Asteroids Isn't Just Fun to Pl...cs, Says Professor Chris Orban

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SPEAKERS

Eva Dale, Chris Orban, David Staley

E Eva Dale 00:00

From the heart of the Ohio State University on the Oval, this is Voices of Excellence from the College of Arts and Sciences, with your host, David Staley. Voices focuses on the innovative work being done by faculty and staff in the College of Arts and Sciences at The Ohio State University. From departments as wide ranging as art, astronomy, chemistry and biochemistry, physics, emergent materials, mathematics and languages, among many others, the college always has something great happening. Join us to find out what's new now.

D David Staley 00:32

Chris Orban is an Assistant Professor in the Department of Physics at the Marion campus of The Ohio State University. He specializes in computational physics, having received his PhD from Ohio State in 2011, with a thesis studying cosmological N-body simulations, and we'll talk a little bit about that this morning. Since then, Chris has branched out into laboratory astrophysics and ultra-intense laser science as a member of the High Energy Density Physics group here at Ohio State. Welcome to Voices, Dr. Orban.

C Chris Orban 01:03

Yeah, thanks for having me here. This is a fun studio to be in.

D David Staley 01:07

I quite agree. I know that you've developed some pretty innovative approaches in your freshman physics class, and I'd like you to discuss some of these; what sorts of things are you doing in your physics classroom?

C Chris Orban 01:16

Yeah so, you know, as a postdoc and as a professor, I would have these undergrads that would come up to me and they said, hey, I want to do a research project with you. And of course, I want to help them and I'm a new faculty member and, you know, everybody here wants students to succeed. But, the problem is that there's a lot of students that, maybe they got straight A's in high school, but no one showed them how to code, no one that showed them how to use a computer to solve a science or a math problem, things like that, until they come into my office, and they say, hey, I want to do a research project. And, I don't want to say I got so fed up with it, but maybe that is the best word. But I just felt like something had to be done to sort of give students a gentle introduction to how you would use a computer to solve problems like that, and to try to see how early we can start, I mean, can we start this in high school, can we start this in middle school, and what kind of activities would really be sort of the baby steps to eventually get into those skills where you can sort of understand more of the nuances of computational physics? But, you know, to do a research project with me, the computer skills is kind of the biggest barrier, and so I really wanted to address that head on and in a national way.

D David Staley 02:18

National in what way, how have you done that?

C Chris Orban 02:22

In 2014, right as soon as I started teaching at the Marion campus, that first semester, I had the "Asteroids" game.

D David Staley 02:31

"Asteroids"?

C Chris Orban 02:31

Yes, that's the one.

D David Staley 02:33

The game from the arcade?

C Chris Orban 02:34

That's right. So, it's a video game, but it has really good physics in it. And if you think about what your goals are in the first semester of physics, the laws of physics are most easily understood for a rocket drifting in free space, right? Because there's no gravity, it's just a rocket, you know, thrusting and accelerating, and all that stuff. And so I said, well, what a perfect canvas for illustrating these physics ideas, but in a fun way that students can kind of appreciate. So that first semester, like that first summer as I was preparing to be a professor, I was building that activity. And my students really liked it, and eventually, I started sharing it with some of the high school physics teachers that I knew and they really liked it, they had suggestions and things. And then, in 2017, I got a grant from Connect and Collaborate, which is an OSU grant program here, and that helped us to launch a YouTube channel that, you know - obviously, YouTube is national, international scope, and so I wanted to make sure that people could get access to it that weren't just in my class, you know.

D David Staley 03:35

What are some of those videos on your YouTube channel?

C Chris Orban 03:37

You know, we started with the "Asteroids" game, we have "Angry Birds" - do you remember the "Lunar Lander" game?

D David Staley 03:42

I do, indeed.

C Chris Orban 03:43

So, you're trying to land a little rocket on the moon and things like that. There's a lot of good physics in those games, you know?

D David Staley 03:48

And you mentioned "Angry Birds", if this is what I'm thinking of, my son used to do this. These were like physics based games, you had to design the car, the vehicle, such to have a certain amount of weight for it to go up the hill, and those sorts of things?

