

Dead Ideas in Teaching and Learning Podcast Series

Episode 3: Dead Ideas in Science Teaching with Carl Wieman

Center for Teaching and Learning, Columbia University

- [Catherine Ross] Hello, and welcome to Dead Ideas in Teaching and Learning, a higher education podcast from the Center for Teaching and Learning at Columbia. I'm Catherine Ross, the Center's Executive Director. Let's get started. I'm speaking remotely today with Dr. Carl Wieman at Stanford University. Dr. Wieman is a 2001 Nobel Prize recipient and holds a joint appointment in physics and education at Stanford. He is also a member of both the National Academy of Sciences and the National Academy of Education. In 2004, Dr. Wieman was the Carnegie Mellon University Foundation Professor of the year, in recognition of his contributions to education. He's the author of 'Improving How Universities Teach Science: Lessons from the Science Education Initiative', which showcases his extensive research into evidence-based practices. He has also recently published on the topic of teaching expertise and its impact on improving science education. Welcome Carl.

- [Carl Wieman] Thank you. Nice to see you at least virtually here.

- [Catherine Ross] Yes. Yes, in fact, we started this podcast series before this pandemic drove us all out of our classrooms. And today here we are recording our conversation remotely as we try to figure out how to use technology to teach remotely. We still intend for this series to be a place where we explore untrue ideas that are widely believed and that drive systems and behaviors in the academy, the phenomenon that Diane Pike called, "The Tyranny of Dead Ideas." And yet, we have to acknowledge that we've had this massive shift in teaching that is ongoing as we speak. So, to that end, how are you? How are you handling this transition?

- [Carl Wieman] Well, you know as somebody who now studies a lot about how the brain functions and works, I'm getting reminded of the issues of cognitive load, and it's reminding me how helpful routines are, when you can just follow without thinking. Right now we change everything. You've got to pay attention to so many different things that makes life so much less efficient. So, it's kind of a good reminder with the dead ideas that if you want people to change, it involves a lot of mental effort.

- [Carl Wieman] It does. I think everybody's struggling with cognitive load these days just trying to process though, what would typically be mundane tasks.

- [Carl Wieman] right.

- [Catherine Ross] Have you sensed that with your students as well?

- [Carl Wieman] Yes, . I just say the ideas. I mean, just being in class and participating it's, there's a wide variation in how students respond, what they do, and everybody's trying to sort

it out. Getting back to the dead ideas and teaching though, I think the same dead ideas that sitting there talking to people is going to, in effect, a way to help them learn. That's still present, and there is still the challenge of convincing them that having students much more actively involved in processing and doing thinking is better for learning, but it is opening up that discussion in a new way, I think. Because people, even the most hardcore believer and what a wonderful lecturer they are, has to recognize at some level that, students sitting there listening to them on a computer screen that's displaying 17 other more interesting things for the students to do is not likely to be very effective. So, it is opening up some interesting discussions I think, and more so to see how it plays out.

- [Catherine Ross] So in a way, it has amplified the message that you've been trying to get across that these are not the best ways for students to learn and that it has put some pressure, additional pressure on faculty to consider changing how they teach.

- [Carl Wieman] Yeah.

- [Catherine Ross] It's not just technology implementation, right?

- [Carl Wieman] That's right. I mean, to a large extent I think that those of us who are working on it and thinking about, the technology allows most of the good things to happen but you have to be more deliberate about it. About how to have the students interacting together more effectively, but in the same way you have to think more deliberately about that. It also makes the things that if you don't think about the evils or data, negatives are just magnified more. So it's kind of amplifying or magnifying everything and it'll make for some interesting discussions, I think. And I think also what we don't have in the past is, really wide spread feedback from students on these methods. And I'm curious to see how that's going to play out, actually.

- [Catherine Ross] Yeah. So, will you be collecting the student experience in some way at the end? This one is still open for debate as it is that at many universities.

- [Carl Wieman] The reason I'm laughing about this, is the standard schedule was such that we were suddenly thrown into switching from in-person to online for the last week of classes on two days notice.

- [Catherine Ross] Oh, dear.

- [Carl Wieman] So that's not very useful data.

- [Catherine Ross] No, no.

- [Carl Wieman] But the upcoming quarter, everybody's doing it. And, of course in my own course, I'm gonna be collecting data, but I'm looking at, my research group has been talking about, gee, this would be a good opportunity for us to really do a very large scale test. And so then it's a question of how much the university is going to buy into this. So, this gets me to

another dead idea. Which is the idea that there isn't really teaching expertise, it's kind of all up to individual faculty. And so there's no reason to kind of do a systematic, careful measures of how effective the teaching is, to optimize it in the same way you would do like with medical treatment or so many other things. And so, right now we're kind of trying, we, being me and my research group, trying to see how much progress we can make in convincing the Stanford University administration that, look, you've got all these different courses, all these different teaching methods they're gonna make wildly different results, you need to think about collecting data in a systematic way and use that to guide what people are doing.

- [Catherine] Yeah.

- [Carl Wieman] So it's unknown yet, just how much progress we're gonna make.

