Intro:

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Erin Larson:

Welcome to Making Waves. I'm your co-host Erin Larson and you're listening to part four, the final episode, of a four episode mini series on education and freshwater science. In each episode, freshwater scientists will talk about an activity they've used in their class ranging from activities that take just a few minutes to entire modules of the course. We hope these will help everyone, from high school teachers through college instructors, get new ideas to use in their classes. If you haven't listened to parts one through three yet, we suggest that you go take a listen.

Erin Larson:

In this episode I'll be talking with Michael Bogan, an assistant professor at University of Arizona, about an activity he uses to introduce his students to stream orders and active learning on the first day of class.

Erin Larson:

Thanks for joining us today, Michael. So to start with, I wanted to talk a little bit about the activity that you'll be talking to us today and if you could briefly describe it for our listeners.

Michael Bogan:

Yeah, so the activity that I'll talk about today is actually just about the first thing that I do in my stream ecology class each semester. We don't have a big aquatics program here at University of Arizona so a lot of our students are wildlife focused or range focused. So they're not necessarily thinking about streams and haven't done any kind of aquatic ecology thinking before the course. So I try to start out fairly big picture and just get a sense of how much people know about streams and how they visualize streams.

Michael Bogan:

And so for me, the easiest way to start with that is talking about stream orders. Talking about the fact that streams are dendritic networks and therefore different from a lot of terrestrial ecosystems in the way we think about how terrestrial animals move through a terrestrial matrix.

Michael Bogan:

So basically we start out the very first day after going over the syllabus. Then I talked real briefly about the water cycle. Most people have had exposure to that and know roughly where water in the streams comes from. Basically we jump off from that point in that first day of class into talking about stream orders and how we can talk about the size of streams based on where they're at in the dendritic stream network.

Michael Bogan:

And so I just spend a minute or two and then introduce the concept of stream orders and how first order and first order come together and make a second order and so on and so forth. We talk about what the highest stream order is in the world and I get the students to guess about that.

Michael Bogan:

And then essentially we do an activity where the students break into smaller groups of three or four students and I ask them to first of all, draw a sixth order stream on the board. So I have a lot whiteboard space, thankfully, in my classroom. And this is a class of usually about 25 or 30 students. So that's a fairly manageable size. So I have them draw a sixth order stream network and then I actually have a set of photographs that I've taken at different places along different stream networks and then ask them to place those photos along that sixth order stream network that they've drawn.

Michael Bogan:

So that gets them thinking about, first of all, the geometry of stream networks and then also how the look of that stream ecosystem and the amount of interaction with the terrestrial habitat and repairing an environment those streams have as you move through that network.

Erin Larson:

Cool. That sounds awesome. So it sounds like in terms of the class context, where you've focused on this, is this a non-majors class or is it an upper level class?

Michael Bogan:

Yeah, so this is a upper level in grad, split level class, so 400, 500 level class. And we have a fisheries emphasis within our degree program here but very few fisheries or aquatics focus students. So the majority of the students who take the class, it's about 75% undergrad, 25% grad students. And most of them are terrestrial ecologists or wildlife biologists focused students who want to learn a little something more about stream things and freshwater systems. It's an optional class. It's not a requirement or anything.

Erin Larson:

And do you guys have a lab component as well or is it more of a lecture focused?

Michael Bogan:

Yeah, that's the tricky part about this class for me is that, I guess, I inherited it when I started here and the class had been dormant for a number of years that hadn't been taught in about eight years previous to when I started the job here. And so I was a little bit limited to the structure of the existing course, which was just a lecture only course, not a lab component.

Michael Bogan:

The downside of that, obviously, is not getting students out to see streams very often and to see the ecological processes we're talking about. The upside of it is that it's forced me to be a bit more creative about in-class activities. I'm using visuals and videos, brainstorming activities that I probably wouldn't have if we had a separate lecture and lab component. And so I've really been striving through this class to make it more of a visual focused class since we don't have that lab component where we can actually go out.

Erin Larson:

Yeah. That's cool. So it sounds like you're trying to introduce more active learning activities that take the place of the lab portion of a class.

Erin Larson:

And so in terms of preparing for this activity specifically and the class in general, are you going out yourself and collecting visual images of streams to use or video or other multimedia? How do you prepare for this type of activity in your class?

