

Higher Ed Rewired
Season 1, Episode 7
“A Brighter Future – Students Build and Deliver Solar Power”
Host: Oliver Wong
Guests: Dr. Erik Helgren and Judy Botelho

Cal State East Bay students engage in hands-on learning by building off-grid solar power and lighting systems designed to alleviate energy poverty—a lack of access to modern energy services. These programs are introducing students to careers in STEM, engaging students in work alongside K-12 students in peer-led service-learning projects, and encouraging students to address energy needs across the globe.

Dr. Erik Helgren, California State University East Bay, Associate Professor and Chair Department of Physics & Co-Director, Social Impact Solar Program

Judy Botelho, Director, Center for Community Engagement, California State University Office of the Chancellor

AMBIENT SOUND

“Hi!”

Oliver Wong: It’s a sunny Saturday in October and we’re at East Bay Discovery Day. It’s a community science festival, started back in the 1970s at California State University East Bay. On this day, Davin [Day-vin] Benson and some other students preside over a bright blue box that looks a little like an oversized briefcase..

AX: Hello. Hi! So you wanna Wanna learn about the solar suitcase?

Woman: Sure.

Davin: So this is the solar suitcase...[fades out]

Oliver Wong: The boxy blue case is a solar power generator, what Davin calls the solar suitcase. It uses sunlight to charge a battery that can run a single light bulb for up to 20 hours. Davin and another student, Kevin Wang explain how it all works.

Davin: So here you wanna flip that switch. And There’s the light!** The power that’s going into that light is coming from this solar panel right now.

Kevin: It’s transmitting through the wire here into the charge controller.

Devin: And here Into the charge control...

[Little kid: The sun can charge that because it’s made to do that.]

Kevin: Exactly.

Davin: They’re called PV panels.

Oliver Wong: Students like Kevin and Davin master these solar power concepts in a class that applies science to address real-world problems. It's only halfway through the fall semester, and they've already learned how solar energy transformation and electrical circuits work. A few weeks ago, they practiced building these solar suitcases, knowing they would someday get shipped around the world...to help communities in places like Tanzania and Puerto Rico where electrical power isn't always reliable.

Helgren: Students, they want to see how they can apply what they are learning.
[MUSIC - POST AND UNDER]

Oliver Wong: Erik Helgren is a physics professor at Cal State East Bay who co-teaches the solar suitcase class.

HELGREN: They want to know how to be able to solve problems. And through the active learning, they get so much more engaged...and as they are learning by doing they are also then learning about how solar technology is a solution to today's energy problems.

[MUSIC - POST AND UNDER]

Oliver Wong: In this episode, a high impact way of making science, technology, engineering, and math classes more accessible and meaningful to students.. I'm Dr. Oliver Wang and this is Higher Ed Rewired.

[MUSIC POST AND UNDER]

[SHOW OPEN PROMO - POST]

Oliver Wong: Welcome to this episode of Higher Ed Rewired. I'm Oliver Wang - professor of sociology at California State University, Long Beach.

Oliver Wong: A student in college today has many good reasons to study STEM. A 2018 report from the Pew Research Center found that employment in STEM-related jobs has practically doubled over the last few decades...and college students who focus on science and math earn higher salaries, even if their job isn't in STEM. Here in California, our robust economy depends on a workforce educated in science and math but currently, there's not enough students going into these fields to meet the demand.

Dr. Erik Helgren, chair of the Physics Department at California State University East Bay has thought a lot about why that is, and this is where we begin our conversation.

Oliver Wong: So Dr. Helgren, you're the chair of the physics department at Cal State East Bay. I'm in sociology down here at Cal State Long Beach. And in my department statistics is the is a core part of our discipline, but it's only one required course for majors. But I can tell you from experience, that it is the one course that so many of our students are very intimidated by because they feel like they're not good at math. And I would imagine that as someone who runs a physics department, you likely run into students who say something similar to you all the time.

Erik Helgren:

Yes, absolutely. There is a stereotype out there that physics and math and STEM courses in general are extremely challenging, you know, but like every stereotype there's there's not that much truth behind it. This is something that we encounter. We talk about it as a faculty, we talk about it in the College of Science, and we look for strategies to make sure that we are welcoming in our classes, that we understand that people have these fears. And we try to make the classes as... approachable as possible.

