ERIK DEMAINE: Yeah, so one of the exciting parts of this class is that we ran an optional session where whoever is interested in doing the research side of the material could solve open problems together. So we call this a problem-solving session. But it's-- all the problems are unsolved in the field. And so it's not a required part of the class, because it's OK to just learn the material. But if you really want to engage with what we're learning about, then you should try to advance the field and solve new problems beyond what we know how to solve.

And so every week I have this session for two hours. That seems to be about the sweet spot. And I would come with a couple of new open problems inspired by the material that we've just covered in the last week of lectures. So this is, I find, a really powerful combination in teaching, where you've just covered in one week the latest that everyone knows. Everyone's at the state of the art. They've just learned what the best results are in the field.

And so it's natural to ask, well, what's next? What would be the next step? How can we improve these results? What would be the next thing to analyze? And so the open problem session nicely dovetails with the lectures, where it's just been a couple of lectures, so it's still fresh in the mind. And now we know all these techniques, can we conquer this new problem?

So the hardest part, of course, as a teacher is picking out what is the right unsolved problem to work on, because they have to be easy enough that you have the hope of solving them in two hours, though, some of them we continue through multiple weeks. But at least you want to make some progress in two hours. Otherwise, you feel like you're wasting time, and it's kind of discouraging.

But you also don't want the problem to be so easy that it's not worth writing a paper about. So the challenge is to find this balance, and also hoping that the problem is within the scope of the material that you've just taught, because it's unsolved. No one knows whether these techniques will apply. But by bringing a few problems to the table, and also by the end, students were bringing in their own suggested problems, you can get lucky.

And so in the session, there were about a dozen people typically who'd show up each week. It would shift a little bit who has the time, because it is kind of extracurricular. But we would get together, I would describe the problems usually within just a few minutes and remind people of the past problems from past weeks and update. If people had any progress since the last

week, then they would present what their ideas were or what their things were.

But then most of the time is spent brainstorming. So often-- we were in a room that had lots of little kind of corners, each with white boards. And so often, different people would say, oh, you want to work on this problem? And if so, come to this little corner. And then they would work in that corner on their problem.

And so there would be a few different groups, each of like three or four people brainstorming about some problem, maybe we could do this, what if we applied this technique that we just learned from class, and this sort of thing. And then I would jump around from corner to corner and try to give my advice like, oh, have you tried this? Oh, this paper seems relevant, maybe you should read this one.

And then in the span of those two hours, often, we would solve the problems we would look at. Certainly, not all of them. But I would say maybe half of the problems that we set out to solve, we actually did by the end. Many of those turned into the final projects for students in the class, so that was another motivator for people to come. And many of them have been published since, so they are now papers in the literature.

And it's been a nice way to progress the field of hardness proofs. And I think I think this approach is really powerful in general for-- probably for more advanced classes, like advanced undergraduate and graduate classes. Anywhere people are comfortable going that extra step and trying out research, I think, this is a really powerful technique of combining teaching the latest material in an area and then trying to push those frontiers and solve new problems.

It takes extra effort, but most professors are also researchers in addition to teachers, so they should all try it. And I'd be happy to give them advice for how to do it. I've been doing it for several years in all of my advanced classes. And in the beginning it was a little-- there are lots of kinks to work out of figuring out what's the right level of problem, but now it works pretty well and pretty consistently.

I think one key to making these problem sessions work is you can't be the only driving force. You need to orchestrate the students to be willing to speak up. I mean, it's always a challenge in lectures to get students to ask questions. But this is like way beyond asking questions, now they have to like suggest answers and suggest ideas. And they have to be in an environment where they're comfortable voicing their ideas and not being too self-critical, because when you're solving problems, it's really-- usually-- most ideas don't work. That's life.

But silence is like the worst thing for solving problems. So even if you have like a kind of lame idea, like you know it doesn't work, it's still worth saying it because it might inspire someone else to have a second idea and a third idea. And just keeping the conversation going is really critical.

So I think whatever you can do to encourage that kind of like-- including yourself, asking silly questions that may not-- the answer doesn't really tell you-- well, what's the right way-- being comfortable not knowing the answers and asking initially stupid questions that might lead into interesting directions, I think, will encourage students to do the same.

And it doesn't work for everyone. Some students remain quiet throughout the whole semester. But hopefully, they at least got to see this picture of how research happens. That's sort of the goal.

The problem sessions are definitely much more personal interaction with me, and so they feel a lot more comfortable around me as the professor. And so, yeah, they're definitely more comfortable asking questions in lecture. It just generally leads to a nice kind of-- I mean, it's really a bonding experience, I would say. So I see it especially within the group that they're super comfortable working with each other because they've solved so many problems together. There's this camaraderie of we can tackle anything.

And so this problem session is continued way past the end of semester. It's been going for another year since. Hopefully, it will continue going. Of course, some students will graduate and leave.

But it's actually been great for my research. If I have a new hardness problem, I can bring it to the problem session, and like wolves they'll attack it. And usually we'll get a solution within a few weeks. So it's really-- and a big part of that, I think, is because they've shared this experience, and they've solved so many things together that it really-- they have a lot of confidence in this context.