using.

Thayer: [33:52] It's really fundamental. I do like to toot the horn of physics, but I forget who said it, but someone says, it's either physics or stamp collecting, when it comes to the way you solve problems, you know, when you drill down deep enough to most other disciplines or certainly most other scientific things, it's rooted in a fundamental knowledge of how these things work. And oftentimes it's really informed by physics. Or even if it's not informed by physics, it's certainly benefited by approaching the problem as a physicist may approach a problem or having the, you know, you pointed out the imagination to bring maybe disparate tools or maybe not what their primary purpose is. And recognize well, what fundamentally is it or what is the underlying aspect that it is. And so it's extremely interesting about how, you know, being forced into a less than ideal situation or a situation that has certainly disrupt many people's lives, devastating, something can come out of it that improves the way that you do things.

[35:08] And that's a statement in and of itself for sure for what we've been through and what we will continue to go through. And one of the things you talked about is kind of the

refinement process. In the spring, you know you went by week-by-week and in the summer, you had a chance to do the labs and then in the fall you've had further refinements to it. I'm pretty sure most things in the spring are still kind of, I don't want to say locked down, but we're still not in the traditional sense. So are there any things, you know, you're thinking of doing different, or changing, or any things that you really like that you'd want to frontload? One of the things I think is really interesting about the situation we find ourselves in as far as scheduling and timing for what it sounds to me, these labs are not necessarily a three-hour window that they used to be in a strict sense.

[36:07] In one of the things I know many physics or many other kind of concurrent lab courses and lecture courses have to deal with is the lecture material doesn't line up with a lab course or something like that. And so have you found any interesting things about maybe how doing the things remotely or something like that, or the freedom to have the students do it when they want to do it. Any of those aspects that are particularly good about the lab at home or the iOLab? Or just kind of more generally commenting on that problem that I'm sure many educators face, when it comes to how do I show, how do I teach the book and teach all the material I need to know while having to have a hands-on component?

Forrest: [36:57] There was a real challenge, just getting students, devices out to students. Now, students that are on campus was pretty easy. They can go to the bookstore and you can also buy them directly from the publisher. But nonetheless, there's things where a student, shipping, of course, mailing anything became a challenge over the last summer. And I had a number of students who were just very slow in getting devices out. Partly it's shipping issues, partly was Macmillan had, or the publisher, the maker of this device were overwhelmed in send demands and they were trying to ramp up supply. For the most part those were met.

[37:41] I did have some students who were overseas and they just could never get the device because of all the problems we've been facing. So going forward, I think a lot of the logistics problems that we've learned from the fall, we will hopefully be prepared for in ways that we weren't, regarding the iOLab device and other things. It's not just the iOLab device, of course. I had a list of items that I asked the students to acquire. Often everyday things like measuring tape and string and batteries and wires. Things that, you know, you can probably get at any hardware store. But nonetheless, you gotta have some equipment to do the labs.

[38:38] Often these were things that we didn't realize that we needed to ask the students to

get before we started suddenly and were into the labs and realize, oh, no, our students don't have measuring tape or they just don't happen to have this equipment. So we need to add to a list of items that we need to make sure the students have. There's a number of items that like for the optics labs, I needed them to have polarizers and some wave plates, things that are actually remarkably cheap and inexpensive. It's not really a big deal to get them, except that buying a wave plate, buying a retarder is something you just can't do unless you're buying in bulk. And so there were a lot of items that I'm just buying in bulk and then putting in envelopes and mailing to my students or having the students come and pick up.

[39:36] And so we have this real problem in distributing some of the devices, equipment that the students will be needing for the experiments. In terms of the labs themselves, well, as you can imagine, we found lots of things that just didn't work. And it's going to be, well, I'll sit down at the list of labs, we'll decide ok that lab worked well, great. This lab, okay, we need to rewrite that one. Because students didn't understand this concept, they didn't have this equipment or I can't spell and I need to rewrite. There's a whole list of edits. And I think it's going to be again, sort of. And it always has been a week to week, here's the lab we're doing. What do we need to do? We have our weekly lab meetings as you've experienced. That's where I throw this out to you. Okay guys, how did this go last week and then you all complain about to me all the things that didn't work. And I'm making notes and I'm saying, ok, I agree this didn't work, this did work. And we'll take those lessons learned for next time. Okay, here's what we're doing next week. Your comments. Here's what, what do you think is working, what won't work?

[41:03] And really those conversations, I don't know how much you appreciated how valuable those meetings were for me that we had every week on the upcoming labs. But it was valuable to me to learn how labs were going. Even this last semester, I usually don't actually teach in the classroom. But this semester because of necessity, I was actually teaching a couple of the labs. And even then, I'm still learning from talking to my TA's about things that didn't work well. Things that did work well. Those conversations are very valuable to me. Hopefully, I can take the sum total of all those lessons learned, apply them to the spring and move on from there.

Thayer: [41:55] It's interesting, I think. I pretty fondly remember every Friday afternoon when we would talk about the previous weeks' labs, it's almost like an airing of grievances (Forrest laughs) that we would have where we would all kind of, some people had more grievances than others, felt much more passionately about some things that other people saw as smaller

grievances. And I thought it was a really kind of interesting process because it was very, very collaborative in the sense that you had to have you at the head, you know, who has the vision for how the lab would work. And then you have ten plus TAs that are each experiencing the material kind of differently or how they lecture at the beginning of the class and how their students perceive the material.

