>> Hello, everyone, and good to see you on this video. It's a pity this has not managed to be in person this year, but I'm very pleased that ICTCM have organized this chance to communicate at least virtually. My name is Conrad Wolfram. I am the Strategy Director of Wolfram Research and also its European cofounder and CEO. We're the folks who make Wolfram|Alpha, Mathematica, Wolfram|Alpha Notebook Edition, and many other computational tools beside that you may have come across. That's my day job. I also set up computerbasedmath.org and computationalthinking.org to assist the student side of this and the human side of this in furthering computational thinking. And that's really what I wanted to talk about in the session I was going to have in Florida, but also in summary now in this video. You see, at the moment we have a real crisis in computational thinking and mathematics across our schooling and this is really born out of a rather simple observation, in a way, which is that in the real world, computers do almost all the calculating, and in the classroom, we have students doing almost all the calculating. And the difference between these two views of the use of mathematics is really driving a wedge between, in a sense, the educational mathematics and computational thinking that we do and what's really, really needed in the real world. You know, we're in a horrific crisis at the moment with COVID-19 and what's extraordinary is the extent, amongst many other things, is the extent to which mathematics is on trial in this crisis. You know, we are literally dependent on modeling, on how we can reduce this pandemic, least affect people with it and, in a sense, mathematics is center stage at, really, preserving life. And in a sense, we've got our specialists who are trying to work out all the consequences and how best to advise how we handle this pandemic in all sorts of ways. And at the other end, we've also got our citizens who desperately need to understand all the charts, all the graphs, all the risks, what flattening the curve means, what it might mean for them, what it might, what individual actions of them, how that might affect the society. What it's reasonable to do, whether going outside or being inside has more risk, or whether you wear a mask or not wear a mask. These societal computational and data-science issues are center stage in our decision-making in the world. COVID is an absolute case in point, but actually, this has been a growing effect over many years, and the question we have to face as we go into the AI age is to what extent our education is really preparing students, or humans, for this world and how we can make better decisions, better-informed decisions, not be misled, potentially, by a small number of people who say they know what they're talking about without [inaudible] being able to evaluate that. So, I think that for several reasons actually the current crisis of COVID is an opportunity for us to really step back and look at what we're doing. Of course, the immediate effect has been for us to step back and do online learning. We have no choice, and that's forced us to look at many of the processes that have been being undertaken in education. And I'm sure that after this epidemic has passed, there will be many longstanding changes, probably for the better, as to how we decide to educate everyone in a practical way. Does everyone need to go into the same classroom at the same time? How are we involving socially adapting everyone? That's a separate, slightly separate question from how they're learning [inaudible], for example. So, that's one way in which COVID has immediately affected our thinking, but there ought to be others, and I want to come back to this idea that we need computational literacy across our societies. It's not good enough to have a small elite who understand data science and the rest of us are kind of hoping to be led by their wisdom. That's a little bit like what happened a few

centuries ago with literacy, when most people couldn't read and write. We have a small number of, in a sense, high priests and aristocrats, usually, telling everybody what to do, and sometimes they were very well intentioned, and they did good things, and other times they didn't. But really, that's no guarantor of future prosperity, and we're now in a similar situation with computational literacy and we need to make sure that we have this real understanding of risk, or data science across everyone to ensure that [inaudible] inoculated against misinformation and be able to make better decisions. I think, because of what COVID has made us rethink, there is a real opportunity now to make these sorts of changes, and I think particularly if you're in college where you have a little bit more freedom than perhaps you do in secondary education, now is a real opportunity to look at your courses and understand whether that shift can be made. So, let's talk for a few minutes about what specifically I'm talking about. One way to think about computational thinking or maths is a four-step process, the first step of which is you define a problem. So, a problem might be how much of a lockdown do we need to put people in, in order to optimize the going away, the end of this epidemic? That might [inaudible] or it might be a much more specific problem. Should people wear face masks in