Oliver Wong:

Do you have a sense of whether or not students are simply not interested in STEM classes or it's that they're interested, but they're afraid of them?

Erik Helgren:

It's definitely the latter. They they are interested. People are extremely engaged when they see what they can do with the science and the physics that they're learning that they can tackle real-world problems that they never thought they would be able to handle. It's just, I would say a confidence problem. Where students don't think they can do it. And we just have to get them over that barrier and show them that they can.

Oliver Wong:

Do you have a sense of what it is that they're intimidated by?

Erik Helgren:

I think I think it's really just a fear of their own failure, a lack of confidence that you know, in, in, in many K through 12 experiences, they've never really had the ability to explore in class and, and fail before. You know, as a scientist, you know, I try to joke with the students, and this is one of the things that I do when when I have an introductory physics class is, I try to make sure that they understand that I too make mistakes, I still make mistakes. I've been teaching this for 30 years and I'm still making mistakes and, and part of science is, you know, learning to fail and brush yourself off and get up again. It's really an inherent part of the scientific method of Hey, you set up an experiment and it doesn't work. You've got to troubleshoot it, you got to get it working. And that that experience of it's okay to fail is something that students I don't think experience before they get to that first physics class possibly.

AMBIENT SOUND

UNIDENTIFIED: "How are we doing here?"

STUDENTS: "We're troubleshooting."

Oliver Wong: Before the science festival, students spent weeks in the lab learning the scientific principles around how solar technology works from Professors Helgren and Katrina Garbesi [gar-BEE-zee] who co-teach the class. Then it was time for the students to put all that learning to the proverbial test...

AX: Student: We are assembling these solar suitcases. We just started it.

Chand: Building it. It's all right. It's a little confusing. But step by step we'll get there. First time so it's a little confusing but we'll get there...We already have the batteries..

Oliver Wong: Chand [chah-nd] Singh is majoring in environmental science. And for her , the decision to sign up for the solar suitcase class tested her confidence.

Chand: This was the most scary class I took for the semester. Cause it was physics in the name of it. And I've never taken physics. And I was like it's upper-division and has physics and so I just wasn't sure if I would have the credentials to continue. Um, it's just a new field. That's why I was kinda scared. And also, you're working with electrical objects. I could electrocute myself. I tend to be kinda clumsy...

Chand: You already have this step...we already did that...

Oliver Wong: Aletheia Tovera [Ah-leh-thee-ah Tovera] is also in the solar suitcase class.

Alethia: I'm taking this to fulfill some upper-division science requirements for GE...my upper division science requirement in sustainability specifically.

Oliver Wong: Like Chand, Alethia wasn't so sure about how well she'd do in a physics class.

Alethia: I'm actually really bad at physics and so I'm surprised I even enrolled in this class. But /// I guess I underestimated myself. Like I said, physics isn't my strong subject so I thought I was really going to struggle. There's still some things I might still struggle with but I'm still able to learn those things I'm having trouble with and remember it and put it into use.

Oliver Wong: Professor Helgren understands why students like Chand and Alethia are apprehensive. He thinks hands on learning experiences like the solar suitcase class can help students to push past those insecurities. Back when he was a college student in the 1990s, this kind of class wasn't even an option.

Oliver Wong:

I'm not going to ask you to age yourself here, but I'm wondering what was physics like when you were going through college as an undergraduate in terms of how was it taught?

Erik Helgren:

Yeah, I would say that. I am like no Professor I took physics with in my undergraduate or graduate career. The amount of physics education research that has been done in the past 10-20 years has been amazing. And I've been a strong supporter of bringing some of those advanced techniques into the classroom. Any sort of active learning that is going on in the classroom, Back in the day when I was taking physics, we had an old stodgy Professor standing up in front of the room. And he because it always was a he, practically would, you know, barely turn to face us and talk to us. He was writing on the chalkboard for 45 minutes and then we left the room.

Oliver Wong:

What are the ways in which you think that approach perhaps doesn't seem as effective with reaching today's students?

