Courtney Plumley (00:00):

We asked teachers how much science, professional development, they've had in the last three years, and nearly half of elementary teachers said none.

Eric Cross (00:10):

Welcome to Science Connections. I'm your host, Eric Cross. I am super-excited to be kicking off the third season with the show. This entire season will be exploring the theme of science as the underdog. And we're gonna make the case for science, by showing how and why it can be used more effectively. In the coming episodes, we're gonna talk about how science can be better integrated into other content areas like literacy and math, and explore some of the benefits that you might not be thinking about good science instruction. But first, science as the underdog. I bet some of you out there feel like science is the underdog in your community at school. I know I have at times. To kick off this season, I'm gonna talk to two people who really studied this question by looking at the state of science instruction across the US. Eric Banilower is Vice President of Horizon Research and Courtney Plumley is Senior Researcher at Horizon Research. Eric was the principal investigator and Courtney an author of the latest in a series of studies called "The National Survey of Science and Mathematics Education." We're gonna dive into the findings of their most recent report to see what the data's showing us. Please enjoy my discussion with Eric Banilower and Courtney Plumley. Courtney, hello. And thank you so much for joining us.

Courtney Plumley (01:25):

Hi Eric. It's nice to be here.

Eric Cross (01:26):

And Eric, welcome.

Eric R. Banilower (01:27):

We're thrilled to be here, so thank you for having us.

Eric Cross (01:30):

I was reading through the report. Four hundred...a very thorough report, 471 pages, I think, as I got it?

Eric R. Banilower (01:37):

And that's only one of the many reports from that study.

Eric Cross (01:40):

Yeah. You all have done your work, so I'm really excited to to talk to you about this. And on this season of the show, we're exploring the theme of science as the underdog. And I think a lot of our listeners, we feel like science is an underdog either in their school or in their district. But you've actually done some research on this, in a 2018 study, "The National Survey of Science and Mathematics Education." So I wanna talk about this report. But first I was hoping you can kind of set the stage. How did you come to work on this report, and then, big picture, what were you hoping to find out?

Eric R. Banilower (02:10):

So the 2018 study that you just mentioned was actually the sixth iteration of a series of studies dating back to 1977. And we collect data every decade or so—you know, plus or minus a few years. And really,

what we're trying to do is get a snapshot of what the science and math education system looks like in in the nation. So my role grew. I started working at Horizon in about 1998, after teaching high school for five years in California. And then going to graduate school. And right about that time, the company was doing the 2000 iteration of the survey. And I worked on it with the team here at Horizon. And then we did it again in 2012. And I had a much more prominent role in that study, and became the kind of leader of the study. And in 2018, the most recent version, we just did it again. So the goal of this study is really to kind of examine key aspects of the K–12 STEM education system. And the main audience of the work has traditionally been policy makers, researchers, and practitioners who work at the federal, state, and district level.

Eric Cross (03:30):

So this study, you took kind of a sample size, but it's reflective of trends that we tend to see across the nation as a whole. Would that be fair to say?

Eric R. Banilower (03:38):

Yes, definitely it is. It is a random sample of schools in the country. So we start with a list of all the public and private schools in the nation, and then do a random sample of those schools, and then work really, really hard to recruit schools to agree to be in the study. And that has gotten harder every time we've done the study, for many understandable reasons. And then once we have schools on board, we sample teachers within schools. So we don't even survey every teacher in a school. It's really a sub-sample. So that we can make inferences about the nation as a whole.

Eric Cross (04:14):

Makes sense. And so Courtney, what did you find out about the time spent on science instruction in US schools?

Courtney Plumley (04:22):

So, I'm gonna talk about elementary teachers to begin with.

Eric Cross (04:26):

Because that was your past life, right?

Courtney Plumley (04:28):

I am a former elementary teacher, yeah. So that's kind of where my head is. And that's relatable for me. Right? So we asked teachers, like, how many days of the week or weeks of the year that they teach elementary school. And fewer than 20% teach science every day of the school year. They kind of do one or two things, for the most part. They teach a couple days a week or they teach every day of the week, but only for, like, maybe six weeks, and then they swap with social studies and they kind of do that across the school year. Which is really different from, like, math, right? We also asked elementary teachers, how often do they teach math, and it's every day of the year. Then we also asked them how many minutes they teach when they're teaching, and we kind of did the math to figure out, all right, if they taught science every day of the school year, how many minutes would it be in a single day, so that we could make a more comparable comparison with math and ELA. If you were to work it out, how many minutes of science an elementary teacher teaches across the year, and break it down to per day, it's like 18 minutes for the lower elementary grades, 27 for the upper elementary grades. Which is not a lot. But it's pretty much an hour a day in math, and 80 plus minutes in ELA. So, a lot less. And then, you

know, when I was teaching, the first thing to go was always science, right? If there was an assembly, if there was early release or whatever, that was the first thing to go. So those numbers might even be higher. Just because they aren't factoring that kind of thing in, too.

