Podcast 32 – Science Communication

Narrator & Editor Richard Gay: Welcome to this episode of 30 Brave Minutes, a podcast of the College of Arts and Sciences at the University of North Carolina at Pembroke. In 30 Brave Minutes we'll give you something interesting to think about. Joining Jeff Frederick, the dean of the College of Arts and Sciences are Jonathan Frederick and Tamara poles from the Morehead Planetarium and Science Center, Velinda Woriax, chair of the UNCP Department of Biology and Amy Gross from the UNCP Geology and Geography department. Now get ready for 30 Brave Minutes.

Robin Cummings: This is Chancellor Robin Cummings and I want to thank you for listening to 30 Brave Minutes. Our faculty and students provide expertise, energy, and passion driving our region forward. Our commitment to southeastern North Carolina has never been stronger through our teaching, our research, and our community outreach. I want to encourage you to consider making a tax-deductible contribution to the College of Arts and Sciences at the University of North Carolina at Pembroke. With your help we will continue our impact for generations to come. You can donate online at uncp.edu/give. Thanks again for listening. Now back to more 30 Brave Minutes.

Jeff Frederick: Imagine if the subject you were an expert in was so complicated that explaining it to the general public was somewhere between unlikely and impossible. Imagine if the specialized research you were engaged in was absolutely critical to public health, understanding the universe, or making an informed decision about preparing for another hurricane, but the scientific method, jargon, equipment, and findings were too complicated to explain in a two-minute soundbite, a Facebook post, or even a 30 minute podcast. And imagine if the knowledge you have spent years accumulating was critical to some global or national or state issue, or even some local matter that needed to be voted upon. Just add one more mountain to climb. Imagine if talk show hosts or next door neighbors were convinced that the one data point they heard on TV or the radio was the one and only element needed to understand something that highly trained experts, scholars, and researchers all over the world had been working on for decades. It's not easy to communicate ideas about anything that's particularly complicated, but the need to take science into the community has never been greater. We've all seen Star Wars or maybe even Star Trek. So we think we know what a laser can do, but who among us can explain how it works and what, other than blasting bad guys, can and should be done with one? Discoveries and their implications are coming faster than ever and while social media is particularly good for letting others know what you had for lunch, it's not all that effective for describing why vaccines are important, or why genetic engineering and gnome editing is science, and not science fiction. As Stanford University Scientist Sarah Brownell, Jordan Price, and Lawrence Steinman have argued, "Developing skills to communicate science at a level that a general audience can understand requires deliberate practice and careful attention to language." Say the wrong thing and you cause a panic. Say the right thing and perhaps a small percentage of the population understands. When communicating with the public scientists use analogies and examples. They think about their audience and they try to keep away from jargon or technical terms that might confuse. Science is usually quantifiable placing math front and center to understanding the natural world and adding another layer of difficulty for many lay folk. The American Association for the Advancement of Science reminds scientists to make their public lessons memorable, meaningful, and miniature. But again, that is easier said than done. And in fact, given the critical nature of taking funding requests to a variety of sources, it is absolutely essential. In short, science is hard, but it's critical for society to know how scientists work, how they conduct research and verify findings, and why scientific inquiry is more important than ever to understanding the world around us. Joining us today are trained scientists who are experts at taking science into the public arena and helping us to understand the impossible. Welcome to Jonathan Frederick and Tamara Poles from the Moorhead Planetarium at UNC Chapel Hill, and to Velinda Woriax, chair of the UNC Pembroke Biology Department, and Amy Gross, from the Geology and Geography Department here at UNCP. Welcome everybody.

All: Thank you. Thanks for having us.

Jeff: Well, let's start with the basics. Why did you become a scientist and in short, what is cool about science?