Michael Bogan:

I spent a long time on my pathway to being a professor and so the good part about that is I've had a lot of field jobs and I've worked in a lot of places and I've been collecting imagery photos and videos and things like that over time. Somewhere in the back of my head thinking about the fact that, "Oh, I could use this in teaching someday," you know? And in some of those cases, some of these photographs I'm using I took 15 or 20 years ago, so it's fun to finally use them in class.

Michael Bogan:

I feel like the students respond strongly to that if they know that you, as the instructor, I have a personal connection to some of the images you're showing or some of the case studies you're presenting. That's where the majority of the material comes from.

Michael Bogan:

There are cases where, for example, I haven't worked in a lot of large flood plain type rivers and so I'll have to pull information either from the internet or from friends and collaborators that will send me videos or images. But I've tried to use my most of my own stuff.

Michael Bogan:

I think it's really important to have an active learning component for classes that don't have labs. I think active learning is useful for any class setting, but it's especially important for these science classes where we don't have labs, they're not going to be going out and measuring things and doing it themselves in the field. And I like this activity because we started on day one, right? We go over the syllabus where you talk about, for five or 10 minutes, about really basic water cycle stuff and then they immediately they're dumped in to active learning, right? And getting up, working in groups, kind of problem solving, trying to draw this sixth order stream network. Realizing quickly as they're running out of space on the board that a sixth order stream network is a lot larger than we thought it was.

Michael Bogan:

So it's fun to see that process going on on the first day of class. And then I think the students have more of an expectation of how the learning is going to work for a class like this that is lecture-based rather than lab based.

Erin Larson:

It sounds like for this activity you're spending the majority of the time in that active learning phase. And then is that standard for the rest of your classes as you go forward in the semester?

Michael Bogan:

Yeah, I try to vary a bit on how much preparation and lecture introduction the students have before doing an active learning activity. So in this case it's a relatively simple concept and so I feel like I can kind of toss them into it and have them figure it out as they go and spend some time. So the introduction is really brief and then a lot of the time, probably five minutes of introduction, and then 15 minutes of discovery time for them to figure out the problem. And then there'll be other times, if we're talking about [Leroy Pops 00:00:08:18] work on filters and how landscape filters and local filters produce the types of stream ecosystems that we'd see at the reach scale.

Michael Bogan:

Then I'll probably spend 15 or 20 minutes in a bit of a introductory lecture type material. They'll have done a little bit of reading ahead of time. And so we'll do all of that preparation and then do 15 or 20 minute active learning activity where they're given a flow regime graph and they're given a photo of the system and they're supposed to, through those two pieces of material, interpret what some of those filters might be, which species might be excluded, which other ones might be present there.

Michael Bogan:

But that obviously it takes a bit more background understanding. And so I'll front load the preparation material for those activities. And then other activities, we'll just launch straight into the activity into the discussion and then making sense of it afterwards.

Erin Larson:

Gotcha. So you sort of mix it up. And it sounds like, if I'm reading this correctly, that the intent of this first day of class stream order activity is to also get the students used to being in an active learning classroom, too. Is that part of why you do it would you say?

Michael Bogan:

Each semester there is a number of students, probably in the one fourth to one third of the class, that have not experienced a lot of active learning and group learning types of activities. And so they can be very resistant to it at first. And so I try to establish basically from the first day of the semester that this is going to be a part of the course. This is how I think is the best way to learn some of this material in the absence of going into the field. And so yes, I want students to understand that from day one so that we're not setting up the expectation that this is going to be a lecture course and you're going to listen to me lecture for 45 minutes or an hour and 15 minutes and then you're going to take a test every few weeks, right?

Michael Bogan:

So that the activities, the hypothesizing, the group dynamics, that's going to be part of it. And I feel like I've been pretty lucky in that in the teaching evaluations at the end of every semester, those 25 to 30 plus percent of the students that were very skeptical of active learning techniques will admit to being skeptical at the beginning of class. And every single person has said at least by the end of the class, they at least see the utility of them. Even if they didn't necessarily still really like doing them every week, they saw the importance of doing them to learning and the vast majority of them, by the end of the semester, really liked doing that kind of activity.

Erin Larson:

That's awesome. And I know you've taught now this class a couple of times and so do you feel like you've changed, especially this introductory stream order activity, a lot based on student feedback? What are some things that students haven't liked as much or have really liked that have caused you to shift to how you treat this first day of class?