Eric Cross (06:05):

So, now I'm curious. That is something that I've seen just anecdotally, science being the first thing to go. I feel like I've seen that almost...it's almost become a meme, that I've heard that so often. Just in your experience, why do you think that is that huge disparity between the two?

Courtney Plumley (06:26):

Well, I mean, when I was teaching, I was teaching third grade. I had an end-of-grade test in math and ELA for my kids. I didn't have one in science. So the administration said, "Hey, if you're gonna drop something, drop something that's not tested."

Eric Cross (06:41):

Simple as that. And Eric, you, past life: physics teacher. High school. What did you see? 'Cause our listeners run the gamut from elementary all the way up to high school. What did you see, as far as relative science instruction in the secondary level?

Eric R. Banilower (07:00):

Sure. You know, secondary is just a whole different situation than elementary. Rght? Because you have departmentalization. I taught science. I didn't have to teach other subjects. And students had periods, and they still do, sorry, they still have periods, even though it's been a long time since I taught. And you know, they rotate from one class to another. So all the classes were essentially the same length. So, you know, when I was teaching, it was about 50-minute periods. So in terms of minutes of a class or minutes on a subject, it's not really different. But what is different is what students are required to take in order to graduate high school. One of the things we asked schools about in this study was how many years of a subject do students have to take in order to graduate? And what we saw was in mathematics, over half the schools in the nation require students to take four years of mathematics to graduate. OK? And the vast majority of the rest, about 44%, require three years in science. Most schools require three years. Very few require four years. And many, or a fair number, still only require two years to graduate. So the expectation of what students are taking is lower in science than it is in mathematics.

Eric Cross (08:20):

So you were seeing the same trend in secondary, essentially.

Eric R. Banilower (08:24):

Yes.

Eric Cross (08:24):

The amount of time devoted to the instruction of science...we're kind of seeing it mirrored just across K–12 across the board.

Eric R. Banilower (08:33):

That's correct.

Eric Cross (08:34):

And that's across the country. 'Cause the sample size represents teachers from Alaska, Hawaii, the South, SoCal, everywhere. So what's been the reaction to that number? Like 18 to 20 minutes is...I mean, it's, it's half of my lunch at our school. What's been the reaction to that number since this data has been published?

Eric R. Banilower (08:58):

I don't know, Courtney, if you want to take that...

Courtney Plumley (09:00):

It's a lot of what you just did. Like, what??? Like, how is it possible to teach all the things you need to teach in such a little amount of time?

Eric R. Banilower (09:08):

What's really kind of surprising to me, though — though now that I've worked on three iterations of the study, it no longer surprises me, but it did at first — is that these numbers really aren't changing since we've started doing this study. You know, people thought maybe with No Child Left Behind and the increase in accountability, time on science might actually go down, because there was more testing in math and English Language Arts. It didn't happen. It was pretty much constant, that this has been kind of the state of science education for a long time.

Eric Cross (09:44):

So Eric, if I'm hearing you right: The past studies, we're not seeing an increase or a decline. This has been this way for how many years, roughly, would you say? Since it's been studied?

Eric R. Banilower (09:54):

You know, I'd have to go back to the 1977 report to get the numbers, but I'm gonna say since then, it has not changed much, if at all.

Eric Cross (10:03):

So this has kind of been entrenched. This has been the norm for almost for the career of a teacher, almost generationally. We're looking at anyone who's been in the highest levels of leadership to someone just entering the classroom, this has been the way it's always been. This is kind of for many people what they've only known.

Eric R. Banilower (10:20):

Right.

Eric Cross (10:21):

Kind of become the norm.

Courtney Plumley (10:21):

We didn't even have science when I was in elementary school. We had science on a cart that came by, you know, every other week.

Eric Cross (10:28):

Was that like a food truck, but like the science version of it? It shows up and does quick science and takes off?