Velinda: I became a scientist because I have wonderment. So I think I grew up and people were pointing things out and I was told to always be observant because those observations meant something. Sundays were spent around the family porch and everybody was there talking about what had happened the week before and wondering about what would happen because they'd seen this sign and they knew it meant a certain thing. And I think that what is important today is tapping into that wonderment, that natural curiosity of students and trying to help them expand upon it.

Jeff: And Velinda, you're not only an expert in chemistry, but also in biology. Tell us about that story. How did you become a Jedi knight in both areas?

Velinda: My dad was a farmer. I think he was more akin to an engineer, so he would take two pieces of equipment that no longer worked together, and figure out some way of doing that. My mother was an educator and so that was the wonderment. She really played that part up. I would think the chemistry part came from my grandparents. Both of my grandmothers were involved in making medicines for the community. So they were constantly involved in mixing compounds together which meant they had to know to be able to identify what they saw in their surroundings, know the correct quantity of those things to add together, and the proper way and order of mixing them. And I grew up under them because we were always around one family or the other. So I think that part came from my grandparents and my parents.

Jonathan: This is Jonathan. Thank you so much for having us here. This is exciting and Velinda's story reminds me a lot about what we hear from many scientists we work with in the work we do with museums and celebrating sciences. It sounds like you had mentors, role models, people tinkering, things happening outside of the classroom. And we do these activities with scientists where we have them think back and reflect on powerful experiences and a lot of times there are stories like that. It just reminds me how important it is that we get young people, or people of all ages, sort of exploring in ways that are novel and interesting and lead to that wonderment you're talking about.

Jeff: So what about the rest of y'all? What got you hooked on science? Why is it so cool?

Tamara Poles: Well, I know with me and this is Tamara, by the way. I know with me, it actually started with a TV show, believe it or not. When I was younger I used to watch the show Beakman's World and it was about this scientist with a lime green lab coat and crazy black hair and he would do cool experiments and tell us why we should care about science and he would do awesome stuff on TV. He had a young female lab assistant and I always wanted to be her because she was always helping him in the labs. She was always taking part in the experiment. So then, I would then try to do the same thing they did on TV by experimenting in my parent's bathroom. But really, I just learned how to like stain different towels with toothpaste, but I took that sense of discovery and curiosity into actual labs and have been excited about it ever since.

Jeff: Did you ever get the lime green lab coat?

Tamara: I didn't, but I do have a tie-dye lab coat and a part of my IMPACTs Program, where scientists graduate in science communication, they actually graduate and get a tie-dye lab coat and I think some of it's from that lime green lab coat...me wanting that way back in the day. I'm like, no, I'm going to one-up it. They get tie-dye lab coats.

Jonathan: GoFundMe for lime green is here. (Everyone laughs).

Jeff: Christmas gifts are out there. Amy, what about you?

Amy Gross: The geologist is here now, but when I was growing up, as you can probably guess, I really liked learning about dinosaurs, as did my brother. I was also very interested in ice ages of the past and the Pleistocene megafauna. I had a healthy fear of the San Andreas Fault. One half of me wanted to move to California and be a private detective like Charlie's Angels, and the other half of me was just so scared of that fault. Anyway, I was just always very interested in Earth's history and thought that eventually I might need to become a geologist.

Jeff: You guys all have individual stories of your own about what got you excited about discovery and inquiry and curiosity and wonderment. How do you translate that to grade school students or other young people? How do you get them excited about having that same kind of moment that you had years ago?

Velinda: I don't think that's hard. I think kids are naturally curious and they want to make sure that they are the center of attention. So they're going to talk non-stop and if there's something to try they want to be the first one to try it. I think you just kind of have to feed into that a little bit. And so that wonderment then becomes if you can put something in their hands and let them figure out something about that thing that you've given them, I think that's one of the ways of using a little snag to get them interested in science.

