2019 Medals and Prizes - Interview with Robert Mann, Recipient of the CAP's 2019 Medal for Excellence in Teaching Undergraduate Physics, September 2019 (by Daria Ahrensmeier)

Interviewer: Hello, Robb. Congratulations on your teaching medal!

Robb Mann: Thank you.

Interviewer: Before we talk about your current teaching, I want to ask you about something interesting I learned about you this week. I heard that you taught high school.

Robb Mann: A long time ago, yes. I was a supply teacher. It wasn't full-time, but in the 1970s, I did this. I supply taught science at several high schools in Burlington and in Hamilton, Ontario.

Interviewer: And did you enjoy it?

Robb Mann: Mostly, yes. I was only a little bit older than the students themselves. And the ones that knew it (or rather figured it out) would push back. But I managed to hold my own. It was different in different schools. The best experiences were when the teachers had clearly laid out lesson plans that I would follow. And I actually like high school students. I mean, when I was teaching it wasn't too much earlier that I was one. But it did give me some insight as to how they think. And there was a huge spectrum of thought and attitude. Sometimes as a supply teacher, although I was mostly called in to do science, on occasion I had to be called in to do something else. The most awkward one was when I had to do a grade nine art class. That was really out of my comfort zone — basically I just maintained the class. But in the science classes, I actually did teach. I would not do just one-shot classes — sometimes I was in for four days in a row or even a week. I think that happened a few times.

Interviewer: You were a student at the time?

Robb Mann: I was an undergrad at the time. I began halfway through my undergrad years, and I did it all the way through to the end of my PhD. And then, I didn't do it anymore.

Interviewer: Speaking of art classes, another thing that I learned about you was that somebody said you had acting training.

Robb Mann: Yeah, I haven't done that for a while. But I did for about six years in a row, I acted in local community theater, yes. So, I played the Grinch in *Seussical*, and I was Mr. Darling in *Peter Pan*. And… yes, so I did some of that, that's right.

Interviewer: You must have enjoyed that, otherwise you wouldn't have done it.

Robb Mann: Certainly, at the beginning! I guess I'd say overall, I still enjoyed it. At the beginning, it was very novel. I hadn't done it before. After about six years of it, it had an element of repetitiveness. And I was going on sabbatical. After that sabbatical, I didn't return to it to the extent I've done it. I've been singing in choirs instead. Acting in a musical is considerably time-consuming. At first, it's a weekly commitment but two weeks before the show is on, you're basically in three hours every night in final rehearsals and it's very time-consuming. And that's partly why I didn't go back to it. I'm not saying I'll never do it again, but, you know, there are people a lot more talented than me that do it.

Interviewer: Did you take anything from your acting experience into teaching?

Robb Mann: Well, yeah, and probably vice versa. Pacing would be one aspect. In acting one of the key things that matters is timing and pacing. It translates a bit differently when you're in front of the class, but nevertheless it's still helpful. When you're acting, the director doesn't like dead space — that really bores an audience. The audience doesn't notice it, but as soon as a character says a line, the next character needs to come in with their line, unless of course there's some other thing that happens. But dead space — vacancy between lines — seems huge to an audience. And to some extent, I think that's true in a classroom. You've got to balance your speaking. On the one hand, students need time to reflect, so you want to put in the necessary pauses. But you don't want to go too slow or too monotonously. So I would say that pacing and timing are probably the main thing I have taken from acting into teaching. [Pauses] And fun and being a bit comedic and all that kind of thing, right? But I was doing that long before I was acting, I guess.

Interviewer: Is it a personality thing too?

Robb Mann: It is partly, yes. That's right. I mean, it's fun to be in front of an audience. That does not bother me.

Interviewer: That's probably helpful.

Robb Mann: It does help, yes.

Interviewer: Did you take anything away from the high school teaching, or did you change very much how you teach?

Robb Mann: Well, I mean, as the students get older, they're more mature … and in university, they want to be there. The main thing I take in either case is that when students ask questions, I always try and turn the question into something useful in the class instead of give the impression that's a stupid question. And often, students know more than they're able to say or to ask. This comes with experience, but I suppose partly in high school and certainly in early years of university teaching, they're not asking the actual question — they're asking what is often a good question but in a very obtuse way, or they don't quite know how to articulate it. So what I usually try and do is I say, "If I understand you right, I think you're trying to ask about X, Y or Z." And almost all the time, they say "Yeah, yeah, yeah, that's right!" So that part helps. It's also true, I suppose, of anybody, but with younger students, they don't know how to formulate their questions very well yet. They have the right intuition more than they have the right level of articulation. That's what I found. Of course, there are exceptions, but almost always you can turn a weak question into a good one or at least a reasonable question. That's one thing I got out of high school teaching.