C Chris Orban 04:01

Yeah, "Angry Birds" is a good example of projectile motion, because you're kind of launching this bird across the screen, things like that. And projectile motion is, you know, one of the obsessions of first year physics classes. People tend to think that making a video game is this really difficult thing, but the code behind "Angry Birds" is not as complicated as you might imagine.

D David Staley 04:21

Well, speaking of code, I know that one of your interests or one of the things you've developed is the STEMcoding Project. Tell us about the STEMcoding Project.

C Chris Orban 04:28

Yeah, so these videos were part of the same coding project and, you know, one of the big efforts of the STEMcoding Project. And so that grant that I won in 2017, I kind of cite that as sort of the launch point of the STEMcoding project; I mean, I was working on it in 2014 and 2015, 2016, but that was really the first grant that we had won. You know, we made the YouTube channel, we started training high school physics teachers with online professional development, and it's really expanded and we get more and more interest every day. You know, every couple days, I get an email from different parts of the nation or the globe of people finding our stuff on either YouTube or ourcode.com, things like that. You know, we like to read kids that one Dr. Seuss book, "Oh, the Places You'll Go!" - I think we need to revise that, it's like, oh, the places you'll get an email from, you know. We get emails from Croatia, England, and India...

D David Staley 05:22

What are they particularly interested in when they contact you, what is it that they're interested in?

C Chris Orban 05:26

I mean, often it's, they're interested in getting access to the teacher solutions. So you kind of have to ask, you know, to email me and ask for teacher solutions, we don't just give those away. And so, that's kind of a fun way to see like, who's interested to use our stuff and doing it in our classrooms.

D David Staley 05:40

Yeah. And to be clear, when you say coding, and computational physics, and bringing coding in the classroom, this isn't just simply using technology, this is, sort of, what, building tools in order to solve problems?

C Chris Orban 05:51

Yeah, so, you know, we want to do more stuff in the future in which, you know, we take, say, videos of experiments, you know, launching a marble across the room or something; we want to sort of take those videos and simulate it and things like that, so there's more of a one-to-one connection to the world. For now, it's just a lot of fun to show kids, here's a video game, here's a physics enriched video game. Obviously, you know, "Candy Crush" is not a very physics relevant game, but there's a whole lot that are and it's not that hard to come up with. Like "Pong", for example, you wouldn't think that -

D David Staley 06:22

Well, that's going back.

C Chris Orban 06:24

I know, yeah. It's a little depressing how few people remember, but I was... I'm 36, so I do remember "Pong" in my early days, I'm not so young as to not remember that, but.

D David Staley 06:35

Well, I won't mention my age, but I am someone who does remember "Pong" and actually played it.

C Chris Orban 06:40

You know, the nice part about "Pong" is that it illustrates elastic collisions, you know, so we have a whole video series on how the kinetic energy before and after the collision with the walls... the kinetic energy is actually the same, and you can use that to make a code and things like that.

D David Staley 06:56

Well let's take that example, let's take "Pong" or let's take any sort of these games - how are you actually using them in the classroom? In other words, students aren't just simply playing games and saying, hey, this is a lot of fun. How do you build a lesson or how do you sort of teach physics with these?

C Chris Orban 07:09

I would give a typical lecture on collisions, you know, and then sort of, after that, the "Pong" activity would try to see if you can use the concepts that I talked about in the lecture and put that into a code. And so, the fact that it's a video game is just this kind of interesting byproduct that makes it more interesting. There's a fair number of other folks out there making coding activities for intro physics that are along the lines of like, well press play and watch this thing do this thing that we've been talking about. And that's, you know, that's one way to do it, but it's, in my opinion, it's not quite as fun as showcasing the games where we actually get to use that physics. And if you think about how we teach in elementary school, kids play games to learn math and things like that, or to learn the letters or alphabet, things like that. And, you know, why do we have to stop using games once we get to college where everything's really serious, you know? I just try to keep the fun coming.

D David Staley 08:07

I was looking at your website for the STEMcoding project, I noticed you have faculty and postdocs and undergrads, it almost sounds like a lab. Is it fair to call this a lab?