Courtney Plumley (10:35):

And New York was, I mean — we always watched Voyage of the Mimi. I don't know if you ever watched that. But that's what we watched every single time the Science on the Cart came. So it's like a marine biology show. Ben Affleck was on it when he was a kid.

Eric Cross (10:48):

<laugh> Really? For me it was, Mr. Wizard. For some of my students, even now, Bill Nye. You know, the Bill Nye show or something would come on. So what happens when you look at less wealthy districts? Is there a relationship between community resources and science instruction, or is it pretty much equal no matter what the district resources are, the school's resources are? Did you see any data there?

Eric R. Banilower (11:12):

Yes. We actually did a lot of disaggregating the data by community type, student demographics in the schools, to look to see whether there were areas of inequities across the country. And, you know, one of the factors we looked at was kind of a measure of socioeconomic status. You know, wealth in the community. By looking at percentage of students eligible for free or reduced-price lunch. And interestingly, in terms of time on science instruction, there is actually not a relationship between income level and how much time is spent at the elementary level on science, which actually surprised us.

Eric Cross (11:54):

Because you might have expected it to be the other way now. And granted, it's 18 to 20 minutes, there isn't much more to shave off off of that. But were there other differences, like when you compared those communities? Maybe it wasn't the amount of science instruction, but was there anything else, like teacher preparedness, resources? Were there anything else that you did see discrepancies in? Or was it equal across the board?

Eric R. Banilower (12:13):

No, unfortunately there, there have been, and still are, a number of areas where community resources are related to pretty substantial differences in educational opportunities that students have. So, you know, we're talking about the high school science requirements. One of the things that we saw was that high schools in less wealthy communities tend to offer less rigorous science courses than high schools in better-off-financially communities. So they may not be AP courses or second year advanced courses to the same extent that there are in the wealthier communities. That's one big difference that we saw. Another one was what you were just saying about, sort of, the teachers who teach in these communities. You know, I think that for many years people have had a feeling that the best teachers go to the better off schools because it's easier to teach there. Well, we see that the schools with the most poverty, they tend to have the newer teachers, who are just starting their career. They tend to have teachers who are less well prepared to teach their subject. And there's a host of other differences we found. And you know, you mentioned the report being 400 pages. This other report that looks at these differences is also quite long, and, you know, identified a number of areas where there are these disparities in the system.

Eric Cross (13:43):

Well, we appreciate you synthesizing this for us, because this is super-important. And you've fleshed out a lot of things. And the fact that it's driven by data, we as science teachers, we as scientists, being objective, really, really value that. Because this is actually validating a lot of the things that our listeners and myself, we experience anecdotally. But you don't have a lot of things to network you. And sometimes, when you see this, you wonder if it's just you, or is are other people experiencing this? And so as you start talking about this data, realizing, oh wow, this is not something in isolation. This is systemic. This is something that's impacted. And then Eric, what you said about schools that were lower-income, that were under-resourced, and didn't offer those advanced classes, what are some of the impacts of that, maybe downstream, of doing that? Not having those AP classes? I just kind of wanted to put that out there and ask you.

Eric R. Banilower (14:31):

You know, this is a really...this is a current debate right now, about what the goals of schooling K–12 should be. You know, are all kids meant to go to college? Should there be alternative paths? And you know, I know when I was teaching, I would have students say, "Why do I need to know this? I'm not gonna go into science. I'm not gonna study physics. Why do I need to take this?" And, you know, the answer I used to give them was, "You never know where your life is gonna end up and what opportunities you'll have. And by having these educational experiences, you have more opportunities available to you. Whether or not you choose to go down those paths, you have opportunities. And when you don't take this kind of coursework, you know, even if you don't want to go to college, you limit your potential careers. Because so many careers nowadays require some technical knowledge, some knowledge of science, even if it's not explicitly a science job. It is embedded in our society now. We are a technological and science-based society."

Eric Cross (15:37):

It reminds me of something that I've told my students, that if you become a scientist, that's awesome. I love that. But if you don't, and you want to be a dancer or an actor or a lawyer or anything that may not be directly related to STEM, I want you to choose it because it was a choice, and not a lack of options. So as long as you're choosing not to go in STEM, and you don't make that decision because you can't, or because you weren't given the opportunity. So that's how I've always had this mindset as a teacher. And I've explained it to my students. So if you say, "Cross, you know what I want to do, I wanna be an awesome chef," which, you know, low-key that's science, right? <laugh> Molecular gastronomy, we know that. But like, you be the best chef. But as long as you're being a chef because you choose that, and you're like, "I love science, but I don't wanna go that direction," we're good.

