Episode 31: Tracy Teal

**KL:** Katie Linder

**TT:** Tracy Teal

**KL:** You’re listening to *Research in Action*: episode thirty-one.

[intro music]

# Segment 1:

**KL:** Welcome to *Research in Action*, a weekly podcast where you can hear about topics and issues related to research in higher education from experts across a range of disciplines. I’m your host, Dr. Katie Linder, director of research at Oregon State University Ecampus.

On this episode I’m joined by Dr. Tracy Teal, the Executive Director of Data Carpentry and adjunct professor in the BEACON Center for the Study of Evolution in Action at Michigan State University. Her research background in is microbial ecology and bioinformatics, and she’s been a developer and contributor to several open source bioinformatics projects. Tracy has a Ph.D. in Computation and Neural Systems from Cal Tech; a Master’s Degree from UCLA in Organismal Biology, Ecology, and Evolution; and a Bachelor’s from UCLA in Cybernetics.

Thanks so much for joining me today, Tracy.

**TT:** Thanks so much, Katy. I’m really happy to be here.

**KL:** So, part of what is so exciting for me about having you on this show is you have this incredible background, at least in terms of your degree titles, which I think is really fun. Why don’t we start out just by telling me a little bit about how those things fit together between the cybernetics and the organismal biology and the computation and neural systems? You know, what do those things mean?

**TT:** Sure. I like to say that all of these degrees sort of show that I’ve been indecisive in the sense that I’ve always wanted to study both computation and biology. So, cybernetics was the first entrée to that, which is really sort of systems biology, and the opportunity to learn about and apply computational techniques to biological questions. Similarly, actually my Master’s is even more confusing than its title because my thesis is in computational linguistics. And in computation and neural systems, similarly, I had that chance to work on both computation and biology, and actually focused in microbiology, which clearly has no neural system.

**KL:** Ok. So, for people who might not know what computation is, can you describe that just briefly?

**TT:** Yeah sure. So, computation, the way we sort of talk about it now is using computers, and so that broadly can mean doing data analysis, image analysis, writing software. Sort of any approach applying computing, like with computers, but often we sort of bring in mathematical approaches, modeling approaches as well.

**KL:** Ok, wonderful. So, Tracy, I had approached you in part because of your role as the Executive Director of Data Carpentry. And this was an organization that I recently learned about, and I think it’s really incredible what the organization does. And I actually took some workshops here at Oregon State that were based on Data Carpentry materials. So, first, for our listeners, can you describe what is Data Carpentry?

**TT:** Yeah, so Data Carpentry, we are a non-profit organization and our goal is to teach data skills to researchers. And, so, we run short, hands-on workshops on the foundational data skills for researchers to be effective and productive in their research analyses.

**KL:** So, tell me a little more about just kind of what are some of the topics that get covered in these workshops.

**TT:** So, Data Carpentry is really focused on researchers who have data, and especially a lot of researchers don’t have this background in sort of what we are calling computation – applying a lot of these computational methods, working with really large data sets, or even data sets that are just bigger than they’re used to working with. And, so, we want to teach the researcher how to manage and analyze that data, and without any prior knowledge required. So, we teach data organization and that’s really how to organize your data in a way that the computer can make effective use of it because how we think about data and how computers think about data are not the same. And then we teach data management, so managing both the data that you’re acquiring and the metadata: the information about the data. How it was collected, the kind of experiment that was done. And then we teach data analysis and visualization in scripting languages. And those scripting languages are R or Python. Those are two different languages, but what both of them let you do is they let you conduct an analysis and also in the process of conducting and writing that analysis, you’re keeping track of all of the steps that you’re doing so you can easily re-run analyses, make changes, and you’re not limited in the amount of data that you can work with or the types of analyses that you can do.

**KL:** So, I mean I love the breadth of what you guys are offering through Data Carpentry. I think there are just some really important skills that you cover. And one of the things that I thought was really interesting was some of the workshops that I’ve attended here at Oregon State. You might think that who you would find in these workshops would be, you know, primarily graduate students or junior researchers. And actually I found that in each of the workshops there were very seasoned researchers who just weren’t familiar with some of these newer tools and kind of languages, and things like R and how to engage with data in newer ways. And they were really interested in learning more skills so that they could then impart those skills onto their graduate students, but also they realized that their graduate students were learning those skills. And so they were kind of at a mismatch in terms of what they knew and how they were dealing with data. I’m wondering if you can tell us a little more about who are the kinds of folks that you’re seeing coming to these workshops and that are really engaging in these skill development.