Erik Helgren:

Students, you know, they want to see how they can apply what they are learning. They want to know how to be able to solve problems and through the active learning, they just get so much more engaged. There are so many more opportunities to tie it into what sort of questions they are asking. They're like, Oh, Well, how does this, you know, tie into why the sky is blue? Or why we see a rainbow or something like that things that they've always wanted to know. But, you know, the, the, the going back to the first question you had, which was, you know, what, what is making them fear being in a science class, you know, oftentimes in K through 12, they're told, you know, just, you know, listen to the professor and regurgitate what they tell you to say for the test. And, you know, don't think outside the box. I think a lot of that is changing now with Next Generation Science Standards and the Common Core that is going to bring possibly more prepared and better prepared students who are better thinkers coming into college. So I think there's good hope for the future.

Oliver Wong: One of the things that you've become known for is your solar suitcase class. Can you first of all, can you just describe what is a solar suitcase?

Erik Helgren:

Ah So what is the solar suitcase? The solar suitcase is a small off-grid, portable electronic power supply it is literally packaged into a small plastic blue suitcase. ///This solar suitcase was developed by our partners that we work with, a nonprofit company, We Care Solar, The goal of that nonprofit was to provide every single maternity clinic in Sub Saharan Africa with their own electric supply system based out of the suitcase so that mothers would never have to give birth again in the middle of the night when it was dark. And we realized early on that this suitcase, in learning about it, had extremely beneficial educational properties to it -- meaning basically that you could teach students here at Cal State East Bay or any, you know, middle school, high school or college level, some basic information about how solar powered electric energy works. And so, the We Share Solar Suitcase ended up being an offshoot that was designed specifically for teaching students at all levels, how to develop an off-grid electric system.

Oliver Wong:

We were talking a little bit earlier about the kinds of physics classes that someone like you or me might have taken when we were undergraduates back in the day and I'm wondering, how does the solar suitcase class — how is it similar or different from some of those older traditional physics classes that students would have taken, let's say a generation ago?

Erik Helgren:

Well, it's completely different than many classes that are even taught today. We teach this class entirely in a lab classroom, meaning that every single meeting pattern we are in that lab classroom. /// There is a lab a hands-on activity that we are doing in each one of the sessions, from learning how basic circuits work, learning about energy transformations and the basic physics of those ideas. To the days when we're building solar suitcases, we have students build electric switch boxes, so that they know how their own electric wiring is working in their home to more advanced labs, where they're learning about solar technology and playing with solar panels and testing their voltages and currents. That's something that never would have happened, you know, sort of back in the day in the traditional physics class. ***So it's this hands on active learning that students are... well, number one very fearful of in the beginning, but then it's one of the aspects that they really fall in love with about this class. And as they are learning by doing they are also then learning about how solar

technology is a solution to today's energy problems. /// So it's that merging and mixing of hands on activities, lab based learning, seeing that they can actually do it that I think makes this class very popular with our students, and is the type of class that I think is can bring more students into a science and technology type field, a gateway type class.

Oliver Wong: One of our producers visited your class on a day that students were assembling the suitcases themselves. Can you describe what was happening that day when students were working in the lab?

Erik Helgren: Yes, absolutely. So at that point that was about middle of the way through the semester, we had taught students how to build simple circuits and use digital multi meters to check that currents were flowing, voltages were live across wires and things like that.

AX Student: That one says positive and this one says negative. You see it? On this edge?

Erik Helgren So they had learned the basic understanding of how circuits worked and how to use the tools that are necessary to understand and troubleshoot what's going on in electrical systems....

AX: Student: Let's go back to the diagram...The big one?

Erik Helgren: And at that day, we basically brought out the blue suitcases. And I love this one image that, you know, in the manual, they show this picture of the suitcase opened up with all the parts laid out. And I love to call that sort of the, the IKEA model that, you know, here's all the parts to the thing you have to build. And it looks very daunting, but that's what the students start off with is they get all the parts out, they check that they have all, you know, hundred or 200 of the wires and the bolts and the nuts and everything that are going to have to go into building the suitcase from scratch. And they follow through the manual. And by the end of the day, like every good physics class, this is you know, just like back in the day, there's still a right and a wrong answer in every physics class.