Eric R. Banilower (16:26):

Right. And if you think about, a lot of social justice issues with pollution and climate change, and you look at which communities are more affected by some of these larger environmental problems and challenges, it tends to be the lower socioeconomic communities, the more poverty-stricken communities have worse water, have worse air quality. And so if, if people from these communities are going to make informed decisions about who they're gonna vote for, about what policies they're gonna support, those are science topics that you have to have some understanding in order to make informed decisions in your life.

Eric Cross (17:09):

Courtney, you were one of the Swiss Army Knife teachers. This is how I perceive it for elementary. You had to teach everything. And shout out to all of my elementary school teachers that have to be mathematicians and grammar whizzes and scientists and PE instructors and social emotional, all of those different things. you also looked at teacher preparedness. How did teachers feel about teaching science compared to other subjects like language arts and math? Did you see anything there?

Courtney Plumley (17:39):

We did, we did. And I'm glad you said, "How did they feel about it?" Because one thing that, you know, in a survey you can't really do is capture how someone actually...how good someone actually...the quality of someone's instruction. But you can ask them how prepared they feel. And you can even ask them like stats, like, "What did you major in in college?" You know. But you really are going on based on what what they say. So we ask them how prepared they feel to teach all the core subjects. And two-thirds of elementary teachers felt very well prepared to teach reading. They felt very well prepared to teach math. But when it comes to science, it's less than a third felt very well prepared. And you know, like you said, when you're teaching elementary school, you're teaching all the subjects. But also in science, there's usually four main instructional units in a school year. And they're all from different science disciplines. So not only are you going on, like, "Maybe in college took a lot of bio classes, but I didn't take any physics classes, and now I have to teach physics to my kids and I have no experience there." So, you know, we also ask them how well-prepared they felt in these different disciplines. And the numbers are even smaller, you know. Fewer than a quarter felt very well-prepared in life science. And like 13% felt very well-prepared in physical science. So there's definitely a big difference between how much teachers feel prepared for ELA and math versus science.

Eric Cross (19:08):

And just from a human perspective, when we don't feel prepared for something, we're not really gonna probably lean into it as much as we are into our strengths. Like, that's just kind of how we are across the board.

Courtney Plumley (19:18):

Yeah.

Eric Cross (19:18):

I'm even like that with my own chores in the house. Or when I have things I need to get done, and I might not be as good at doing those things—it's gonna be a heavy cognitive load; I'm gonna have to do some background research—I tend to find other areas to excel in. Like, I'm gonna be productive in this other area. I'm gonna really crush it here. But this other thing gets put to the back burner.

Courtney Plumley (19:36):

Totally. And the same reason I might skip science today, <laugh> 'cause it's scary.

Eric Cross (19:41):

Yeah, exactly. But I love this book. <Laugh> Or we could do this math, and let's really, really dive deep into it. Now, did you also look at professional development and instructional resources that are being provided?

Courtney Plumley (19:53):

We did.

Eric Cross (19:54):

And on the whole, how was the amount—and I'm seeing a trend here, so I'm kind of feeling like I know where this might go—but I wanted to ask it, did the amount of professional development and resources for science, was there much of a difference between that and other subjects?

Eric R. Banilower (20:10):

Well, I'll start on this, and Courtney, feel free to jump in. You know, one of the things that we asked was how much kind of discretionary funding do schools devote to science and how much to mathematics? So, for consumables or equipment and supplies or computer software for teachers to use in the classroom. And it's hard to compare, I think, across subjects because the demands for this kind of supplies, et cetera, is very different, I think, in science than it is in mathematics. Right? We have a lot of, you know, equipment for doing investigations, consumable supplies in science. And those things need to be replenished on a regular basis. It turns out, when we look at the data for school discretionary spending on this kind of stuff, the median school spends less than $2 per student at the elementary level on science, compared to over $6 for mathematics. At the high school level, it's kind of reversed. Schools spend more money on high school science than they do on high school math. but even still, at the high school, it's less than $7 per student. Which is not a lot of money being devoted to thinking about all the materials, supplies, chemicals, et cetera, that you need to teach science well, at the high school level. More disturbing is the fact that, you know, we were talking about inequities before, schools that serve less well-off communities spend less than schools that serve wealthier communities, by quite a big amount.

Eric Cross (21:46):

So essentially the per-student thing just kind of popped out to me: So, like, an expensive Starbucks drink is what we're spending on science per student.