**TT:** Thanks, yeah that’s a really good representation of what we’re seeing sort of across the board. And we are really excited to see this range of career stages at the workshops. And, as you say, it really is this new way of working. It really is a new way of working; we really are in this paradigm now where data production is no longer limiting. We’re creating data faster, more data, more types of data. So, everyone is sort of confronted with these large amounts of data. So, they do need these new ways of working.

So, for graduate students, I mean, right, learning these skills. For faculty also, you know, they want to learn these skills themselves, but also to be able to help their students, to mentor their students. But we’ve also had faculty come in saying, “I know that my lab needs to be doing things another way. I’m not going to be the one conducting the work, but I want to be the one, I want to know what that is. I want to be able to set up my lab so that we can promote and use these new techniques.”

**KL:** That’s incredible. I love to see that diversity in your audience. Can you tell us a little bit about how Data Carpentry came to be?

**TT:** Yeah, so this is, it really came from seeing researchers with a lot of data and sort of struggling to work with it effectively. And so we had, the National Science Foundation has biocenters, which are centers focused on biology, and we got together some of the people in training and on the technical side on these different biocenters and we identified the shared need for training across all of our centers. And we decided that we wanted to develop curriculum together rather than independently each of us developing new curriculum. And a lot of us were Software Carpentry instructors. I’ll speak a little bit about what Software Carpentry is. But what Software Carpentry does is it really teaches with a hands-on approach, really engaged learning. And so we wanted to teach what we were going to teach in that same way. So, we developed curriculum, we identified the skills that we needed to teach. We really wanted to teach these foundational data skills that we talked about. We developed curriculum and we taught a few of these workshops. And after we taught a few of these workshops just in the biocenters, we saw that there was a lot of interest outside of the biocenters as well. So, we talked with Greg Wilson who one of the founders and at the time the Executive Director of Software Carpentry. And he said, “That sounds great. You should do that.” And so we started up Data Carpentry. Kind of focused on really working with data, whereas Software Carpentry had a little bit more of a focus on software development best practices. So, for people maybe a little more engaged already in doing scripting or working with software, better practices. So, we kind of reached different audiences and have a slightly different focus in how we’re teaching these kinds of approaches. And that ours is very focused on how are you going to do your data analysis, and Software Carpentry has had that focus on doing software development.

**KL:** We’re going to take a brief break. When we come back we’re going to hear a little bit more about helping researchers develop new skills. Back in a moment.

[music]

# Segment 2:

**KL:** So, Tracy, the fact that you have this whole kind of company – Data Carpentry – around this idea of training people and helping them to develop these skills with data and data management and data analysis it kind of begs the question of, you know, why do we need this? Isn’t this something that is covered in graduate programs? And, how are these kind of workshops fitting in with that? Can you speak to that a little bit?

**TT:** Yeah, that’s a really great question and, you know, I think we’re at a transition point right now with university curriculum and the needs of researchers. And, so I think now a lot of universities are seeing the need to integrate data training, computational training. Not even sometimes as a stand-alone class, like, you know, go over there and take that course. But to integrate it into a biology course or a psychology course. And I know I can point you out some places that are doing things like that. But, in general, there’s just a big gap in this type of training at universities. And, so we say we’re kind of, we’re training in the gaps. We’re looking to deliver training that people can come to across the whole department, and also that’s quick. You know, everyone that we talked about in that first set – graduate students, professors, post-docs – they can’t take a semester long course typically. They don’t have that kind of time in their schedule. And so, we want to be able to provide these workshops that will get people started learning these new skills. And we know that we can’t teach everything in two days, but we want to give them the foundational skills to get started. And we also, most importantly, want to give people confidence. The confidence that this is something they can learn and that they can go on to continue to learn more. A lot of researchers now who have tried to learn these skills maybe have had sort of a disempowering experience. Taken a computer science course that wasn’t really geared towards what they needed, or been sort of in an unfriendly learning environment. So, we really want all our workshops, we have a code of conduct and we really strive to have really friendly environments for learning to increase people’s confidence, their knowledge of these skills, and empower them to go on to learn more and enable more research.