Erik Helgren: The whole goal of this thing is to get lightbulbs on, right? So go ahead, plug it in.

Student: Hey here we go!

Althea: Nice

Erik Helgren: The light bulb came on and so you got an A.

Erik Helgren: And so it's literally a light bulb, aha moment that the student realizes, oh my god, I was able to do this. I was able to get the right answer in a physics class.

AX: Student: "The light bulb should light. Hurray! We got a light bulb to light. It only took a few hours...."

Erik Helgren: And I always have my camera ready, because I still love taking the picture of the students when they first turn on that light bulb after building a suitcase for three hours, and the right answer turns on and the expression on their faces is always priceless.

Erik Helgren: And, you know, it's not supposed to be straightforward. And this sort of circles back around to the question you were asking way at the beginning, which was, you know, what do I think is one of the biggest problems, why students might feel that a physics or stats class is hard to do, is because they're not used to failure. And so, in the solar suitcase, there inevitably are, you know, 400 steps that they have to follow in order to build this. They're going to get a few things wrong, but you know what, it's okay. Because part of the scientific process is failing, learning from that mistake, fixing it and moving on.

Oliver Wong: The East Bay Discovery Day Science Fair is one place where students get to translate their new found knowledge into action.

AX: Child: But how much sun? You need to have a lot of sun, right? What if it's a cloudy and windy day??

Davin: Without any shade it's .8 amps. These only take .35. So it's been running this and charging the battery at the same time [Fade out]

Oliver Wong: The service learning part of the class is a big draw for students. Computer science major Davin Benson says the best way to learn something is to teach it.

Davin: ***I really like the service-learning component of this class - having to go out and get involved in the community in some way. It really helps cement this stuff as important and ties it in with you a lot deeper than just: here's a class I'm taking for a grade. /// I definitely am really enjoying this class I would say more than my other classes. But I'm really glad that I took this class that's for sure.

AX: Enjoy the rest of the fair!

Judy Botelho: I often talk about that service-learning really replaces a textbook. And so students are doing community service as part of their academic study.

Oliver Wong: Judy Botelho [Bo-Tehl-oh] is director of the Center for Community Engagement at the California State University Office of the Chancellor. Her job is to support service learning across all 23 CSU campuses.

Judy Botelho: Service Learning allows students the opportunity to really grapple with some really hardcore decision making allows students to engage in a way that allows them to say, my voice matters. My questions are not dumb. And it's okay, if I don't know right now.

Oliver Wong: I think you've been involved in some of the research that's beginning to look at whether or not the incorporation of service-learning is actually helping to improve people's matriculation rates, graduation rates, and staying within the majors as a consequence.

Judy Botelho:

Yes, we just completed a three-year system-wide study on STEM service-learning courses. And while our sample size was small, so I don't want to overstate our findings, we are really excited to see that in particular graduation of first time freshmen for our traditionally underserved student population. So African Americans, //Hispanics, and Native Americans, that their graduation rates were higher for those students who took a service-learning course than those who did not.

Oliver Wong:

I would not have intuitively thought of service learning as being incorporated into STEM. And I think partly it's because I might have some of that traditional mindset that science classes take place in labs as opposed to out in the world. And so I'm wondering, was there a period or portion of time where you had to convince both students and faculty that this can work and that this would actually benefit people across the board?

Judy Botelho:

Oh, most definitely. We're still struggling with this. The first thing and the most often thing I hear from STEM faculty is this is scary. And I'm going to lose a lot of my curriculum and what I need to teach, I have such a massive amount to teach in a short amount of time and now you want me to add this, it's not possible. And what they realize much like I would say any student is that by the end of the semester, or the second time they teach it, what they have given up is nothing compared to what has been achieved. Faculty, we talk a lot about students needing to fail and to not be penalized. Well, I would argue the same needs to be true for faculty.... And I think we need to allow that space and growth for these type of experiences to occur and for faculty to get comfortable and to hone in because it's not going to be perfect. I think that is scary for STEM faculty in particular. Now again, this is where the CSU I think is so wonderful and that we do have service learning offices on each of our campuses because they do have support there. And we do have faculty who have been teaching this for a long time. And they are a support to faculty to say, it's going to get better. And here are some other things to try. And I think we do that really well in the CSU. But I really can't stress it enough that if we want to allow students the opportunity, that failure will lead to success, and you need those failures, we need to also have that message for our faculty.