Eric R. Banilower (21:57):

At the high school level. Yes.

Eric Cross (21:58):

At the high school level. And I get those catalogs in the mail, from all of those big science companies. You can't get much for seven bucks. At least, nothing high-level. And I know I do a lot of 99-cent store science. I go down the street, go to the 99-cent store. Thankfully we could do a lot of awesome science with just, you know, cheap things. But a lot of the higher level experiences, they're pricey. But the experiences are so rich! And $7 at the high school level is nothing. It's not much at all.

Eric R. Banilower (22:28):

Yeah. It is definitely, you know, kind of shocking to think about what we're investing in our children's future.

Eric Cross (22:37):

Now, just to put you both on the spot, 'cause I feel like that we've identified some...we're seeing a trend here, we're seeing a pattern. We're talking about, you know, being science teachers. There's a pattern going on here. Do you think it's fair to characterize science as the underdog?

Courtney Plumley (22:52):

I think in elementary school, it is a fair statement. Because, like we said before, I mean they're gonna preference math and ELA almost all the time. I mean, the other thing you'd asked a little bit ago was about professional development, too. And we do have some data on that. And we ask teachers, you know, how much science professional development they've had in the last three years. And nearly half of elementary teachers said none. And I know I didn't have any science professional development. If I was gonna pick from among the catalog, I was picking one that I needed more, like math. Math and ELA. I keep making that statement, but just over and over, it's the truth.

Eric Cross (23:31):

And going back to what you said earlier, because that's where the accountability was, right? And that kind of came top-down.

Courtney Plumley (23:38):

Yes.

Eric Cross (23:38):

And influenced everything else.

Eric R. Banilower (23:40):

Yeah. Now, really interesting thing that we did, a year or so ago, 'cause someone asked us, you know, "Hey, could you look at this?" is we compared elementary science instructional time among states where science counted towards accountability versus states where science doesn't count towards accountability. And at the upper elementary grades, more time was spent on science in schools in states where they had science accountability. Now I'm not arguing for adding science to accountability systems. But that's a pretty telling piece of data.

Eric Cross (24:19):

What gets measured gets done.

Eric R. Banilower (24:20):

Yeah.

Eric Cross (24:20):

Or what was getting evaluated was getting done. And that raises, that opens up a myriad of other questions about testing, and what that reveals, and all of those different things. But at the end of the day, what you're finding is that the things that were getting tested were the things that were getting the priority.

Eric R. Banilower (24:36):

That's right.

Eric Cross (24:37):

How did we get to this point? And Eric, you said it goes back at least to '77, but we look at society and we're...I wanna say we're post-pandemic, but we're we're not. but we're trying to, we're trying to get past that. But we're looking at...we had innovations in biology, we have innovations right now in green energy and electric cars and all of these things that are STEM-based. We know that these are things that have moved humanity forward. And we look at the pipeline of people who are in STEM and we, we see the disparities and things like that. Why was science given less of a priority? I'm just curious. Maybe, Courtney, we could start with you, if you have any ideas. Or Eric. Either one. But how did we get here?

Eric R. Banilower (25:22):

<laugh> I think Courtney wants me to take that one. I'm older so I've seen more <laugh>. So, you know, I have the gray hair. She doesn't. I think it's complicated. And I know this sounds cliche, but but schools are a reflection of society, right? And, and so science education, you know, if you think back when Sputnik was launched, there became this great demand in America to improve and produce more scientists and engineers in response to this Cold War threat. Right? And then in the '80s there was rising, oh, the gathering storm was an economic argument that we needed to increase science and math, you know, education and people going into those fields in order to compete economically against the global competitors. And I think that America has always produced a fair number, a large number, of high-quality scientists and engineers, you know. And we still lead the world in many ways. But where we've identified as a problem is who has those opportunities to go into those fields. You know, it used to be a very select, a very male-dominated, white male-dominated field. Right? And other people didn't have the opportunity, or they were shown the way out pretty early. And we, I think, have come to realize as a country that, you know, the, the greater the diversity of thought that we can get into these discussions, the more innovative we can be and the more productive as a society we can be. And so I think we've had this shift in the country to, instead of thinking about just the quality for the select few, but to be thinking about the quality for everyone. And so that makes it seem like some of these challenges are greater than they used to be. And I think they're different challenges, right? We've evolved as a society and I think schools have evolved.