C Chris Orban 08:18

That's a good question. One of the nice parts about being in Ohio State is that there's so many students here and so many undergrads, and grad students, and postdocs, and programs, and things. And so, one of the things I like to do is that when... so let's say there's a physics student just got her PhD. Well, you know, maybe there's a month or two before they're leaving for another job or something like that. If I have some grant funds, I can hire them to make videos with me, things like that. And, you know, one of the big issues in STEM is the lack of diversity. And if you look on YouTube, and you look at the different YouTube channels for STEM that are out there, relatively few of them are female-led, for example, or minority-led, or whatever. And, you know, being at Ohio State, I can recruit from, you know, we've had people on the channel from Young Scholars Program, National Society of Black Engineers, we've had people on the channel from the Society of Women in Physics, and it's great to be able to recruit from all those different groups, and they're often very eager to help and they really appreciate the mission that we're trying to do. So the kids, ultimately in high schools, can see people that look like them doing physics and coding and science and having fun.

D David Staley 09:27

So I know that part of your practice includes using visualizations and simulations, and I know you're part of a group, BuckeyeVR Group. Tell us about this group and just how you're using visualization and simulations.

C Chris Orban 09:39

You know, virtual reality in education is something that's kind of been this perennial topic for a long time. I mean, it's... in the last couple of years have had kind of increased interest as, you know, Facebook bought Oculus Rift and all this stuff. And so, kind of how I got into it, the 2014-2015 academic year was sort of my first year teaching as a professor, and one of the courses I had to teach was electromagnetism.

D David Staley 10:03

Okay, which is...?

C

Chris Orban 10:05

So, electromagnetism gets into, not just the physics of, you know, balls shooting across the room, it starts to get into, how do electric charges behave, how do currents behave, how do circuits behave, how does light behave, things like that. What's the physics and the math behind those things? So, I mean, mostly, it's for engineers so that they have some familiarity with these things to do engineering jobs and things. The second semester of physics, which is the course I'm talking about, you take all that machinery from the first semester where you're doing asteroids and all these other things, and then all of a sudden, you have electric fields and magnetic fields, and you have to visualize these things. The visualization challenge of that second semester of physics is considerable, and one of the barriers in that course. And in 2015, I believe it was summer 2015, Google has this big conference where they announced all the fun stuff that they're working on, and two Google employees had kind of banded together, because apparently, at Google, like 10% of your time is like up to you to do whatever you want with it, which is pretty nice. I wish-

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David Staley 11:06

To work on experiments, or cool things, or...?

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Chris Orban 11:09

Yeah, whatever they want. And so, what they did is they said, hey, what if we use a smartphone as the display for virtual reality experience, and we just made a little piece of cardboard that would hold the smartphone in place. And-

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David Staley 11:20

Like glasses or goggles or something like that?

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Chris Orban 11:22

Yeah, it looks a lot like VR goggles, except for that it's, like, vastly cheaper,

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David Staley 11:28

Made of cardboard.

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Chris Orban 11:29

Exactly. You can literally drive over to Staples right now and get one for 10 or 20 bucks.

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David Staley 11:33

D David Staley 11:33

Yeah.

C Chris Orban 11:34

And, so I saw this thing and I rushed in, bought one, downloaded some of the apps, walked into Chris Porter - who's a physics education research postdoc here at Ohio State - walked into Chris Porter's office and I showed him the thing and I said, like, we have to do something with this. And then lo and behold, in fall 2015, there was a computer science student in my class who was amazing at coding up these 3D virtual environments, and I was like, you're hired. And within a couple of weeks, we had this demo out with electric fields. And so now, if you go to the Android or the iOS store, you can download this electric field visualization app - and you have to have the, you know, the $20 headset, or whatever - but it will work on Android and iPhones and things like that.

D David Staley 12:19

So what's that experience, if I were to pop that on, how would I experience or visualize electrical fields?

C Chris Orban 12:25

Yeah, so some of the visualizations have a positive charge or a negative charge or both in there. And basically, what you would be looking at is sort of these two spheres, one with a plus sign on it, the other one with a negative sign on it, and then there would be these arrows, sort of in the air, pointing in the direction of the electric fields. And often, that electric field structure is hard to visualize, just in general, like, if you imagine... I mean if I could show it to you, and you could look at it, and I'd say, all right, well, that's cool, but can you imagine me even trying to draw this on a whiteboard? I'm not that much of an artist, David. And so, to compensate for my lack of artistry, I would, I'd rather make a smartphone app that shows you what it really looks like than sort of me bumbling around on a whiteboard trying to explain it.