[42:45] And then you have the students, some of which might be very interested, might not be very interested, might know a lot about it, might not know a lot about it. And so it really kind of shape those discussions of the process. It kind of reminds me of kind of a living, breathing, you know, physical machine, so to speak that is kind of the process of learning, right? Where we're teaching students that are learning the material themselves and then we're being taught how to teach kind of in a feedback loop with the students.

[43:21] And I always, I always thought those were particularly fun and what was even better is they were productive. Because having taught several semesters, you know, even if it was something like the typo on page four is fixed, a student would always give me grievance about that, we fixed it. Or, you know, a bigger thing where, oh, this set of experiments within this lab, one of the friction experiments didn't quite work right. And what did we need to do next time? Oh we needed to make sure that in the prep work we would find all the carts that had the right wheels for that week and to do those things. And I always thought these things were very fun, very interesting, and very emblematic of what we're trying to do.

[44:05] Or, you know, particularly what you're trying to do with the students and what you're doing with the TA. And it's really impressive how those things have been able to continue as we've moved on online to do a lot of these things. Doing it in Zoom. I always thought it was interesting the features that Zoom has. Like who thought we would need breakout rooms? Or the person who designed breakout rooms were thinking of, you know, maybe a waiting room or something like that where, you know, oh, step outside, we need to talk, but breakout rooms for us was oh, these are our tables or each of the individual lab experiences. And so that's another interesting thing.

[44:46] I don't think when this iOLab was made that they were thinking, ok, we're about due for a pandemic. It's been 100 years. We know this is law of averages. Statistical analysis says, unfortunately, this may come up within our lifetime. I'm sure Actuarial Scientists thought that, but that's neither here nor there. But I don't think Macmillan was thinking that. And so that's another very interesting thing how technology's able to adapt, or particularly people are able

to adapt to their present situation. It's certainly something that you have done in spades over the spring and the summer, in going into last spring, this summer, this fall, then going into next spring is certainly something that's continuing to go.

[45:37] And so I think we're kind of ending our kind of time here about talking about the different ways in which teaching, and teaching physics to introductory courses are important in having that lab experience at home. And just kind of your final thoughts on, you know, I know you've talked a lot about there are very good things that have come out of this. Some things that you want to carry over to the classroom experience in the future. But before that, I had one specific question that I always thought was interesting because this is a very big problem or a very difficult challenge when it comes to students is make-up labs. And so I was interested to hear your thoughts on in the future that do you think having this experience and having kind of these set up labs, the iOlab, they may not be the same as the in-person labs. Do you think this would ever be for students who can't schedule that make-up lab for a variety of issues always come up over the course of the semester. Do you think there's any potential for to take some of these labs and have them as backups if you need to in the future in that regard?

Forrest: [46:52] Yeah, and, you know, in the fantasy world that I like to live in, I would imagine even continuing to use the iOLab devices when we return to the classroom. I would love to have a regular in-person experience, nonetheless, with our iOLab devices or something else. I like the idea of having the students actually doing experiments on their own outside of the classroom and bringing what they learned into the laboratory environment when they're meeting their lab partners. I can imagine the iOLab device being part of that. So as part of the lab preparation there, it would be assigned to actually do an experiment or even create an experiment with the device. Even maybe asking a very abstract question and your assignment is, ok, using the equipment available to you, go measure the acceleration of gravity. Write your report. Come to me when you're done, that kind of thing.

[48:02] Where they have the equipment, they don't have to be in the laboratory to actually do the experiment. I would like to carry that out or, or have the ability to make an assignment like that, which I really haven't had the past. You have a student, in the past they have a computer and lots of paper, but often basic measuring tools they didn't have. With something like this, they can have that. And incorporating that into laboratory would be definitely something I want to carry forth.

Thayer: [48:34] That sounds great. It definitely sounds like the, despite the challenges we've been through, there is a silver lining certainly in technology, as much as it itself has helped saves the day. Technology has reminded us how important non-technology, I guess, so to speak, is what we do in our everyday life. Thank you so much, Dr. Charnock, I really appreciate you being here and sharing with us your insight on how did we teach a physics lab that's based on hands-on experiences in a world where being hands-on is kind of discouraged, though. It was a great experience. And I greatly appreciate your time here.

Forrest: [49:20] Thank you. It was a lovely conversation and it's good to see you again (music)

Derek: [49:27] That was Forrest Charnock, senior lecturer and undergraduate physics lab director here at Vanderbilt University, interviewed by physics grad student Thayer Walmsley. Thanks to both Thayer and Forrest for sharing their time and experiences with the podcast and our listeners. I really enjoyed hearing how the move to remote and online teaching helped the physics labs at Vanderbilt do more to teach problem-solving and help students see physics in the world around them.

[49:53] Leading Lines is produced by the Vanderbilt Center for Teaching and The Jean and Alexander Heard Libraries. You can find us on Twitter @leadinglinespod and on the web at leadinglinespod.com. This episode was edited by Rhett McDaniel. Look for new episodes the first and third Monday of each month. I'm your host, Derek Bruff. Thanks for listening and be safe. (music)