Eric Cross (27:40):

There is a conversation I was in on a plane with a person who was a materials manager for a company that made the adhesive for sandpaper. And we were flying...I was flying to Denmark and he was flying to some other Scandinavian country. And we were just talking about it. And he came from another industry, and somehow the conversation led to science. I don't know how that happened. But somehow I just started talking about science and I asked him about, Eric, kind of what you said about the US kind of leading the way in science innovation versus the rest of the world. And I asked him why. And he said one of the reasons why is because the heterogeneous thought. The different groups of people that are coming to a problem actually create more innovative and novel solutions. Versus when it's more homogeneous. And everyone's either culturally or just for whatever reason, kind of thinks a certain way. While they might have a more efficient way, the variety of solutions are not as varied and not as novel. I was reminded of that story based on what you just said. So it's really interesting. So it seems to be that it benefits if we have more heterogeneous groups, more folks who are contributing to STEM, because that's gonna be solving the next problem more efficiently. Or I guess maybe in my head it seems like the next we need...we do really well when we have a dragon to slay. I mean, it seems like we come together when that's the case, right? Like, I dunno.

Eric R. Banilower (29:06):

No, I think that's...I think that's accurate.

Eric Cross (29:09):

Later on the season of the podcast, we're gonna explore ways to better integrate science with other subjects like literacy and math. Were you able to study at all any more integrated approaches to science instruction? Does any of your research support that approach?

Courtney Plumley (29:25):

Not on the national survey, we didn't study that. And it's something that we've talked about before, because it's difficult to get teachers to...we were talking about instructional time. It's hard for teachers to put a number on it when they're integrating, because, you know, it's not like I have my science block from 3 to 3:30 anymore. Now it's kind of scattered about. But it's something that has been in the ether. We've been looking at it in a couple of projects. So there's some evidence that it can be effective, especially for getting more, you know...the idea is you can get more time for science if you are integrating with other subjects. But one thing to kind of caution is like, students need to have opportunities to learn each discipline when they're doing integrated instruction. So you don't wanna just have, like, math in your science. Kids already know to just, like, support it. Then it's hard to take time from math to put it into science when they're not actually learning anything new. That's the easy thing to do, though, is say, "Oh, my kids already know how to measure. We did that in a previous unit. So now we'll we'll do it as part of our science instruction." So it's a lot of work to make it so they're learning something new, mathematics and science, at the same time. And it's not really something that we think that teachers should be having to do on their own, with all the other things that teachers have to do. The last thing they need to do is be creating their own, you know, curriculum. Something that's already...you know, it's not straightforward. So we've been talking about it, we think it's really something that instructional materials maybe need to be focusing on instead of teachers having to do that on their own,

Eric Cross (31:01):

Teachers would implement it, but asking them to create it is a whole different thing, and it's a huge ask.

Courtney Plumley (31:08):

Yes.

Eric Cross (31:08):

Yeah. And, did I hear you right? So the ideal situation would've been the students learning a newer math concept, but embedded in a science kind of context? Or was that the better way? Versus, "I'm gonna take a math concept they already know and then just put it into the science setting?"

Courtney Plumley (31:26):

Well, if the idea is that you can get more science time if you're, you know, integrating things, so you can maybe take time away from a specific math block by putting it with science, or whatever, then if the math is something that the kids already know, now you're just taking away. I think that that has to be new in both cases, in order to justify having more time.

Eric Cross (31:49):

Right. Eric, in the secondary level, any thoughts on that? On integrating these disciplines together?

Eric R. Banilower (31:56):

I think, you know, just like at the elementary level, it can be challenging to do it well. When I taught, I taught my last couple years in a kind of school-within-a-school kind of situation, where our goal was to try to integrate science, mathematics, and language arts. And it's hard to do that in a meaningful way. And we did not have curriculum materials given to us to help us do this. We were trying to figure out how to do this on our own, while we were teaching 200 kids a day in our subjects. Right? And five preparations. And you know, it's a big ask of any teacher. And there are teachers who thrive on this and are great at this. And, you know, that's one thing I wanna, make clear: our data is about the system, and we are former teachers. Almost everyone who works at Horizon is a former teacher. We have the greatest respect for teachers and what they do. And what our data is showing is are kind of like areas where the system isn't providing teachers and their students the opportunities to do great things. I think at the high school level, there has been this idea of project-based learning where students are bringing together different skills, different ideas from across disciplines. And I think there's, again, a lot of potential in doing that. But trying to develop those experiences so that they are doing service to the different subjects, so students are learning what they're supposed to learn in English Language Arts, that they're learning, important mathematics, and that this is in a science context, where they are getting to do and understand what science is and how science, as a discipline, operates...that's just a really hard thing to develop.