Tamara: I think creating a safe space. I very much agree with Velinda on that one. Allowing them to be curious and explore on their own but yet creating that safe space for them to do so and helping them and monitoring that. Personally what I like to do is I like to have hands-on activities. With the hands-on activities, I try to create it around stuff that they care about. Yes, I might care about something different than what these kids care about, but I need to figure out why should they care? Why should they get excited about my research or why should they get excited about research in general? And what can they do that is similar to what I'm doing to get them excited and make it relevant to them. And I think that will help spark that curiosity for them because it's relatable to them and they're getting their hands dirty.

Jonathan: That's right. I want to echo that. The idea that kids are natural scientists I think is well established. I mean, by our own nature we are curious by design. We have these big brains. We want to explore and we actually never lose that. At any age you find people wanting to try and test new things, but children in particular are just adept at the process of science. They want to build. They want to iterate. They want to build again. They want to have the blocks fall down to put them back together and see what happens and that's just the fundamental nature of what being a scientist is. I think a tougher question is how do we not beat that out of them or bore them to death? This may be me getting on my soapbox a little bit, but I think it's important to keep young people and all people engaged in science in ways that make sense for them. Meet them where they are. You heard Tamara talk about it. She saw something in that female lab assistant on that television show. So representation matters. Hands-on activities matter. Keeping it fun matters and there is a subtle art to how you do that. As you said in your introduction, it's deceptively difficult to make things simple or to make things easy, so that's where we need the help of experts to get involved and want to do this work. Like these great scientists we have here and we need universities and cultural institutions like museums and libraries to foster this sort of ecosystem, that's a lot of fun for people to play in a safe and celebratory way.

Jeff: And science is one aspect of learning that's not just about the destination. It's not just about getting the answer. There's so many answers along the way and so much curiosity by creating a journey of inquiry. How do you guys do that? I mean, what is an example of an interesting activity that you've done with young people that really got them excited about the process of doing science?

Amy: When I do classroom visits at the grade schools I always bring a collection of minerals. So, as Jonathan and Tamara were saying, hands-on activities are something that the kids really enjoy and they don't get bored very quickly and it allows them to get their hands dirty, but it also allows them to do some simple scientific tests. So I'll give each table a collection of minerals. I will teach them the different tests for the minerals. So, they might have to test the hardness of the mineral and that's where you run the mineral along a glass plate to see if it'll scratch glass or not. They might test the streak of a mineral which is the color of the mineral when powdered. If they're old enough students, I might give them dilute hydrochloric acid and then they can put a drop of acid on different...

Jonathan: Danger! Yeah, a little bit of danger.

Amy: They like danger.

Jonathan: Yeah! Of course.

Amy: And instruct them, you know, you really only need this on the minerals that have a clear or milky color and they would be testing for the presence of calcium carbonate, trying to figure out which mineral is calcite. So, in a hands-on activity like that, they're actually conducting tests to try to identify these unknown minerals and they seem to respond very well.

Jeff: And you're actually, without them knowing it, sort of teaching them how to scaffold an increasing amount of complexity into the analysis that they're doing.

Jonathan: And I think it's a key to have ways to fail because that's an important lesson in science. I think you scientists here have some failures in your past. I don't want to make any assumptions, but where the research didn't go the way it was supposed to or the dissertation needed to be reworked. I think providing safety nets for people to do that. Like through different activities, where they can make messes and they can do things quasi-dangerous and screw up and then try to kind of deconstruct what happened to figure out how to make it work the next time is key.

Jeff: And even on one level if the findings come out of one research experiment that are, you know, mind-blowing you're about to change the entire way in which people look at this piece of knowledge. You have to go back and replicate it multiple times in order to make sure that the science and the journey that you started on continues to reach that same destination. That sort of adds this one additional layer of complexity. Okay, great. You did it once. Keep doing it.

Jonathan: Right.

Jeff: So all of you are engaged in all sorts of different programs and outreach activities. Talk about some of the very specific programs that you are part of. I know the planetarium does an awful lot of things that we've been able to partner with. Talk about those programs and what you're trying to accomplish.