Oliver Wong: I think that's a really, really great point. And as a faculty member, I can certainly understand some of the trepidation or concerns around that.

Oliver Wong: I'm going to now turn our attention to the kind of current and immediate future of some of the programs that you're trying to implement across the system here. If one took a snapshot of how service learning is currently offered in the CSU, what you would likely notice is that much of that, if not all of it is currently offered primarily in upper division classes. What difference Do you think it would make if more service learning was integrated into lower division classes?

Judy Botelho: I have... argued that we should not wait in STEM disciplines for service learning to take place in the upper division, that if it happened earlier, we would be providing students with that opportunity to make those connections earlier, to recognize the importance of the work that they're doing in the lab. And they start getting those early research skills and those early research methodologies that are so critical.



Oliver Wong: Professor Helgren at Cal State East Bay agrees. He says that offering these classes earlier could help solve a known problem in science education: it's known as the leaky pipeline, a phenomenon where students start out excited by science and math but eventually drop away..

Erik Helgren: And that pipeline is leaking from, from the bottom to the top./// And it's really unfortunate because when I volunteer in my kids' classrooms, in sort of the K through 12, middle school, elementary schools, there are as many girls excited about the science that we're teaching as compared to boys. But by the time these students reach college, and they're choosing their majors, not many of them are continuing on into physics. I think that's something that we're certainly cognizant of, and we're working on. And I think it ties back to what are the types of classes that we're going to be teaching and how do we teach those classes so that we are not contributing to the leaky pipeline and we could even possibly rectify that leaky pipeline. So that underserved student populations, women in physics, they come back into the fold, they come back and start taking those majors more and more in the future.

Oliver Wong:
You've touched on this a little bit, I think just now. But what are some of the consequences of the leaky pipeline if it's left unchecked or unaddressed?

Erik Helgren:
Well, I think you have, you know, the problems associated with implicit bias and you know, a small population of people that are, you know, doing all of the work, then you don't have the diversity of voices that are contributing to solving some of the world's biggest problems. We have climate change. We have fundamental physics problems. We have fundamental ideas that we need to develop as humankind in order to understand the universe around us. And if we don't have that variety and diversity of voices, we're losing out on some of the best possible ideas.

Oliver Wong: Dr. Helgren has been teaching the solar suitcase at Cal State East Bay for the last few years. He knows of many students who've gone through the class and how they've been impacted by the experience. He even keeps a collection of snapshots on his phone of that "aha" lightbulb moment that happens in the lab. But there's one student in particular who stands out in his memory.

She was the traditional, tentative, not confident student who developed the skills was able to get the light bulb to turn on, had that aha moment. And in her evaluation, I was really pleased to read that she stated all these things that she was not very confident coming in that, you know, we were a supportive team, Dr. Garbesi, and I teaching physics in a way that she could certainly understand. And the labs helped her to learn that by doing it by hand, and then by the time she was done, we had one event where she had to talk to the Cal State East Bay President Leroy Morishita and explain how the solar suitcase was working. And he said, Oh, that that totally makes sense -- totally understand now -- And she was thrilled that she was able to talk to the president of Cal State East Bay and explain how the solar suitcase went. And that's when she wrote her eval at that point that said, you know, she considers herself now a woman in STEM because she understands the science of solar technology.

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Oliver Wong:

That's Dr. Erik Helgren -- Associate professor and chair of the physics department at Cal State East Bay. Earlier, we heard from his solar suitcase students as well as from Judy Botelho, director of the CSU's Center for Community Engagement.

[THEME MUSIC - POST AND UNDER]

Oliver Wong:

And that's it for this edition of Higher Ed Rewired. We'd love to hear from you about educational innovations you'd like us to discuss on the podcast. You can reach us by email at graduation initiative at cal-state dot e-d-u. That address is also on our website at higher-ed-rewired-dot-com.

OW

I'm Oliver Wang, and from all of us here at California State University -- thanks for listening!

[THEME MUSIC]

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