D David Staley 13:06

It's almost like you're climbing inside an electrical field.

C Chris Orban 13:09

One way to explain is that, I'm trying to show the student what I think of when I visualize an electric field in my head, I'm trying to show them the thing that is in my mind for what it is, rather than, sort of, like, drawing a crude thing on a whiteboard and waving my hands and say... and then that's actually it's in 3D. And I should say that we've done studies on using this in the classroom and trying to see how much it can benefit the instruction. So, not only did we make these apps - and by the way, we got a big grant from the STEAM Factory to help with all this, so I want to acknowledge them, and we're both STEAM Factory cheerleaders, I think.

D David Staley 13:45

That's right.

C Chris Orban 13:46

And so, part of that grant we got from STEAM Factory helped us to do the largest study of VR integration in STEM we think that's ever been done. So, we had over 600 students in the study, it was done on the main campus in 2017, it was actually 600 students in the first study and then in the spring 2017, another 500 students in the fall. And Chris Porter was kind of the driving force behind it. I mean, I helped with, you know, win the grant in the first place, but, you know, I was advising as much as I could along the way. But yeah, we did sort of the largest study that's ever been done, on seeing what can be gained from using this technology in the classroom.

D David Staley 14:27

So who are the BuckeyeVR Group?

C Chris Orban 14:29

Thank you for asking me that because I need to shout them out. So, Chris Porter has been there from the beginning, he's a postdoc. There's also Bart Snapp in the Math department, he uses BuckeyeVR in his Calculus III courses. Jim Fowler is also kind of on board with that, and then Jon Brown, who is in the Chemical and Bio-Chemical department - it's always a mouthful - but Jon Brown has been there from beginning, you know, Jon's contributed some of the best ideas we've had for developing new stuff. You know, so we've got the physics side, the math side, Jon also likes to contribute chemistry visualizations to us. We're all working together to try to make free resources that people can use if they're interested in using VR. I'm Janet Box-Steffensmeier, Interim Executive Dean and Vice Provost for The Ohio State University, College of Arts and Sciences. Did you know that 23 of our programs are nationally ranked as top 25 programs, with more than ten of them in the top ten? That's why we say the College of Arts and Sciences is the intellectual and academic core of the Ohio State University. Learn more about the college at artsandsciences.osu.edu. So I want to take you back to your dissertation work, cosmological N-body simulations. You have to tell us what this is, but maybe start by telling us or reminding us what cosmology is. Yeah, I would say that cosmology is the quest to understand the universe on the largest scales and on the largest timescales. You know, so how big can we understand and how long ago can we understand, is how I would define it. I was a grad student here at Ohio State from 2006 to 2011, and I worked with David Weinberg, who's now the Astronomy department Chair, and he assigned me to a project basically doing computer simulations of how galaxies form in an expanding universe. And the things that you want to know when you do those kinds of simulations are, how does the, you know, the details in the universe affect the way that galaxies form. Or even more broadly, the way these like giant filaments form, or the voids, form, things like that, and those inbody computer simulations are the best way to kind of do that. So that's kind of what I focused on my PhD work, and we tried to understand these things. It's a very pretty thing to look at, I'll say; you know, I feel bad for my colleagues in particle physics, that the only thing they really have is like these pretty Fineman diagrams, but besides that, there's not a whole lot of pretty looking plots to look at. So, cosmology is a good exception to that rule. These days, I don't do as much cosmology research because I am a finite individual with a finite amount of time on my hands. I've been doing a lot of other fun stuff. But what I am doing is I am working on a planetarium show with the planetarium. Wayne Schlingman is helping me, also Mike Stamatikos at the Newark campus, because Newark has a planetarium, actually, their science museum there has one that Mike Stamatikos helps to run. And we're building a planetarium show in the history of the Big Bang, not necessarily from a science point of view, but historically, how did the Big Bang model develop? What was sort of its origins?