Eric Cross (33:53):

So what I'm hearing—and I really appreciate the nuance in this, because it's not a simple "Yes. Integrated is better,"—I'm hearing "Yes. Quality control." "Yes. It needs to be written not by teachers; they're the practitioners." It's "Yes. And," not just simply binary. Which...it's so easy to wanna chunk things and say yes or no on things. But this one seems a much more nuanced approach. And in a future episode, you mentioned project-based learning, we're gonna try and talk to people who have thoughts on this. And I really appreciate that you talked about project-based learning, because also, how do you evaluate that? How do you evaluate whether or not it is high quality? Is this is something I see? You know, high-quality standards, highest quality science teaching, highly qualified teachers. It's something that I see often. Now, based on all your research, this is kind of the 30,000-foot view. What advice might you have for people who are thinking about changing the way science is taught in this country? Which hasn't changed since 1977, at least since we've been measuring it. Any advice for people who do want to act? Another way to ask, it might be, if you were given a magic wand, <laugh>, you have all power, what might you do if you can control the entire vertical system?

Eric R. Banilower (35:07):

Yeah, so a clarification, I do think science instruction has changed. It has evolved. I think there's a lot of really good things going on in different pockets of the country. One of the challenges is bringing those good ideas and good practices to scale. Right? There are approximately 1.2 million teachers of science K–12 in this country. That's a lot of people. And about 80% of those are elementary teachers who are responsible for teaching other subjects as well. So my thinking is often about, "How do we take what we know and that we've learned through decades of research is effective, and impact a large number of teachers, and therefore a large number of students?" And you know, Courtney I think has hinted at this already. And you've mentioned it too, Eric, is that teaching is a profession, right? And it's a craft. But in no other profession do practitioners have the expectation that they're developing their own tools and methods for their work. I know when I was in my teacher preparation program, and it's still extremely

common, one of the assignments perspective teachers are given is to develop a unit and develop a lesson, right? You don't have doctors being asked to develop new treatments and new tests to use. Their job is to get to know their patient, assess what's going on, and then using research-based methods to develop a plan of action, right? And I think that analogy works really well in education and is a way that we could have a scalable approach for kind of raising the floor across the country for the quality of science education. Giving teachers research-based materials, high-quality instructional materials, that they can then use and adapt to meet the needs of their students, would allow them to focus on getting to know their students, seeing what their strengths are, seeing where they have room for growth, and using the materials they're given to help those students progress. And I think that is definitely a way where we could have a big impact at a large scale.

Eric Cross (37:39):

Courtney, same question: Magic wand, all power. You can change systems from the elementary perspective. What would you do? I'm assuming part of it's gonna be changing that 18 to 20 minute time. But even for that to happen, what would you do? What would you change?

Courtney Plumley (37:57):

Well, I don't know. Like, for it to change, I don't know the answer to that. But yes, increasing the time would be great. And like Eric was saying, giving teachers— 'cause again, I'm coming in, not enough probably background in science—and then, you know, when I was, when I was teaching, we had one set of textbooks for the entire grade. Six classes, right? Like, share them. But third graders aren't gonna read textbooks anyway, right? So instead I'm going to the teacher store. I'm pulling things off the shelf. And like, "OK, yeah, sure, I'll use this." And nowadays, teachers are going to Teachers Pay Teachers or whatever. Because I didn't have anything good to use. So like Eric is saying, if I had instructional materials that were good instructional materials that were gonna teach my kids, that they were gonna be engaged, that they weren't sitting and listening to science, but they were doing science, you know, and I had professional development to actually help me do it? That's what I think we need to have. And I mean, I know there are some people out there that are working on that, but it's not a lot. I mean, if you look at Ed Reports, they rate how well-aligned science curriculum are to standards. And there are two right now that have Ed Reports green lights. There's Amplify and there's OpenSciEd. You know, so there's not much out there for teachers to use. And, so it's hard. It's hard. Where am I gonna go and get this stuff if it doesn't exist? And so I'm making it up by myself. Which we already said is not the best use of teachers' time, when they've got so many other demands on their time.