Michael Bogan:

Yeah, I've been lucky. I really haven't changed this initial first day of class activity at all. The first semester I taught this class, I was thinking about my own stream ecology class experience as a graduate student and thinking about how I didn't know much about aquatic ecology at that point. And we launched into river continuum concept early in the semester and I remember thinking how completely overwhelming that was because there's so many moving parts to that one figure, inner continuum concept paper.

Michael Bogan:

And so I thought, the first time I was teaching this, "Okay, how can I get the students to realize that intuitively they already know parts of these complex theories or these complex concepts, like the river continuum concept?" They know when they're out looking at a stream, whether it's wide or whether it's narrow. They know that in these headwaters the streams are narrow and there's a lot of canopy cover. As they move to these larger river systems that they've seen before, that the riparian area moves away to the wayside.

Michael Bogan:

And so intuitively they have an idea of what should be some of the strongest influences on stream ecology, right? But if you just toss a list of all these processes and all these things at them, it can be totally overwhelming. So I like starting with this stream order and mapping activity because it basically gets students, number one to think about streams as these dendritic networks that are connected. And number two, to think about how the physical habitat and the influence of the terrestrial habitat changes as you move through the stream network, right?

Michael Bogan:

So even though that first day we're not talking about course particular or organic matter, we're not talking about [parafite 00:12:44] and we're not talking about all these terms that they've never heard before. They're looking at the images and they're seeing, oh yeah, I see a dense canopy in these headwaters. There's a lot of leaves on the ground there. And again, these things are visually apparent to them and the changes across that continuum become apparent. After we do the group activity, we discuss how similar the different groups, place the photographs along their sixth order stream network. What were some of the similarities? What were any discrepancies? And then I'll give them a little information about where the photos are actually from just so they have a sense of where the images came from and how close they were to being right.

Michael Bogan:

And then the next week when we actually do launch into river continuum concept and we do get into the jargon, they've already got the visuals established in their minds as to how the look of the stream changes. And I think once those visuals are locked in their minds, then it's a lot easier to just glue the jargon onto the visuals that they already have.

Erin Larson:

And so it sounds like, in general, this activity has been something that you've done with this optional upper level stream ecology specific class. And I don't know if you, in your current position, are teaching other types of classes, but do you feel like you've taken lessons from teaching this stream ecology class and applied it either to outreach activities and how you approach doing outreach about streams or teaching other types of classes or how people could do similar activities in an intro psychology class or something like that?

Michael Bogan:

I mean I haven't had to teach any of the large classes here yet, so I've been a bit buffered from that. I have used a similar activity in doing outreach and teaching at local high schools. So I think the level that I pitch this initial activity at is a good level for basically from high school to grad school as long as you're not that familiar with stream ecology. So it works pretty broadly.

Michael Bogan:

Thinking about how you could do it in a much larger classroom of more than 40 or 50 students or if you don't have a lot of whiteboard space, that's where I think I'd have to get a little bit more technologically creative. I could see a situation where you could still do this in a large lecture hall, but you would have to ask the students maybe to pair up with the student next to them and work on a laptop or a computer screen and you can have them draw in Adobe or draw in whatever kind of program you want to be used. Draw that same sixth order network work, have 10 JPEG images that you have them arrange. And then rather than everybody being able to see what everybody else's work is, if you can see on whiteboards maybe you could project a few of the pairs of students images up onto the main projector in the screen room.

Michael Bogan:

I haven't really thought about that until today. But I think there's ways you could adapt it for a larger classroom and still make it work. Some of the other activities I could do later in the semester that get more complex, I think are fairly limited to a smaller classroom. On a scale of 20 to 50 students.

Erin Larson:

Yeah, it does sound though... I like that idea of introducing active learning on that first day because I know I've TAed and taught in some active learning classrooms where students understandably, they're like, "Whoa, what are we doing now? What is this?" And so making it a clear expectation from the outset seems like a really good general takeaway too from this particular activity that seems to have worked well from what you described.

Michael Bogan:

Yeah. And a lot of the students are at the junior level and so they've had large introductory courses and then they've made into maybe our basic ecology courses, 300 level courses where they're doing a bit more free thinking and a bit less busy work in homework. But they usually haven't gotten to the type of classwork where they have a lot more freedom and there's a lot more hypothesis building and conceptualization and visualization. And so I think it's important for me to establish that on day one in.