**KL:** It seems to me that Data Carpentry is really working with an idea of kind of building community, which is something that I really believe in in terms of just the research community and making connections among researchers. To what degree do you see people, you know, having a kind of researcher community beyond the workshops? Because I could imagine some people might say, “Can you really learn these skills in a workshop setting, and really be able to apply and use them?” Which is where I also think your website really comes in handy in terms of just having a lot of resources. But I’m wondering if you know, even anecdotally, of kinds of communities of researchers that are going beyond the workshops.

**TT:** Yeah, that’s a really great question and that community piece is really important to us as well. You’re right, you know, you can’t learn everything in two days. And so, in the workshops themselves, you know, as I said, they’re friendly and we really want people to be talking with each other. You know, talk with your neighbor, get to know your instructors. So, the community building starts there. And after the workshop we want to continue to promote that and develop communities of practice. So, it’s not only that you’re having and trying new skills, but there’s people to look to when you have questions. Or just to promote the ideas here that, you know, even though something maybe seems a little bit hard right now, it’s going to pay off in the long run in terms of being effective, of being reproducible. So, I mean, in all honesty that’s something that we could be doing better, and that’s, you know, when you talk about where we’re headed, that’s something that we’re trying to do. Is to provide better infrastructure for learners after the workshop to help them build those local communities. And so, I know we’re also going to talk a little bit about our instructor community, and that plays another role in building sort of this community of practice.

**KL:** Absolutely, one of the things actually that I really appreciated about the workshops that were held here at Oregon State is that the instructors were from Oregon State. And so I knew that if I had questions following the workshop, I could follow up with those instructors. And it wasn’t like someone had come in from the outside and I didn’t have on-campus resources of people I could follow up with. And I thought that model was really a good one. Is that something that you typically see that instructors for the workshops are coming from particular institutions or is kind of a mix?

**TT:** So, that’s something that’s really been a transition for us and for Software Carpentry probably over the last year. Initially all of the workshops, we train instructors, basically, actually, all over the world and when people, you can go to our website, you can request a workshop, and we will find instructors for your workshop. And in the past that’s meant a lot of times flying people in because there weren’t as many instructors or they were sort of clustered regionally. But in the last year we’ve really grown that instructor training program and we also now have partnerships. So, where we are partnering with a university to help them build their local capacity because that is really the most effective way for people to learn the skills. It’s not just running that workshop, it’s having the university have that capacity to have instructors, as you say, who can teach Data Carpentry, Software Carpentry. But not only those. Other things, right. So, our instructor training is based on educational pedagogy and how to teach. So, we really find that people who go through our instructor training program teach not only Software Carpentry and Data Carpentry, but they teach, you know, RNAC for bioinformatics or some data visualization things. So, they’re really building a training capacity at the university at the instructional level, and then also building those communities and people to continue to talk to. So, that’s a really important part of our organization going forward, is really fostering these communities and helping local organizations and institutions build their own programs to support each other and their students.

**KL:** I think that’s such a crucial component of what you’re talking about in terms of kind professional development as researchers. Many times it seems like researchers train in isolation. And I know that’s certainly, it can change based on one’s discipline. But there are a lot of researchers who I could imagine it would be very difficult for them to admit, you know, mid-career or part way through their career that there are things that they don’t know. And it can be kind of a vulnerable thing. Is that one of the challenges that you think researchers are facing regarding kind of learning these new data management skills and analysis, is just this idea of even admitting that they need those skills?

**TT:** I think that there is some of that. I think there’s maybe getting to be a little bit less of that because we say that people are motivated by frustration. In the sense that, you know, they just are finding that their old strategies aren’t working anymore, right. So, I think, they sort of are like, “Well, heck.” You know, like “Got to try something else.” And, you know, I think that’s what’s so great about working with research communities is that they are people who are committed to sort of lifelong learning, right. That they’re not, you know, your degree doesn’t finish and you’re done forever. So, once people sort of recognize that this is something they need, they often are really motivated to seek out the training. And that’s, when we look at sort of surveys of researchers, you know, it’s not us, you know, saying, “You guys need this training.” It’s researchers themselves that are really demanding this training, and there’s a survey in Australia that, Resource Bioinformatics Australia, and 50% of their researchers said that the most useful thing they could do was offer training. And that was more than provide funding or access to compete power. So, I think that we’re really starting to see researchers embrace this idea that they need to learn this.