I think one of the most important things is to try and help the students walk through the subject from their point of view, from where they are beginning.

Interviewer: In your talk, when you received the teaching medal, you talked about teaching young students as well as more experienced students, grad students, and up to faculty, things they have to learn. For somebody who didn't attend your talk, what would be the main message that you would want them to get?

Robb Mann: Well, I would say I think one of the most important things is to try and help the students walk through the subject from their point of view, from where they are beginning. And I would say when I've made mistakes and when I've seen other teachers make mistakes, they're either assuming too much prior knowledge or they're not assuming enough prior knowledge. Usually it's the former but sometimes it's the latter. And it does take a bit of energy, but with experience, you get used to it. Of course, schooling has changed a bit … I don't deal with children very much to the extent I have in the past, when I've taught Sunday school. But you know, when I teach an eight-year-old kid, I ask myself what did I know when I was eight? It's where you are coming from — ask the student what did you do recently, what are you doing lately? And then I calibrate my knowledge with them, or with the general public.

For example, I usually say, "You probably understand planetary motion to be like this," and I'll make movements with my hands or something. I try and find common ground with whoever I'm teaching and then I get them to branch out elsewhere. That's what I mean by starting from their viewpoint. I think certainly with individuals, that's the best way to do it. In a group of course, not everybody is at exactly the same place, though statistically most of the class is at the same place. And I guess the fact that I came through the Canadian system, the Ontario system, that also helps. So that would be the main thing. Begin with the science the person knows and help them move from there.

Interviewer: Another thing you mentioned was that you're training future scientists.

Robb Mann: Yeah.

Interviewer: Do you see everybody as a future scientist? Do you try to achieve that for students who, for example, are taking a service course?

Robb Mann: Well, to a certain extent, yes. I'm teaching engineers this fall, so they're not going to become scientists. But to a certain extent, I would hope a person taking one of the courses I've taught would understand something of what it is like to be a scientist, to think like a scientist, even if they're not going to become a scientist. And I try to have good expectations for that. A lot of teaching I've done in first year was for students who are going to be scientists, chemists, biologists, some earth science, some in math or computer science. I include mathematicians — they're not exactly scientists but they're close enough. With engineers, it's a bit different but, in some sense, engineering is applied science.

When they are people in the arts disciplines — and I have done a little bit of teaching arts courses at the University of Toronto and in Waterloo — then I know they're not going to be scientists. But I try to give them a little bit of insight: "This is how scientists think about a problem." And I do that with the general public as well. I'm not trying to get them to be like me, because I know they're not going to be. But I do try to get them to see what it's like to be that kind of person, I guess. Here is where the drama comes in. When you go to see a drama or watch a movie, what makes a drama good is when

you can see something from a particular character's viewpoint. I think for the people that are not going to become scientists, it's the same kind of thing. How can you understand this subject from their viewpoint to the extent you are able? Whereas for the aspiring scientists the technical skill is also very important. That matters a lot. That doesn't matter as much for people that are not going to be scientists.

Interviewer: So, it sounds like when you're teaching, you're trying to understand the people that you're teaching —

Robb Mann: Yeah.

Interviewer: —to make progress. But on the other hand, you also want them to understand you better.

Robb Mann: Well, to understand the viewpoint — I don't want to say "me", I mean a scientist in general. But to some extent, me, because … I'm not every scientist, of course. Scientists have their own personality spectrum. But there are things they value, they look at the world from a certain viewpoint and it's a very valuable viewpoint. And they all share this in common. I would hope that those who are not in the sciences, even if they don't want to adopt a scientific viewpoint, can at least perhaps understand how and why others do. I think that would help a lot instead of being fully repelled by it.

Interviewer: Definitely. A population that would be pretty close to being a scientist would be grad students. You mentioned that there's very little research done on how grad students learn.

Robb Mann: Well, there seems to be little. I could find one paper on how they learn. I found a number of papers on their attitudes to teaching.

Interviewer: Do you have any ideas on how to support people who want to study how grad students learn?

Robb Mann: I have several ideas. Someone should write a PER proposal on doing studies of how grad students learn. The study I saw was consistent with my own experience: grad students cross conceptual thresholds. I've supervised a lot of grad students now … if you count research students, if you include undergrad summer research, I've supervised on the order of 120. From this database I have (informally) found that there is a maturing process. A PhD student in the second half of their program will, if they're doing well, cross a threshold of scientific maturity where they just somehow intuitively know how to do better. Every now and then, there's one that doesn't make it, but most of them do.