Jonathan: Tamara, should we talk about IMPACTS first? I don't want to put you on the spot. I know you want to throw it to me, but I think you should talk about IMPACTS.

Tamara: I was going to throw it to the Science Festival first because we were born out of the Science Festival, but we'll wait for Jonathan to talk about the Science Festival. So IMPACTS stands for inspiring, meaningful, programs, and communication through science, and in this program we train scientists how to communicate to the public and then create opportunities for them to practice and hone their skills in science communication. It's a state-wide program. We train 50 scientists a year. We have two trainings on Saturdays when they learn how to not teach like they are professors. Sorry for those of you that are professors. Sometimes you can get on the boring side and when you go into a classroom most kids aren't going to be interested in a PowerPoint. So how do you go into a classroom and get kids excited about science but not teach the way that we've been taught throughout our years in college how to teach? How to mix it up in the classroom and get kids excited, and then another training is how to go to a community event or festival, get people excited from K to gray. Get people excited about science when you have to compete with rides and cotton candy. How are you going to get them to come to your table? So that is what the training is. Then, we give them opportunities to go to these events with me and with other staff at Morehead Planetarium and Science Center and practice. They get consultations from us. So that's what the IMPACTS program is and what it does. We do lots of awesome events. We partner with UNC Pembroke on a lot of things. It's actually one of our sites here. We're based in four locations around the state and Pembroke is one of them and we do a symposium here at UNCP which is a conference-style event for kids, where we bus over a hundred kids from Cumberland County and Robeson County into UNCP and there's a conference. The IMPACTors that are in the program are running the concurrent sessions. There's a keynote address which, of course is hands-on and engages you with the keynote address and then the concurrent sessions that the kids get to go to are all fun. It's about 30 minutes a piece and it just gives kids a taste of different STEM fields: science, technology, engineering and mathematics fields. It's just a really fun day and also the kids get Swag Bags, too, so it's a good time for everybody - the instructors and also the kids. So that, in a nutshell, is the IMPACTS program and what we do here at UNCP.

Jonathan: And I would say what's fun about that? I'm curious from the scientist's perspective about how did you feel about those the first year you did it when you got out there in front of the kids. Were you nervous? Was it fun?

Velinda: I think part of that for us, both Amy and I have been going out into the schools for a number of years, so that part was not the different part. The different part for me was not talking with the student from this locale but from other locales and thinking how can I tie in from students here? I think I had that part down, but that's very different from how to talk to a student from another location. That's because everybody brings a little bit of something different to the table. Our experiences are not the same. Like my grandparents I alluded to before. My grandmothers, one could read, the other one could not, but they both did the same thing in the community and I think that's important for me is realizing that you still have to tap into that same curiosity level but the way of doing it is different, very different.

Jonathan: Cool. You know the one thing neat about IMPACTS that I love, is that it fits into this whole world of #scicom. Its science communication and it's really exploded in the past decade, but why we decided to launch this program in North Carolina is that it actually tracks with real data. What we used to do as museum educators from UNC Morehead Planetarium and Science Center, we would go out and do fun events with the public and they like it, but if we bring experts and scientists there, the audience loves it. It hurts my feelings a little bit, because I thought I was doing a good job, but really meeting actual experts makes a difference. And this survey data has been replicated nationally and is as solid as it comes that having scientists share their love of what they do with the audience makes a lasting impact. So that's one program that we do to get people excited, but it's all part of the North Carolina Science Festival.

Tamara: I was also going to add that another really cool feature of the IMPACTS program is that we mainly focus on training diverse scientists how to communicate to the public, because there is a misconception within in kids and also adults that all scientists look like Einstein, but we don't. We come in all shapes, sizes, genders, everything, so we make sure to have a diverse group of scientists going out into the public because I can't tell you how many times my IMPACTORS go to a classroom or go to an event and come back and they were shocked by hearing a kid say, oh, you look like me! I can be a scientist, too! And that is so powerful. Representation really matters. And I think that's one of the best parts about this program, that we make sure, and we know representation matters. We very much take on the intent. We have the right intent of doing this program. So yeah, that's what I wanted to add about the impacts program.