I think there’s still some reluctance in some cases, especially when you talk about, you know, scripting. And there is a little bit of a disconnect sometimes between using graphical user interfaces and sort of hoping that they’re going to do everything you need it to do. And then sort of realizing that ultimately it’s going to limit you and just end up taking the steps to learning some scripting. And, you know, but also, right, our workshops really are focused on these foundational skills. We have really thought about, you know, what is it that you need, what level of kind of data knowledge and literacy do you need to work with data? But it doesn’t mean that everyone’s going to get to the same place at the end, right. It means that maybe some people will, you know, do great data organization, learn how to get, you know, some into R and do some initial data processing. And that will be the extent of their need for these tools. Other people might get a little more engaged, start to do modeling, create, you know, fancy visualizations. So, we just get people started on the path and then they can sort of figure out where they need or want to end up with these skills. It’s not that everyone needs to achieve some same level of mastery. It’s that we need to move the conversation to where people are feeling like they know what to do with their data, rather than really sort of sad that they have all this data and don’t know where to start.

**KL:** I love that and I completely agree with it. Nobody should be sad about their data and not knowing where to start.

**TT:** That’s right. That’s one of goals is that people should feel excited about getting data, rather than frustrated or sad, right.

**KL:** Yeah, absolutely.

**TT:** And honestly right now that’s where people are. You know, you’re so excited about generating the data, and then you get it and then it’s sort of like, “Oh, now where do I start?”

**KL:** Yeah, the air goes out of your balloon a little bit.

**TT:** Exactly. And you say, you know, you type in, “Learn R” into Google, right. And it doesn’t necessarily provide a lot of insight. And so, we’re operating, we’re kind of giving that, lowering the activation barrier, helping people get started. That’s kind of a lot of what we’re about.

**KL:** That’s wonderful. Well, we’re going to take another brief break. When we come back we’ll hear a little bit more about the Data Carpentry instructor community and some of the advocacy that the group is doing as well. Back in a moment.

[music]

# Segment 3:

**KL:** Tracy, one of the kind of my favorite things when I think about Data Carpentry is I think about just this group of trainers and instructors that is out in the world helping researchers figure out some of this stuff around data management and data analysis. I’m wondering if you can tell us a little bit more about the instructor community that’s affiliated with Data Carpentry. About how many instructors do you have?

**TT:** Well, so between Software Carpentry and Data Carpentry we have over 400 instructors.

**KL:** Wow!

**TT:** On six continents. And it’s sort of based on these core principles. So, Greg Wilson really started this instructor training program for Software Carpentry. And we’re really fortunate to share this instructor training program. And it’s based on educational pedagogy sort of, as I mentioned, and sort of how to teach these skills. So, we run a two-day workshop to teach people how to teach. And, so the idea is that these people will sort of learn how to teach in this really hands-on way that’s really core to our workshops. But also how to contribute to and use our lessons.

So, all of our lessons are available online. They’re under the Creative Commons license, which means they’re free for re-use. And so, people can use these materials on their own for self-guided learning, but also people could pick up these materials and teach them outside Software Carpentry or Data Carpentry workshop. And so, these lessons have, in many cases, hundreds of contributions from, you know, 30 to 50 contributors. So, usually someone teaches, you know, their semester course and they use the materials, and then they put them away, and then they bring them back out for the next semester. But here we’re teaching these materials over and over again, so we’re consistently refining them. Trying to make them better. It also lets us incorporate new things. So, if a new, like, R library comes out that is just really what every data scientist is using, we want to incorporate that. We can modify our materials to incorporate new things. So they’re really agile in that way as well.

**KL:** I love that. That’s so great to have that flexible curriculum.

**TT:** Yeah, it’s really, again, it’s just something that I really love about Software Carpentry and Data Carpentry is this really, you know, it’s materials built by practitioners for practitioners. So, it’s really practical. It’s really what people need and it’s really responsive. We’re not engrained in anything other than really presenting learners with sort of the best tools that are available to them.

**KL:** That’s awesome.

**TT:** So, it’s really unique I think in the training space. And we’re actually seeing this sport of strategy go out a little bit from just our materials to other people developing new curriculum in other areas that maybe isn’t our focus, but they’re taking this collaborative lesson strategy.