This needs patience. I often find supervisors want their students to be more mature than they really are. And I think if we overemphasize that expectation, there's a high probability that a grad student will never reach the state of scientific maturity and competence they can reach. It's what I meant when I said in my talk that we cand and do lose talent if and when we don't pay attention to these things. So it needs some patience. It's a very funny push-pull combination. I'm not saying we need to be so laissez-faire that students don't do anything, because some students need a good metaphorical kick. But it's got to be a smart metaphorical kick when they need it, not just a powerful one.

So yes, I do think grad students — I've gotten away from your question — I do think that understanding how grad students learn merits study. My impression is that the physics community generally feels that by the time students have completed undergraduate work, they should know how to learn physics. But there are additional conceptual thresholds to cross — that's my conjecture. The one study I read bore it out, but I think a lot more could be done on this.

Interviewer: Actually, we have one little study waiting to be written up that we did on a flipped graduate course. We looked in depth into how the students learn. It was quite surprising.

Robb Mann: What did you find out?

Interviewer: They struggled with identifying the parts of the content that were most relevant, with time management, planning and organizing their calculations and all that. We're going to use it as a pilot for the next implementation of the course. That's the plan.

Robb Mann: I think that's really good. I mean, it's like — you could have said that about a first-year course, right?

Interviewer: Yes.

Robb Mann: That they're not good at organizing. I think it's not because the students are stupid. I think it's primarily the nature of the subject, that when they're in grad school they have new conceptual thresholds to cross. So, they're sort of back to being first year students again, in some ways.

Interviewer: Another thing you mentioned that I found very interesting was that faculty have more need for interaction. They should learn from each other, if I understand you correctly. Is that how you meant it?

Robb Mann: Well, what I meant was that, yes, I think it is helpful. That was partly the motivation for a teaching workshop we have had at Waterloo for the past 15 years. We call it a teaching retreat day where we can discuss

ideas of what works, what doesn't, and how we teach. Quite frankly, I think we would benefit from more of this, but it's very hard to carve out time and resources to do this for teachers.

Our university, and probably many others, have teaching centres that encourage education in teaching. However my experience is that these centres — even at Waterloo — tend to be heavily slanted towards arts disciplines. Those methods and techniques either don't apply in the sciences, or they apply very weakly. I have advocated this over the years, and at Waterloo they have done a lot to gear things more towards the sciences … but there's still a lot of distance to cover. I think that universities could allocate more resources in that direction, particularly to hire people that specialize in training science instructors. I am guessing if we had the resources, there would be a reasonable fraction of our PhD graduates in this country that would love that as a career job.

I think that universities could allocate resources towards hiring people that specialize in training science instructors.

Interviewer: I think a combination of teaching and education development or research would be fantastic.

Robb Mann: That's exactly what I mean. We have a few people that do it. One of my former students is doing that in the math faculty of Waterloo, a mixture of the two. But still, there is a long way to go.

Interviewer: I think that perhaps just like research faculty do research, teaching faculty should do research in teaching. But that's just my personal view. So, you say for your department, you have this once-a-year teaching retreat? What do you talk about?

Robb Mann: Usually we have a theme. It's been common to invite in an external speaker. We've had Peter Knight, we've had Eric Mazur come in, we've had quite a number of different people come through. It consists of a plenary talk for everybody, and then sometimes workshops with people. One year we had a whole session about developing better labs, for example.

Interviewer: Is there something you would like to do in this retreat that you're currently not doing?

Robb Mann: It probably would be worth having a workshop about how to get PER going at Waterloo. Basically very little is done on that at Waterloo in physics. I would put that high on the list as to what's needed and what could be done. Another one would be a workshop about how grad students learn, and what are good policies for supervising grad students. We sort of assume faculty intuitively know how to do it. I think a lot of them don't intuitively know how to do it. Some of this is being looked at now at Waterloo, but it is early days.

Interviewer: One thing that I find valuable for faculty members, as an educational developer, is feedback on their teaching. So, something that we offer is observing classes, giving feedback on teaching materials and course design. Does that appeal to you?

Robb Mann: You mean to do it or to get it?

Interviewer: To get it.

Robb Mann: Yes it does. When a person comes up for tenure, at Waterloo we do have other faculty members go and sit in a class and provide feedback. But that's about the only peer-reviewed feedback for teaching that we actually have. The rest is student evaluations. And in some sense, you could argue that, well, we peer-review research, why don't we peer-review teaching? Of course, the chief problem with doing this is that it is very labour-intensive.