- [Catherine Ross] Well, I think the problem always with evaluation of teaching, and I think you've pointed this out in your writings, is that you're conflating, yes, we want the information about the student experience but then it gets used to somehow become the metric for evaluating teaching which is problematic especially in a situation like this.

- [Carl Wieman] Yeah, that's right. It has problems in all different ways. It's certainly useful to have that, but it's much more useful to have students actually learn, but they go on to life to do with .

- [Catherine Ross] Right, right, right. So stepping back in time a little bit, why did you feel like it was so important for you to turn your attention from just physics, but I don't mean just but physics. I'm sorry.

- [Carl Wieman] Yeah.

- [Catherine Ross] Are there problems and challenges of helping universities teach science? Could you sort of walk us through that? What ways are your thinking?

- [Carl Wieman] Yeah, it's a 20 year blog but I'll try and keep it a little bit shorter. Yeah. So, a lot of this didn't have anything to do with my classroom teaching. It really started with my physics research and working with the graduate students in that, and realizing that these students could do really well in all the courses. And then they come in to work in my research lab and they were pretty clueless about how to actually do research. And the ones who had done the best in all the tests and exams, almost... Well, never turned out to be the best physicists, the most successful researchers. And so, after I saw that happening enough times and I also then did a very systematic, being a... I'm always been a good experimental scientist. I did a very systematic analysis of the graduate admissions, folders, and sort of looking at what predicted who was gonna be a successful physics graduate student. And, there just wasn't anything. And so it made me think that, gee, there was something different going on here. And so I just started treating it as a science problem of, okay, what do we know about how people learn? How they learn physics, learn to do physics, and reading the research literature on that. And

after some years of sort of seriously pursuing this, realizing, well, we did know quite a bit about learning, we particularly knew quite a bit about learning physics at the university level. And that explained this puzzle, which said that, there was a completely different way to think about what people learned in courses, but also a completely different way to think about teaching and what was most effective. And that I could also start doing experiments and teaching and learning physics, at the same time I was doing research on with the atoms and lasers. So, that sort of got me into that. That was 30 years ago. And then I continued in that work and I was interested in it. After I got the Nobel Prize, people paid a lot more attention to me.

- [Catherine Ross] Funny enough, right?

- [Carl Wieman] Yeah. Not that I knew anymore or was more competent. But then I reached the point where I was, you know, there were literally hundreds of individual experiments in a individual course, science courses, sort of showing these methods work better, often much better. And so that to me, it was just kind of thinking about, okay, what's the next step of this being more broadly used? Just doing more individual experiments is not gonna make a larger scale change. And so that was the idea. Then I need to do the experiment of scaling it up to universities level but with the science education initiative and seeing, could you change entire departments? And that was a decision where I recognized that there just were very few people, if any, who were in a position to do that other than me. Because of, frankly relevant or not, attention. You know that all about Nobel Prize I got and my background experience in this and so on. And so that led them to that study of essentially institutional change and experiments in that.

- [Catherine Ross] So your regional aha moment was with grad students coming into your labs and not being what you would consider sort of lab ready, in terms of the way in which they were trained in physics?

- [Carl Wieman] Yeah, my work is, and the way I looked at this, really forever is, from the perspective of that nature of expertise of how do people who are experts... And I don't mean extraordinary, I just mean, like a practicing engineer or a scientist, or a good medical doctor, how do they think and function, and then how do they learn to do that? And so that goes to all the way back to working with my graduate students to kind of, how do they make decisions in solving these kinds of problems and how does one learn to make these kinds of expert decisions?

- [Catherine Ross] And so that then kind of focused some of your work on undergraduate science education, because that's sort of the beginning of that path?

- [Carl Wieman] Yeah, that's exactly right. And as I said, I was so then particularly pointed that direction first because I did teach and I felt some commitment to that. But then also it was because I had these graduate students who could do spectacularly well in all these undergraduate courses and it didn't really seem to give them any physics expertise at all.

- [Catherine Ross] Wow, that's so interesting. So you probably pretty quickly encountered a whole bunch of dead ideas in that work and ongoing work that you've done since. What... What factors do you see? I know you've mentioned that it's been very difficult to convince people to change, but what are the things that keep people entrenched in their dead ideas versus that might help people change these beliefs other than, you know, a pandemic?

- [Carl Wieman] Yeah, I've come to see that the most fundamental dead idea was one that I certainly had too, and really, to me, it was only kind of looking at data quite extensively convinced me otherwise, which is the idea that the brains are kind of, come in pretty much fixed. And education's about taking the brain with what capabilities it has and giving it knowledge. And it was, my looking at my graduates and looking at graduate admissions convinced me, no, there was no way to predict, in other words, there was nothing I could measure about that brain that said, what was going to be different and realizing it was actually after I got the graduate school and who it had interacted with, and so on, that the brain was actually changed, the educational process was about developing, that brain, okay? And so that's a very fundamental difference that frankly it's hard for people to accept that. I think there's some basic work in psychology where they talk about the fundamental attribution error. Somebody is doing something and it's wrong, that it's something wrong in them and it's not, you know?