Jeff: And I can tell you, you know, all of these kinds of things are really working here. You know, UNC Pembroke is a school where the overwhelming majority of students here are female. We're also a minority-serving institution proud of our American Indian roots, but also have plenty of African-Americans, Hispanics, lots of first-generation college students and our STEM growth here at this minority-serving institution is up 35 percent in the last five years. So the message of all these programs is getting out. I can be whatever it is I want to be and whoever I am. There's someone else in science who's just like me. So we certainly are all benefiting from this. What about the biggest misconceptions that folks have about how scientists work? How do you teach people about how scientists go about what it is they do every day, not just at an event here or there, but on a daily basis?

Velinda: I think we do science. I think we do science on a daily basis and that's one misconception. The misconception that the scientist is different from the average ordinary person. But that's what we are. We are average ordinary people, most of us (everyone laughs). There are very few Einsteins, right? And the thing about that is getting them to understand that science is methodical and those folks. That's how I am. I am so methodical it just drives other people crazy, but you have to be methodical in what you're doing. And secondly, you have to understand what the parameters are and what dynamics can be altered and how did just random alterations influence your data and understand how to repeat and what repeating really means? Keeping things identical and doing it the same way each time. The thing I think is a negative for folks is science is slow. It's not something that you will get an immediate response to and if people are in the moment, they don't get that response in the moment. It takes a long time to go through that methodical replication in exactly the same way each time to derive the same response and know that your data is good.

Jonathan: But I would also add that I think there's a stigma. You mention the lab coat and the Albert Einstein kind of stereotype, but also that it's a lonely person working by themselves under a fluorescent bulb in one lab. We have field researchers. We have people out working in interesting places and it's a really incredibly social endeavor. So scientists talk to each other and collaborate with each other just like you would in any other field.

Velinda: And it's global.

Jonathan: And it's global. That's a great point, yeah.

Jeff: So let's those turn it back on you guys here for a second, Talk about some portion or some element of science that was particularly hard for you, because one of the raps that science gets is that it's just so hard. What was one thing that was really hard for you to get as a student or in your career? How did you eventually get comfortable with that idea or that task? And then how would you then use your ability to overcome that obstacle to teach somebody else to keep going when science starts to get hard?

Jonathan: I just hosted a Science Cafe with a quantum computing expert. This is where the science communication world can backfire in that the format is at a local pub. We let the scientists have a beer and chat with the audience.

Jeff: Sounds like chemistry to me.

Jonathan: Twenty minutes, then we get to Q&A, but I didn't realize how advanced quantum computing was and he says basically something along the lines of, oh, by the way your computer runs on electrons. Let's just skip past that and get back to the... and I was like...?

Jeff: Wait a minute!

Jonathan: So for a topic like that, sometimes you really do need to break it up into smaller pieces. We needed to hear a short talk on how computers work, which would be interesting because I don't know. Do you know how computers work? I'm not totally sure. I know that they're great. (Everyone laughs) The second thing is how does quantum physics work which is... I've read chapters in books and I still don't totally understand it. And then finally putting it together. This future of computing and the possibility, the really exciting possibility of quantum computing. But, I would say that science is hard and I still don't understand it and certain topics like that, but breaking it up into more manageable chunks certainly helps in talking to experts but I'm curious to hear what others say.

Velinda: I think what you said was really important and that's the fact that sometimes if you think a subject is too hard you're going to gloss over it and that doesn't bring other people in and get them interested in that. So if you gloss over it and they don't understand it, they're not ever going to have that interest. Why would they want to go into that particular field? And I think that's really important, getting things at their level and to the point that they can manage it. You’ve got to have a little bit of background. Maybe not every minute detail being there but some background.