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David Staley 17:36

So, like, the idea, the history of the idea the Big Bang?

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Chris Orban 17:38

Absolutely. And so, it goes back to kind of, you know, Einstein published his theory of gravity in 1915, and then in 1917, he started thinking about the cosmological consequences of that. But Einstein did not think that the universe was expanding, did not think that the universe could expand or that that would make any sense. And so, just from his own instinct, he sort of counted that out. But, it was people like George Lemaitre and Edwin Hubble, who convinced Einstein that indeed, the universe is expanding. And so, there's an interesting story behind all that, which will be a great planetarium show that I hope you'll watch.

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David Staley 18:17

When will we get to see the planetarium show?

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Chris Orban 18:19

We will probably unveil it in the fall, when the students get back. I hope it'll be done over the summer. But, I have a really nice visualization in that show that I made using the kind of simulations I did in my PhD thesis. So, I shouldn't say that I don't do any cosmology anymore, because I did have a lot of fun making what I think is a pretty interesting visualization of the Big Bang.

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David Staley 18:41

You say you've... well, you still have a hand in cosmology, but that you've moved on to laboratory astrophysics, and in particular, plasma physics. Tell us about this research.

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Chris Orban 18:50

Part of my research is with the Extreme Light research group at Wright-Patterson Air Force Base, which has either the most intense laser that the Air Force owns or one of the most, so they have a laser system out there that they're doing experiments on. Before you ask me if they're shooting down drones, no, they're not shooting down drones with it. It turns out that once a laser is above a certain intensity, it just ionizes the air, ionized air acts like a mirror, and so you can't... the laser doesn't go more than a few inches. So, you got to pump all the air out of the chamber and things like that. But there's interesting research you can do to try to accelerate particles up to high energies and things like that, try to make compact sources of radiation. Another research group I collaborate with, which is more on the laboratory astrophysics side - Anil Pradhan in the Astronomy Department, he is trying to understand, basically, the way that X-rays sort of bounce and propagate through the sun. And that turns out to be a very important problem for understanding the sun, there's still a lot we don't understand about the sun. And in 2015, there was a laboratory astrophysics experiment that told us that the matter in the sun is probably more opaque to X-rays than we thought it was. And so, that mystery is still essentially unsolved. And so, Anil is coming at it from a theoretical side of saying, well, how can... can we look at these theoretical quantum mechanical models and try to figure out are there reasons to think from a theory side that it should be more opaque? And then there's other people that are working on the experimental side, of what kind of experiments can we do to try to, to verify this conclusion so we can try to figure this what in the world is going on. You know, it's kind of embarrassing to have, you know, light shining on humanity for thousands of years, to have science be this advanced, and then we don't really quite understand what's going on in our own sun.

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David Staley 20:46

What is or who are the High Energy Density Physics group?

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Chris Orban 20:51

Yeah, the High Energy Density Physics group; it's me, it's people like Doug Schumacher and Linn van Woerkom - I don't know if you know Linn, he was Director of the Honors and Scholars program for awhile. And so, at one point, I was a postdoc in that group. And so, the High Energy Density Physics group is kind of our labs, the Scarlet Laser in physics, and also those of us that collaborate with Wright-Patt as well. So there's sort of, there's a lot of expertise in intense laser physics. I should also give a shout out to Enam Chowdhury, who's also part of that group, and he's transitioning from physics to, I believe in material science as a tenured professor, Enam is also a big driving force in Scarlet and that group as well. And so, we're all kind of working on similar things, although not exactly the same thing. And so, a lot of students come together for journal clubs and things like that, we use a lot of same codes. We have a reasonably sized group within the physics department.

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David Staley 21:41

Turns out you and I share a commonality in that we both host a podcast. Tell us about the podcast that you host for the STEAM Factory, I believe.