Interviewer: And people are not trained to do it.

Robb Mann: And people are not trained to do it, that's right. So, does it appeal to me in the sense — do I think it should be done? Yes. Do I think it should be added to faculty workload? Well, even if I did, it is hard to believe it would ever happen. But I think it's one of those things that would be useful. Again, you could imagine if universities build up a cadre of teaching faculty to do teaching research, they could provide this kind of feedback. Sometime in the nineties, I did have people come in and give me feedback in my own classes — people from the teaching centre came in and gave me feedback on how I was doing, and I took pointers from them. But they were not from scientific disciplines. So, they could and did give useful feedback in some ways but not in others.

Interviewer: When you think about your experience as a teacher, how has it changed over time? Do you think the students have changed? Do you think how you approach them, that has changed over time?

Robb Mann: I think all of it has changed. As far as the students go, in my talk I said I think the biggest change is that the best students are better than they've ever been. By this I mean that undergraduates and grad students are carrying out research at levels and capacities that I never saw happen 25 plus years ago. Their computational skills, their skills in labs, their comprehension of research is all much much better. And probably even right out of high school, in the first year, you can see these students that take off. I don't know why that is but I conjecture it's because of more flexible polices in education that encourage student creativity. However the flipside of that - maybe for the same reason - is (I think) that middle-of-the-road students are depleting in number. Or another way of saying it: the weak students are

getting weaker. Why this is, I don't know. Let's just pick a semi-arbitrary baseline. A 1990 student that got between 70 and 75 as a grade in a course was a decent, solid student. They had a reasonable grasp of the subject material. They weren't going to take off like a 90+ student, but I felt they really had a good basic grasp of the material, whereas a student that got 60 or lower was weak. My impression now is that students getting grades in the low seventies have a level of comprehension and a grasp of the subject material that is just not as solid as their 1990 predecessors. Perhaps they get the grade because we're too easy on them. I don't quite know the reason, but I think they are weaker. Why is that? It may be because of the same more creative policies in high school that emphasize less the basic reading, writing, and arithmetic skills. That's possible.

Another possibility might be the growth in the number of students. And offering programs in such a way that have led students to think, "Okay, to get through this year and this program, I need five courses — but I only really care about three of them so I'll work on those and not on the two I don't care about." They're being more utilitarian. That's quite possible. I really don't know why. But when I talk to other people, anecdotally, I find people tend to agree with me. I don't know how you'd study it, but I think the students have changed in that regard, so it's sort of good news and bad news.

For me, the advent of projecting on screen, PowerPoint, is something I use for two reasons. One, my blackboard writing is lousy, whereas PowerPoint is clean. Two, I'm facing them most of the time instead of the board. Of course there is value in a class for students to see an instructor work something out in front of them and I try and do that a bit. But I also provide rather detailed PowerPoint slides. They have equations with full solutions on them and so on, and I let them have that.

Is that good for them or bad? It's a mixture. In the old days, they would have to copy: there was no choice. In these new days I like to think, ideally, they should work through the solution and see it. Some of them do, some of them don't. But in the old days, some of them took good notes and some of them didn't, right?

I think that teaching styles have changed. If you need to show videos, it is easy now. 30 (even 20) years ago you never used to be able to do that, at least not easily — you could show a movie, but it was a lot of trouble to set up. I haven't used clickers but a lot of people do. That's another new phenomenon. In first year, I tend to emphasize demonstrations more than I used to. I have more demonstrations now by a notable margin than I did when I first started teaching first year almost 20 years ago. That's another way I've changed.

Interviewer: Do you find these developments that you talked about both in domestic and international students?

Robb Mann: What do you mean by developments? Do you mean changes in the students?

Interviewer: The strong students are getting stronger; the weaker students are getting weaker.

Robb Mann: That's a good question. The international students from the Orient I would say have — statistically — better technical skills. But their reflective skills appear to be weaker. The converse tends to be true for domestic students. Their technical skills, statistically, are not as strong but they appear better able to understand why they're doing what they're doing. They want to talk about the big ideas. But as for doing the ``bricks and mortar" calculations, they're not as strong at it as most international students are. Of course, there is a range everywhere, but if I had to give a crude classification, that's how I would say they would differ. It would be great to have a survey that could test my impressions.

Interviewer: From that what you have observed, where do you think this is going?