Amy: Okay. So a course that I really struggled with was structural geology. Now, it was one of my favorite courses and something that I wish I could teach here eventually. I've now had several courses in structural geology, but you have to have a really good grasp on geometry and it had been a long time since I'd had any practice with geometry. Oh, and trigonometry. So I went into that class and I hadn't had the proper math classes that I needed for like ten years. So I did struggle and I tried really hard on my homework and homework assignments. I ended up getting a C in that class which was not reflective of how much I learned by the time that class was over. Of course, what I had to do was go to old textbooks that I had or things I found online and basically reteach myself some of the concepts of geometry and trigonometry and just practice over and over again some of those homework problems. By the time that semester was finished I felt like I was pretty decent at structural geology and I could make a geologic map and I could draw a cross section and I remembered how to use a protractor and I'd keep all these things in mind if I was ever going to.... I wouldn't be teaching that to the grade school kids for a demonstration, but if I was ever going to teach college students here I might start with a review of the important trig functions.

Jonathan: I'm curious. What kept you going and not just scrapping it? Was it because of the big picture or...?

Amy: Well, the big picture. Yes, but my story is unique. I was actually at West Virginia University in a graduate program for economics. And I was so miserable and I discovered that I would much rather watch Discovery Channel, you know, any science, but particularly geology. I was much more interested in what I was seeing on the Discovery Channel than reading about classical economic theory. So I already knew that I had tried something else in the business world and didn't really like it and really wanted to be a scientist. That kept me going.

Jeff: So, what I'm hearing is how do you eat the elephant? Sometimes you have to eat it one bite at a time. You master the first step and then that builds your confidence to climb to the second one and eventually to the third. Then, before you know it you put all these pieces together. And you probably all have stories of the motivation and sense of accomplishment you have from taking on something like geology and becoming proficient at it and helping you in all sorts of other things. Let's shift gears one more time. So, if a member of the general public, who hasn't done science for a long time, was to spend a day with you, or spend a day in your lab or spend a day researching with you, what is it that you think that they would immediately learn about how scientists work every day?

Amy: So, okay, if a member of the public was going to come do some kind of research activity with me, my choice would be digging a trench near a known fault, perhaps a lesser known fault like the Woodstock Fault that is in the Somerville-Charleston, South Carolina area. And what they might notice is that the work outside can be hot and humid and sticky and they might get bored easily at first. But you have to dig your trench and you have to carefully go through and look at the different layers of sediment and there are certain things you might be looking for like what we refer to as sand blows or sand volcanoes which are evidence of past liquefaction that only happens in larger earthquake events. So it might be a slow day for them and they're going to drink a lot of Gatorade but by the end of the day if we have hopefully found a sand blow or two and been able to kind of explain this in context and take some samples to send off for some kind of dating method to try to narrow down, you know, how long ago that event happened maybe by the end of the day they would see that science requires fieldwork. In particular all scientific endeavors require patience and perseverance and there's always a possibility that where you dig your trench you're not going to find anything, but you just have to still know that it was a good day in the field and you're going to try again somewhere else.

Velinda: Invite them to come back tomorrow (everyone laughs).

Amy: Send them to Velinda Woriax's lab next time.

Velinda: And I think what's true, too, is that there has to be that element of patience. Sometimes you overlook something very obvious because they are just accustomed to that thing being there. But now that thing might be different, that obvious thing that now is a little bit different, that may be the unique feature and I try to incorporate that into my courses. Everything that came about as being brand new discoveries were not planned. Sometimes things just happened and somebody was observant enough to see this thing's just a little bit different and hmmm... wonder why that is.

Jeff: So sometimes what changes is not the answers you get but the questions.

Velinda: Yes. And that's usually what happens with research. One result leads you maybe in a totally different direction with a totally new set of questions.