Chris Orban 21:49

Sure. You know, when I started at the Marion campus, you know, I had already bought a house in Columbus, because I bought a house as a postdoc, you're probably not supposed to do that. And so, I live very close to the Columbus campus here, I walked over this morning. And suddenly I was in the car for, you know, four, six hours a week, and I started just loving these podcasts. I mean, the "Serial" podcast came out, and, you know, "This American Life" and "Radio Lab", and all these things. And I just fell in love with it. And there's so many interesting stories that I heard that I wanted to get on tape. You know, it was that impulse that drove me to sort of ask the STEAM Factory said, well, can I have some help from interns to do something like this? And they, you know, when you ask people, sometimes they say yes, and they said yes. And so, the STEAM Factory has been very helpful in sort of letting me borrow interns for periods of time to work on these things and edit these things. And for a while, they were able to hire specifically journalism students. And I did not realize how amazing the journalism program is at this university, and every one of those students that we worked with was just sharp as a tack, and very helpful for getting the thing off the ground. So that's kind of my guilty pleasure of building that, and we've actually recorded in the same studio that we're in today.

David Staley 23:04

What's your podcast called?

Chris Orban 23:05

"Life, the Universe, and Everything". So if you go to the STEAM Factory website, you can sort of click around and find our podcast. It's available on iTunes, Google Play Music, Stitcher, Podbean, I think that covers it. Yeah, so if you search for "Life, the Universe and Everything", also, if you search for STEAM Factory it might be a little bit easier to find that.

David Staley 23:26

So tell us how you ended up as a physicist, what was your journey to becoming a PhD physicist?

Chris Orban 23:33

It's funny because, you know, when I was in college, all of my friends were changing majors. And I feel like most undergrads probably change majors about once, or maybe even twice - twice for you, David?

David Staley 23:44

Twice for me.

Chris Orban 23:44

C

Chris Orban 23:44

Okay, you're signaling over there. So I was one of those unusual kids, I never actually changed my major. I was... I started as physics, I finished in physics. And it was... it goes back to basically when I was about 12 years old and I was interested in science, I was reasonably good at math - I wasn't like this math prodigy or anything - but, you know, everybody said, oh, you should do engineering, you should do engineering. Well, I thought about it, and I went to one or two engineering camps; I was always fortunate to do so because my family could send me to those. And I tried the engineering camps, and I just didn't like it, I didn't like the making of stuff for the sake of making stuff. And I realized that the thing I was really interested in was, you know, the ideas behind it and the science behind it. So, it goes back a long way. I mean, my mom has pictures of me making space shuttles when I was a kid. I grew up in Florida, near Tampa, and the space shuttles would sort of like... when they're landing, they'll fly over Tampa on their way there. It's funny because, you know, occasionally, just out of the blue, there'll be a gigantic boom and you won't know what's going on until you think about it, like, oh, there must have been the space shuttle flying over. So I got to see two space shuttle launches when I was in high school, things like that, so maybe that had a little bit to do with it. It's always just been a dream of mine, and it's great to be able to be a physics professor.

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David Staley 25:05

Tell us what's next for you research.

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Chris Orban 25:07

So, I'm gearing up to do this recording we're doing in May. And so, I'm gearing up to train more teachers in how to do coding in their classrooms. So, we do online professional development - space is still available if you're listening out there - and so we do regular video chats with those teachers to get them up to speed on how to do this, because a lot of teachers were never, you know, were never taught how to code as part of their education. And so, we try to correct for that, and, you know, hopefully, we'll be able to do some detailed studies in the fall of how do students interact with these coding activities? What do they gain, does it change their STEM identity? We published a study on this last year with just some preliminary results from OSU, Marion, but we want to do an even larger study and try to see like, what really is the value of these activities, because you can't just put something in a classroom and just assume that it's doing better than what you did before because you feel good about it. You really have to get the hard data on what works. And a colleague of mine that helps me with that is Richelle Teeling-Smith from The University Mount Union in Alliance, Ohio. She'll be working closely with me to train those teachers in the planet studies and things like that. So, I'm excited about that. I hope that the students like the activities and it has a high impact, but we'll have to see what the data shows.

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David Staley 26:22

Chris Orban. Thank you.

C

Chris Orban 26:24

Thanks.

E Eva Dale 26:25

Voices from the Arts and Sciences is produced and recorded at The Ohio State University College of Arts and Sciences Technology Services Studio. Sound engineering by Paul Kotheimer, produced by Doug Dangler. I'm Eva Dale.