Eric Cross (39:27):

Eric and Courtney, listening to both of your responses, it created a visual in my mind. And Eric, I loved your analogy of...I started thinking of a chef, a welder, and a farmer. And I thought about the chef saying like, "You're a great chef! Now, can you go farm, and make your own food, so that you can cook it?" Or the welder who has to make his own welding tools and go smelting. You know, making the different rods. I'm not a welder. But you know, all those different parts. Or the farmer who has to build his own tractor and innovate all that stuff. You're absolutely right, the way you articulated that. And then Courtney, you essentially said, "Give them the tools and then teach them how to use it so they can go and actually be effective with it, because you're in front of kids doing so many different things." There's only so much time in the day, and teachers want to do these things; they want to, but you end up having to triage when you're asked to. Going back to Eric's analogy, if you're in the ER, but you're also creating the vaccines and you're also doing the research on which types of vaccines are gonna be the most effective, that's, that's a lot to ask. And so, I appreciate both your responses on that. Now, last question,

what are you both working on now? This report came out in 2018. What's, what's next on the horizon? Actually literally, that's no pun intended. <laugh> What's next? <laugh> What's next for, for you both? What are you working on?

Eric R. Banilower (40:42):

Well, you know, we would love to do another national survey, in a few years. We have to get funding to do it. And you know, that's always something that takes effort and isn't a guarantee. We've written grants to do these studies in the past, and there's also the dealing with the reality of the situation. I think a lot of schools, still coming off the tail end of dealing with Covid, are overwhelmed. And we've had a hard time, I mentioned before, recruiting schools, and it gets harder every time, just 'cause they have so much on their plate. And I couldn't see going to a school now and saying, "Hey, one more thing. Do you mind?" So I think we have to kind of wait a little bit for things to settle down before we can do another one of these studies. It just doesn't seem feasible right now. But we'd love to in the not-too-distant future. Other than that, Courtney and I actually work on some projects together and some projects not together. One of the things that we're working on together is a study of a fifth grade science curriculum that was developed by Okhee Lee at NYU and her colleagues, that is both aligned with the NGSS and purposely designed to support multilingual learners in developing both their science knowledge and skills as well as their language skills. And we've been working with the crew at NYU to study this curriculum and try to figure out, how well it's working and under what circumstances. So that's been a really interesting project that's going on right now.

Courtney Plumley (42:26):

I recently worked on a report with the Carnegie Corporation in New York that actually I think, compliments what we've been talking about a lot. It's about the status of K–12 education in the US — or science education in the US! <Laugh> — and so as part of that report we interviewed like 50 science education experts across the country. We surveyed teachers, people in the university settings, researchers, and everything to kind of get a little bit more update of the state of science education right now. And so a lot of the things we've been talking about, we still are talking about with the people in this report four years later. So, work in progress. <Laugh>

Eric Cross (43:09):

And again, going back to 1977, based on what Eric was saying earlier, we're looking at these large systems, these systemic changes don't happen overnight.

Eric R. Banilower (43:20):

That's right.

Eric Cross (43:21):

It's very slow-moving.

Eric R. Banilower (43:22):

That's right. I would say there is progress. I think we've learned a lot. We are getting better. Are we there yet? No, we're not happy with where we are. But I think, you know, I think it's important to be hopeful about the direction things are going in.

Eric Cross (43:37):

Well-said. I agree. Courtney. Eric, thank you so much for unpacking that report that speaks to, that validates what so many teachers across the country are experiencing. And thank you for your advocacy for high-quality science education, for equity, and your passion for supporting teachers and being that voice from a data-driven perspective of what teachers experience and then advocating for solutions for them. It's super-encouraging for me, and I know it's gonna be really encouraging for a lot of our listeners. So thank you.

Eric R. Banilower (44:10):

Thank you for having us.

Courtney Plumley (44:12):

Yeah. Thank you, Eric.

Eric Cross (44:15):

Thanks so much for listening to my conversation with Eric Banilower, Vice President of Horizon Research, and Courtney Plumley, Senior Researcher at Horizon Research. For much more, check out the show notes for a link to the 2018 National Survey of Science and Mathematics Education. And please remember to subscribe to Science Connections wherever you get podcasts, so that you're not missing any of the upcoming episodes in Season three. Next time on the show, we're gonna start laying out the road map for using science more effectively. And we'll start by looking at the how and the why of integrating literacy instruction.

Susan Gomez Zwiep (44:49):

When we look at Science First and build language development around it, the experience tends to be more authentic and organic.

Eric Cross (44:58):

That's next time on Science Connections: The Podcast. Thanks so much for listening.