One of the kind of unintended consequences of the instructor training program has really been this community of instructors. It’s just really a fantastic group of people who care, not only about sort of computational skills and data, but care about training other people and bringing these skills to them. A lot of them are self-taught and so they don’t want other people to have to go through what they did. Or they’re seeing sort of the power of these tools in their own research and they want to bring those to their people. And so, it’s really just sort of an enthusiasm for the topic and also for people. And so, these instructors are great to interact with on a day-to-day basis, but they are some really strong advocates for a lot of what we teach in terms of reproducible research, writing these scripts, often science. And they’re exemplars as well. They’re publishing papers that are open access, they’re providing their code and their data with their papers. And so, they’re good models in the scientific and research community for how we’re hoping that research can be done to sort of to advance research and advance science.

**KL:** It sounds like an incredible group. I also want to point our listeners to episode eleven with Steve Van Tuyl who is actually the person, one of the people, who led the Data Carpentry workshop here at Oregon State. And he works a lot with data management. And in that episode we talk about data management best practices. So that might be of interest to our listeners.

So, one of the things that I think also could come out of this instructor community, and I’m just kind of curious about some of the advocacy that Data Carpentry is doing, you know, is that something that the instructor community is a part of? Or what is the relationship between those two things?

**TT:** Yeah, so I think the instructor community is a part of it. Not necessarily in a way that’s been specified. It just sort of has turned out that way in the sense that being a part of this community sort of exposes people to a lot of the benefits of these practices. I think, you know, we do tend to, we write papers, give talks, both from our staff and steering committee members and instructors. So, in that sense I think people are promoting those aims too. So, it’s sort of more advocacy in terms of actions than it is actually like, you know, lobbying on Washington DC or something. But, you know, things like this too. You know, I’m always happy to have opportunities to speak, you know, at conferences or podcasts like this because that’s a part of talking about these tools. And not in the sense of, you know, you should write scripts so that other people can re-run your analyses, but these things will make you more productive and also actually meet a lot of the standards that are required now from journals and from granting agencies. So, it’s just creating that awareness of how sort of useful these things are. And kind of one of our favorite lines is, you know, “You want to write these scripts so you remember what you did because the you of six months ago is terrible at answering email.” And that’s certainly true as I look back at some of my analyses I ran a few years ago, and wish I had done some things better. So, I think we’re all continually learning how to do better. You know, who knows if we’ll get to best, but what we can do every day is a little bit better.

**KL:** Well, Tracy, I think the work of Data Carpentry is so valuable. And for folks who want to learn more, who maybe want to become involved in Data Carpentry, what can they do?

**TT:** Yeah, so, we do have a few ways. One is if you want a workshop at your university, you can request a workshop on our workshop website or on our website. If you are interested in becoming a partner and helping to build that local capacity at your institution, we have information on how to be partners on our websites as well. And being a partner means that we run some instructor training for you, we help you get some workshops started, you can run what’s called self-organized workshops. So those kind of ones, like the one you experienced where the local people just organized stuff when they need to. So, those partnership programs. If you do want to become an instructor, actually we have a huge demand for instructor training. So when I say we have 400 people, current instructors, we actually when we have an open listing for instructors we had 600 people on our waitlist.

**KL:** Wow.

**TT:** Which we can’t handle quite yet. So, we are tying instructor training to partnerships right now so that we can kind of start to spin up on some of these communities. So, that’s the best way to get instructor training. We will very shortly though have an open call for instructor training, so keep an eye on Twitter or our website – Software Carpentry’s website – for that opportunity. So that will be more broadly available. Also, really focusing on supporting building instructor communities in emerging economies. So we just ran an instructor training in South Africa. We’re working in Brazil. So, that’s really another area of focus for us in building instructor communities. So if you are from those regions too, we’d be happy to chat with you.

**KL:** Awesome. Well we will definitely link to the resources from your website in the show notes so folks can follow up. And, Tracy, I just want to thank you so much for coming on the show and sharing a little bit more about the work you’re doing with Data Carpentry. And good luck with your future endeavors.

**TT:** Well, thanks so much. I’m so glad to be here and I’m so grateful to have this opportunity to talk to you and to be a part of Data Carpentry. It’s really the instructors and people like you who are excited about things that make this a really amazing job and organization. So, thanks so much.