Robb Mann: Where do I think it's going? I think that technical skills seem to be sliding and getting weaker — that's what the high school teachers told me a month ago when I was at an OAPT [Ontario Association of Physics Teachers] meeting. Quite a number of high school physics teachers felt that students coming out of elementary school were notably weaker technically, so they were trying to play catch up. But there is only so much they can do. I have a niece who, when she finished grade 12 in Toronto two years ago (and that was in a stronger Toronto high school). I said to her "I hear kids have a lot of anxiety, is that true?" She said "yes". I asked why. She said "because by about grade 12 a lot of us have figured out it's been too easy for us and we know university isn't going to be that easy. So we have anxiety that we're not well enough prepared." I think that needs to be reversed. It's easy to say, "well teachers, you're just not hard enough on them", but there is only a limited extent to which this is true. Part of the problem everybody is facing is simply the enormous growth in the body of knowledge of everything, particularly science. We want to show students all the new dazzling things in science to keep them interested — but there are so many dazzling things and there is still only 24 hours in a day. I think that's an enormous challenge. Plus you want them to learn the basic skills. I don't have a good answer for how to deal with that issue, but I think it is an issue.

Interviewer: If you had a magic wand — providing infinite time, infinite money and anything else you need — how would you like to teach students?

Robb Mann: You mean how would I like students to be taught at all levels, or how would I like to teach them in what I teach?

Interviewer: Both.

Robb Mann: Alright, let me do the first one then. The first, if I had a magic wand, would be to carve out a certain amount of time for basic skills. The argument of the old school system pre-1980 was that it was boring. The bright students got bored easily, and even the ones that weren't as good got bored. However it had a strong emphasis on basic skills. Not a lot of flexibility for creativity, but there was something valuable in learning basic skills. It trains you. It gives you a base to be creative. So I think more emphasis needs to be on that.

But I would not want to lose the creativity. So, if I had a magic wand, I'd tell the wand to find me the right balance between the two, and I would go "ping" and strike it. So that's one thing I would do.

What would I do at the university undergrad level? I like to give bonus questions, to have carrots instead of sticks. I still think physics can be a bit fearsome — the courses tend to have more sticks than carrots, perhaps because we think that we have to be tough so that they learn. I'd rather have carrot-and-stick balance. Engineering programs in Waterloo take students who got grades in the 90s, but their physics midterm average is typically 10 points below the other courses. I don't see why the physics average should be substantively lower than averages in other science or engineering or math courses. I think we need to create corrective measures to ask questions that the students are just capable of answering at that time. The problem with the `tough approach' is that it just demoralizes most people. My experience is that many students think "Okay, I have had it with physics. You know, I don't need to get a 60 in something I used to get an 85 in and also, I don't need to get a 60 in something while I'm getting 79 or 81 in in the other courses". I think that is a real phenomenon that probably reflects the need for improvement in pedagogies. So, if I waved a magic wand, I would solve that problem of demoralization that I think affects too many undergrads in physics.

Interviewer: So, I hear that you are thinking of this as a result of pedagogy, not so much the students not working hard enough?

Robb Mann: Well … it's a mixture. There are some students that really don't work and for them, honestly, my sympathy is very low. But what I generally see is a lot of students that really do work and yet they get hammered. Those are the ones I have the most sympathy for, because they really are trying, and not getting anywhere. That's the group that needs the real improvement. It could be that some students are a lot brighter than their grades give them credit for, but for certain reasons, they are not mature enough or something went wrong for them that they weren't expecting. They're not developing the way they should, and I think we need mechanisms to help them with that.

There are studies being done on how one's emotional mood and dispositions strongly affect one's ability to work. I don't want to mollycoddle students to make it really easy for them, but on the other hand, I think a tooth-and-claw Darwinism approach to learning isn't very good either. It just appeals to the cream at the top. I think there is a lot more cream that could be up there if we change things.

I'm an idealist. I really think we could do better. I've seen it with grad students, students that really felt inadequate and thought they couldn't do research. I have seen students leave programs that shouldn't leave the program. Under the right conditions, students can and do flourish.

Interviewer: Is there anything else you would like to say to your readers that I have not asked you yet?

Robb Mann: That's a good question. Having worked with the CAP Award for Teaching Excellence in High School / CEGEP Physics for a while, I have been very impressed with the hard work that high school physics teachers are doing. I would like more interaction and networking between high school teachers and university teachers. I would also like to see more emphasis on research on how grad students learn, because all the emphasis is on the first year/second year. We need more emphasis on the upper years and on grad school and need to put the resources behind it to support that. We tend to think that their learning is going to happen automatically and osmotically, but it doesn't. It happens, but weakly, poorly, and slowly, for too many students. I think that PER research has helped first year teaching a lot. Let's do that same kind of research for upper levels too.

Interviewer: That's a good way to end. Thank you, Robb.

Robb Mann: Thank you.