underground systems, in subways? So, that's the definition. The next stage of the mathematical process or computational process is you abstract that. You turn that into, in a sense, mathematics. It might be an equation. It might be a matrix. It might be a machine learning setup. And you then take that step two, that's the question, abstracted, and you then use the magic, in a sense, of computation, of step three, to take that question to the answer. We're familiar with equations that work out, you know, x equals two, for example. That would be an answer that you get at the end of step three. Now, the point about step three is that traditionally at schools we've done all that by hand. What we need to be doing is much, much more of that on the computer. Step four, if you take that answer and we evaluate it. Did it make sense? Did x equals two meet, did it answer the question we defined originally, or do we have to go round and do this process again? You see, only if you have a computer can you ask complex questions, hope to extract them to things that you can then actually work out. So, the computer fundamentally changes what it's possible to learn, the tool sets you can use, and how you can understand and experience the world around you in a computational way, and that's why it's so critical that we embed computers in computational thinking. And you see this all over the place with what's happened with COVID. There's no possibility we could even have started to model any of the pandemic in any way without modern computational technology. And even there, we're struggling with the complexity of the problem. So, what can you do now to move, oh, incidentally, I should say on that previous point, we just put out a blog post, my colleague, Dan Robinson put out a blog post explaining how you apply the four-step process I talked about to modeling the pandemic and some ways in which that's been done. And I think that's very helpful for students to see mathematics and computation in action. So, moving on to what can you do now, that's one of the sorts of things you can do now. I think another opportunity we have is that, in some jurisdictions, I know in the UK, exams in key years have been canceled and so a number of weeks that we thought were taken up with exams are actually now available for doing different things in the classroom. Obviously, this is a real struggle for teachers, because it's, like, can we come up with a lot of new material. I know at Wolfram, we'd be trying to put out helpful materials, I hope, which are [inaudible], not necessarily following the

curriculum, though some of them do. Our computer-based maths modules are things really to expand your student's computational thinking, and I encourage you to take a look at those and to try some of those out. They're very much in beta at the moment, but we really would like as many people to try them as possible. Things like whether, lots of different rich kind of problems and ones that use a wide range of mathematics, hopefully to get students interested in.
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The other thing that I've been working on hard and was hoping, in fact, to give its first showing in March was my book. You'll see it behind. Here it is closer up, "The Math(s) Fix, An Educational Blueprint for the AI Age." This is really a fuller picture of some of what I've just talked about in this brief introduction. What I'm trying to do is really go through explaining, in a sense, the problem in some detail. What is the problem with mathematics? How have we got ourselves into this fix, hence the term "maths fix." In fact, I've come up with that term because I think mathematics has got itself into a bit of a fix. It is a rather addictive fix for many policymakers, and it's also relatively hard to fix, and so that's the reason I called the book "The Math(s) Fix," but the good news is, I am proposing, specifically, a fix and a way forward. And that's really how the book progresses, from problem to the proposed fix, the proposed solution to some of the challenges in trying to implement that solution, both political and practical. Some of the ways we need to address what different groups, whether it's parents or students, of course, themselves, or teachers, or policymakers, or governments, or politicians, concerns they have in what must be an important change to make. So, I hope that was a brief introduction to the sorts of issues that I would have liked to talk about in more length last year, this year, rather, 2020. I'm already tuning the year out of my mind, I think. But I have very much signed up for ICTCM 2021, and with any luck, we will be able to have that physically in person. And I hope meanwhile everyone stays safe. This is a very challenging time, a time in which we've got to keep our wits about us. We've got to listen to reason and we've got to help, instead of move ourselves in a sense to a era where we less and less trust the great mathematics and science and computation that we've brought up, and computational power over the last number of years, we've really got to go to a new enlightenment, a computational enlightenment where, really, computational literacy, computational thinking are spread across our societies and move us to a new, better era. Thank you very much.
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