**KL:** Thank you and thanks also to our listeners joining us for this week’s episode of *Research in Action*. I’m Katie Linder and we’ll be back next week with a new episode.

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# Bonus Clip #1:

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**KL:** In this first bonus clip for episode thirty-one of the “Research In Action” podcast, Dr. Tracy Teal discusses what’s next for Data Carpentry. Take a listen.

So, Tracy, what is next? What are your future plans for Data Carpentry?

**TT:** Yeah, so we started really just about a year ago as a non-profit and we received funding from the Gordon and Betty Moore Foundation, the Data-Driven Discovery Initiative. And as a part of that we scaled our capacity. So, last year we just taught about 30 workshops. We’ve already taught more than that in the first quarter this year.

**KL:** Wow.

**TT:** But another key thing that we want to do is develop materials in new domains. So, because we have this focus on data, we really want to be teaching with the type of data that researchers are seeing. And that means in the domain that they’re seeing, so it’s a concept that’s familiar to them. Both because that makes it a lot easier when they go back to work with their own data – that what they saw in the workshop is what their data looks like – but it also makes learning new skills easier because they already have a framework to build those skills on top of. You know, I understand why I would want to ask that question. You know, here’s the tool that I would need to answer it. So, we do want to broaden the domains that we have and the data types. So, we started with ecology and that was the topics that I talked about earlier. We’ve also developed workshops working with genomic data. So, specifically with the genomic phylotype and that teaches about genome data, but also teaches the command line for bioinformatics tools, automating bioinformatics analysis, and actually cloud computing because in genomics research you can’t run things on your own laptop. We also have developed lessons working with geospatial data in collaboration with NEON – the National Earth Observatory Network. And so those are specifically focused on working with geospatial data types, and so we piloted a couple of those. So, we wanted to continue to develop those two and start to teach more of those workshops. Also, on our roadmap is high performance computing. So, teaching, you know, biologists, digital humanists how to work with high performance or high throughput computing, meaning that they can run their analyses if they can’t run on their own computers. And we’re also looking at workshops potentially in working with image data, and workshops for social sciences and libraries.

**KL:** Wow, well I cannot wait to see what is coming up next and really look forward to taking more workshops through Data Carpentry.

You’ve just heard a bonus clip from episode thirty-one of the *Research in Action* podcast with Dr. Tracy Teal discussing what’s next for Data Carpentry. Thanks for listening.

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# Bonus Clip #2:

[music]

**KL:** In this second bonus clip for episode thirty-one of the “Research in Action” podcast, Dr. Tracy Teal shares about the logistics of collaborative lesson development. Take a listen.

Tracy, one of the things you talked about a little bit was collaborative lesson development. And I’m wondering if you can share a little bit more about that. Particularly just the logistics of it. How, if you have so many people and they’re contributing, you know, little things here and there that they’re learning as they’re conducting these workshops and facilitating these learning experiences for researchers. You know, how are you managing that? How are you managing, you know, changes or updates to the lessons, or even the creation of new lessons?

**TT:** Sure, yeah, so this is something, again, that Software Carpentry started. And it’s through, we use GitHub. So, it’s a version control system. So, basically it keeps track of different versions of things. So, sort of like in Google Docs or Word how you can kind of keep track of the different things that have gone one. It’s traditionally used for software development, so for code. And the idea is that if you have code that’s working, you can’t just randomly add new things in because it could potentially break it. So, there’s a process where you sort of submit a change for review and people review it and say, “Ok that looks good,” and they merge it into the code. It’s the same for our R lesson. So, we have our lessons and someone says, “Oh, I think there was a typo,” or maybe, “I think we should teach this concept instead of that concept,” and they put in it’s called a polar request, but it’s really just a request to make some changes. And then we have moderators for each of our lessons, so people who are in charge of deciding if those changes go in. And then we merge those changes in or have some discussion about it. So, it’s all kind of moderated through this GitHub version control system as it was sort of co-opted from code development to do lesson development.

**KL:** What a cool structure. I love that idea.

You’ve just heard a bonus clip from episode thirty-one of the *Research in Action* podcast with Dr. Tracy Teal sharing about the logistics of collaborative lesson development. Thanks for listening.

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