Tamara: And speaking of totally different direction with a totally different set of questions... so in the field of informal education where I am my background is science, I have a biology degree of BS in biology and a minor in environmental science. But what I do every day is different and in informal education, I work at a planetarium and what I do is I train scientists how to communicate to the public. So every day looks different. Everyone around me has a different STEM background and they're all doing something different with either science or science outreach or coordinating what type of programs go on within a science center. So if I were to bring somebody over to my job to shadow me, I think the first thing that they'll learn is the breadth and depth of science. It's more than just what we see on TV. You can be a science communicator, you can be an educator, you can do all of this stuff and then I would take them to a training or an event where my Impactors, the scientists are participating and then they can see more variety of STEM. And we're not pigeon-holed. I am not just doing biology. No, if I like art I can do art and biology. I can blend different techniques and backgrounds together and they'll be able to see the breadth and depth of science, technology, engineering, and mathematics. And also how fun it actually is. Yes, every day you're in the lab and you're testing things and some things may not come out right but there are things that we do know and there are cool things that we do want to tell the public and get the public excited about. And I think the visitor, when shadowing me, will see how much effort the scientists are putting into getting people excited about their field because people need to be excited about STEM and it's awesome and it's fun and it's a way to give back to your community. So I think they'll see that as well. So they'll see all of the venues that they can go through with STEM and actually how cool STEM actually is.

Jeff: Good stuff. So last question. We'll see if I can get a volunteer here. Talk about a complicated topic that's hard for people to understand and you pick the topic.

And then break it down into a couple of different steps, so that a member of the general public or an elementary school kid or anyone in between could walk away with some understanding of a complicated idea that you have made approachable.

Velinda: I'll give a stab at that. So chemical bonding. I am trained as a chemist and having folks understand what bonds are and how they coordinate molecules and gives shape to molecules...they have a really hard time doing that. And one of the things about that, too, is the difficulty getting them to understand the strength of a bond or the distance between bonds. So I kind of equate bonding to be kind of like human relationships. And in human relationships my example is: Let's say it's a really weak bond like a van der Waals, it goes and comes back again. That's kind of like you see somebody, you kind of like them a little bit. You ask them out. You go out and at the end the night, “I don't want to do this all over again,” so that's the end of that. But then when you get a stronger bond, like a hydrogen bond, it's kind of like you are going to date this somebody for a little while, not just a one-time date, it's several times, maybe a couple months dating and then you decide this is not the right person. Then, the strength of maybe like an ionic bond, a strong ionic bond might be things like you like somebody enough to where you're actually going to marry them and you’re going to live with them for a while, but it is short term. But a covalent bond might be something like you're going to marry this person and you're going to live with them 50 years and that person is the love of your life and you're staying with them for a really, really long time. So that gives you an idea that it's an attraction. Attractive force between different types of molecules and they're going to hold on to each other for a little while, sometimes hold on for a really long time, depending upon the bond type, so there is a strength in that relationship and it's totally dependent upon individuals and how that person is and characteristics that they have. That sort of thing.

Jonathan: She's a natural.

Tamara: I wish you would have been my chemistry teacher.

Jonathan: That's exactly what we want when scientists communicate. Tie it to something that we all can identify with, break it down into steps, and make it meaningful.

Velinda: It's because I've done activity with chemical bonding with kids that were in kindergarten and they could understand that part.

Jeff: I think that the last time Richard checked our podcast had been heard in 60 different countries. There's people in 60 different countries now looking for that ionic bond that will take them through the next 50 years.

Jonathan: Or not! Think about the hydrogen bond for some people.

Jeff: There you go! I'm not judging. Well, this has been great. I thank all of you for your expertise and your passion today and particularly our friends from the Morehead Planetarium who have come down to join our conversation. Tune in next time for another edition of 30 Brave Minutes.

Richard Gay: Today's podcast was edited by Richard Gay and transcribed by Janet Gentes. Theme music created by Reilly Morton. Thanks for listening and go Braves.

Good job everybody!