- [Catherine Ross] Right.

- [Carl Wieman] Rather than realizing, no, there's a lot of external factors that come into play here that are important and so on. And you see with, discussions with Bagley all the time, it's always very quickly switches to the characteristics of the students and that being determining how successful that is as opposed to what they're doing and the teaching process that's helping or not helping those students develop capabilities. Anyway, that's a really fundamental thing and so what helps and convinces people is, is they have to see about or at least what we've seen is most effective. The instructors, they have to see in action where that's wrong, that they see that somebody else teaching their students where they're in their department and so they don't have any excuses for something different maybe in the same course they've got, and see that, gosh, the students are behaving completely differently, and the students are much more engaged but they're also learning and they're capable of things that are far beyond, what the faculty thought was possible. And so that's what we've seen now. That's kind of a slow painful process to have.

- [Catherine Ross] Yes.

- [Carl Wieman] And it's kind of funny because these are all scientists who are supposed to believe in data. Well, data on learning doesn't nearly convince them as much as seeing a student they knew be transformed in a new way. That they're human beings first and they respond to individual humans, stories, and actions better.

- [Catherine Ross] That's really interesting. Diane Pike's first dead idea that she talked about was the idea that students just aren't as prepared as they need to be, or as they used to be. And this notion that faculty always tend to blame the students without ever thinking about how they might be doing things differently to engage those students. So I think that sounds like you just experienced that in its full effect.

- [Carl Wieman] It's actually kind of amusing this discussion about students not being as well prepared or not being as good at work habits or any of these things. This comes up almost every time I give a talk about these subjects to faculty which... So that's maybe a hundred times a year. And it's kind of funny because you can actually look at the record and the written record of teachers complaining about students not being as well prepared. I think it goes, I think they can trace it back to Socrates. Pretty much, pretty much the invention of writing is when it's first written down. So, I've actually come to see that there's sort of a fundamental bias in the way people function that always makes them see people who are different are in some ways less capable because it always magnifies that the positive differences and minimizes the negative differences. So there's always this tremendous bias but it is so funny how it's just always such a common thing even when it's so obviously not true.

- [Catherine Ross] But, and that's very powerfully connected I think, to the, your recent article, 'Expertise in University Teaching and the Implications for Teaching Effectiveness, Tvaluation and Training'. When you arguing that in addition to disciplinary expertise there is this thing called teaching expertise. And, further against all prevailing beliefs, it can be taught and it can be learned. That's even a harder push, I think.

- [Carl Wieman] Yeah, although it's coming along. Like I said, the science education initiative at UBC in Colorado, it wasn't the only model, that was an extensive way to do it, but it was an experiment. And the fact that we were able to make very widespread change, entire departments, does say that if you set up a system that really is paying attention to these things and rewarding it, it's not trivial, but it's very possible. We had lots of departments where it worked quite well so it's not like it's an enormously difficult problem but it is something you do have to take it seriously. And it's a substantial shift in attitudes both faculty and the administrators.

- [Catherine Ross] So, is that related in some ways to another point you made in your article about how teaching gets evaluated in the academy? And you talked about that change in attitude and valuing of this work?

- [Carl Wieman] Absolutely. I mean, the evaluation of teaching is for so long, just been essentially student popularity. It's not even student popularity, is students popularity compared to other things they've seen which is so fake, seeing nothing but really bad teaching. Well, if it's a little, not quite so bad, they'll think it's great, you know? And so, whereas research now is such that, there's really no excuse for not saying, look, we have lots of reasons, saying these practices lead to better student outcomes. That faculty members should be evaluated on how

well they know about and are employing these methods, in the same way we certify doctors, right?

- [Catherine Ross] Right.

- [Carl Wieman] 1830, it was just fine to declare yourself a doctor and do whatever treatments you wanted. Now, we expect that you have to know certain things. You have to know what the best treatments are, to be allowed to practice medicine. And we just have to recognize that we've reached that point in teaching at the university level but it takes some pile to make these changes.

- [Catherine Ross] I hope you're ready to work another 30 years on that one.

- [Carl Wieman] I'm trying to survive the pandemic just like everybody else, first.

- [Catherine Ross] Yeah, exactly, exactly. Oh my gosh! This has just been a fascinating conversation and I just wanna thank you so much for being here or should I say being there?

- [Carl Wieman] Yes.

- [Catherine Ross] And talking to us across timezones.

- [Carl Wieman] Yeah, well, it's been a pleasure. And I hope that technology all works and so lots of people stuck in their houses will get to listen to it.

- [Catherine Ross] If you've enjoyed this podcast, please visit our website where you can find any resources mentioned in the episode, ctl.columbia.edu/podcast. Please like us, rate us, and review us on Apple podcasts or wherever you get your podcasts. Dead Ideas in Teaching and Learning is a product of Columbia University Center for Teaching and Learning, and is produced by Stephanie Ogden, Laura Nicholas, Abie Sidell, and Jon Hanford. Production support from Kate Tighe-Pigott. Our theme music is, "In The Lab," by Immersive Music.