Michael Bogan:

And it's in the syllabus, it's in my grading rubrics, I tell them from day one, This is not the kind of course we're going to do homework every week, you're going to fill out these assignments, you're going to take quizzes. This is the kind of course where you're going to be challenged to think conceptually, to think a little bit broader and to think about questions that don't have a single answer or even a single set of answers. That's really important for me that they understand that from day one.

Michael Bogan:

So even as far as the grading goes, a significant portion of the grade comes from active participation in the class. They don't have to have the right answers when they draw on the board. They don't have to draw well on a board. They see my horrible drawing on the board all the time. But to me that's a big part of this class is put them out into the real world even though we don't have the lab component to go into the real world, right? So we're putting them out into the stream, asking them to think about what they're seeing in that stream, what they're seeing in that flood plain image, what kind of processes might be happening here. What's the history of that site, what kind of floods and droughts that come through here and how does all that affect the ecology of the stream ecosystem?

Michael Bogan:

I find that the students really rise to the challenge even if they're a little intimidated at first by not having a study sheet that has the right answers or the short answers.

Erin Larson:

And it sounds like it's great that you've had the opportunity to teach this class multiple times, too. And you're obviously very experienced in teaching in stream ecology. And so I was wondering if you could share with folks listening to the podcast, if you have any advice for people, whether they're grad students or postdocs or professors who are starting out, who might be teaching in the aquatic sciences for the first time. Anything that's maybe particular to aquatic sciences or just teaching in general?

Michael Bogan:

Especially for teaching in stream ecology, one of the big points that I make over and over again in class is how dynamic streams are and how streams are three-dimensionally dynamic and four-dimensionally dynamic, that is added flow component change through time. But I think that lends itself really well to visuals to both photographs and videos. The amount of flash flooding videos you can find out online on YouTube is pretty impressive. So even when you can't take the students out to the field, you can show them visually what's happening in the stream ecosystems. You can show them some of the processes that are happening through the use of media. And so I think that is really key for me to engage students in the classroom.

Michael Bogan:

And then additionally, of course, having these activities where students can build their own hypotheses about a given ecological process, about a given stream ecosystem that they're seeing in an image or on a flourishing chart and give them some flexibility and space for creativity and interpreting those visualizations.

Michael Bogan:

And then as far as the active learning, don't be afraid for those to fail the first time around either. So the activity I described was one I just got really lucky that it popped into my head probably a week before

the first time I taught this class and it worked great the first time and it's worked great every time since. Other activities later in the semester, some of the time they work the first time and other times they don't at all.

Michael Bogan:

The first year I taught it I tried a bio-monitoring exercise where they broke into groups, each had a certain stream and had a certain community of insects in that stream and they had all the bio-monitoring protocol they needed to figure out whether the stream would score high as far as an index of biological integrity. And so I though, "It'd be great if I could somehow incorporate stochasticity into this and the fact that some streams are affected by mining spills and other streams aren't."

Michael Bogan:

And so I came up with this really elaborate way of using dice and rolling dice and if you get certain combinations of numbers borrowing the dice, then you've got either a flood or an acid mine drainage. I think out of the seven groups, one or two of them actually ended up getting disturbances with the rolls of dice that I came up with and the other five had no problem. Their stream never experienced any disturbance. So it totally failed as a teaching technique.

Michael Bogan:

And so then I was able to realize, okay, next year I won't quite be able to incorporate that chance because the chance could work against you while you're doing these activities.

Erin Larson:

Yeah, it's good. I like that advice of trying things and sometimes they're just going to fail and you'll learn and you'll move on and make it better next time.

Michael Bogan:

Exactly. And I don't ever shy away from telling the students that either. I say, "We're going to try something new. I've got this idea and hopefully it'll work out." And then at the end if it doesn't work out, then you say, "Well, I won't do that again next year. I'll try something else."

Erin Larson:

Yeah. It's a very meta, the science of teaching science teaching.

Michael Bogan:

Yeah.

Erin Larson:

Yeah. Great. Well, thanks so much for sharing your stream ecology teaching expertise with us today, Michael. It was a pleasure to have you on the podcast.

Michael Bogan:

Thanks for the invitation. Great.

Outro:

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