

There's never been a better time to go into math

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Transcript from the English captions uploaded with the video, regrouped into paragraphs of about a minute. Each timestamp links to that moment in the video. Caption wording is kept as published, including its small slips.

Chapters

- [\[0:00\]](#) Math student angst
- [\[3:10\]](#) How does math work?
- [\[11:24\]](#) A proof machine
- [\[25:12\]](#) A conjecture machine
- [\[26:59\]](#) A theory machine
- [\[31:31\]](#) If AI is better at everything
- [\[34:58\]](#) The best time to enter math

Math student angst

[\[0:00\]](#) Well, let's talk about it. It feels like the whole math world is on fire talking about AI in math. I have been thinking about this for a very long time. So I put up this post last week soliciting questions that people had on the matter, and a lot of what I saw were comments from students, maybe PhD students or undergrads who had been planning on going into math or adjacent theoretical fields who were basically just saying, what am I supposed to do? What am I supposed to do next when the future seems so uncertain? You know there's a lot of fear that math is dead or math is solved or even if you don't believe those that whatever the thing that math will become is is unpleasant or not what you wanted to do. I've also talked to a lot of different professors who are essentially throwing up their hands saying what am I supposed to tell my students like how am I supposed to advise them in this moment and I thought for this video I would focus on one specific comment that I saw that felt emblematic of so many others. A math PhD here, just tell me what to do tomorrow. So I would make the case, and I want to see if you agree with me on this, that there has never been a better time to go into math, that there's never been a better time to fund math, and that maybe the most radical change that we'll see in this moment is a reframing of how we assign academic credit, but that the actual institution of math and what it is remains surprisingly unaffected, even in a hypothetical future where machines can Machines can do anything that mathematicians can currently do, but better.

[\[1:20\]](#) For the first section of this video, I just want to lay out a framework for how I've been thinking about it, where we just list out all the things that it is that mathematicians do, and then we list out all of the ways in which math is valuable to the world, and then we think about where the money comes from and how the latter two relate to each other. I think this is a useful exercise to do with any career, regardless of the presence of AI, but once AI enters the discussion, what you can do is you can do it with any career, regardless of the presence of AI, but once AI enters the discussion, what you can do is you can do it

with any career. What you can do is ask, suppose that machines are better than people at each one of these tasks or maybe even all of the tasks. What happens? I'm certainly not going to be able to claim to predict exactly what would happen. I want to put very wide error bars around things that I say in this video. But broadly speaking, I want to give you kind of a best faith effort at trying to think that through and bring you along with me. And by the way, it might be worth prefacing saying, I don't really have any skin in the game for necessarily wanting more people to go into academic. academic math. In fact, if anything, for a while I've thought that perhaps too many students go and pursue PhDs for the wrong reasons. You know, it's very comfortable to continue with some form of school if you've always liked school and been good at it, and PhD programs kind of feel like an extension of that.

[2:26] Whereas what you should be asking is how do you want to add value to other people in the world and how can you use and develop your own skill sets to better do that. do that. Maybe academic research is the way to do that, but it might not be. And it's important to ask that question. For example, a lot of people leaving academia in response to the present moment are doing so motivated by a sense that the best thing they could be working on is AI safety. And if that's you, great, go do that. Run, run, run. But the main people I want to talk to right now are the ones considering leaving out of fear, out of a fear that the career won't exist or that it won't be something that they would enjoy. Anyway, because I really do believe that not only is it going to continue to exist, it stands to be highly useful, maybe more useful than it's ever been, and also just joyful.

How does math work?

[3:14] All right, so first, what goes into math research? The obvious one is proving theorems. This is where a lot of people spend their time. You have the tropes that a mathematician is a machine that turns coffee into theorems. But everybody has known for a while, and it's a huge part of the discussion now, that that is not everything. That is very far from everything. One nice quote on this matter is that good mathematicians prove theorems, great mathematicians make conjectures, and the greatest mathematicians write definitions. And so we can even add that to our list. You know, aside from proving theorems, you have the exercise of deciding what's even worth asking. There's a lot of taste making in that. Having a certain sense for when an idea might be interesting enough that it produces good math. And then instead of saying write definitions, I'm gonna go ahead and throw in a third category of theory building. You know you have a bunch of theorems that are proved or maybe you have some sense of what questions are worth asking. But we actually wanna get out of it is like a broad understanding of of what's really going on here. You know, when Descartes introduced Cartesian coordinates, it wasn't so much any one question that was being answered, it's just an entire framework of thinking.

[4:13] Or when Galois was introducing the very seeds of group theory, the significance of that had very little to do with, you know, the unsolvability of the quintic. It's that it was a new way of conceptualizing what was going on that would produce an incredibly flowering portion of math that was highly useful for the centuries thereafter. After I think Grothendieck is a good example of this too. He had all sorts of metaphorical ways of speaking but one of them was if you're trying to get from the top of one mountain to another you know one way is to solve all the problems to like go down the mountain and then go up the other and the other would be to have a rising sea that lifts up between the

mountains and just sail from the top of one to the other and the analogy that rising sea is kind of all of the theory that you build not necessarily proving one particular theorem but giving a deeper overall understanding. understanding to what's really going on. You also have the component of applications. figuring out in what way all of these abstractions can be plugged into the sciences and engineering. And with all these categories, another implicit part of what's going on is clearly communicating what was done to others. It's not just vomiting out a proof, it's giving a reasonably motivated exposition of what that is. Or in building the theory, it's not just like listing a bunch of definitions, the great mathematicians will effectively communicate why these are the structures worth engaging with.

[5:23] And try to convey some of their taste in that. Shifting over to where the value is, the most obvious one here is the applications, you know, the relevance to science and engineering. And the thing everybody writes about in their grants for pure math at least, is how sometimes these applications can be very downstream, decades or even centuries later. You know, to highlight a few classic examples, you have a bunch of Italians trying to solve cubic equations in the 1500s, one weird trick for that involves taking the square root of a negative seriously. seriously propagate the theory building of that down a few centuries and you have imaginary numbers which are a critical part of quantum mechanics and electrical engineering and studying waves and like pretty much everything. You have questions about Euclid's fifth postulate resulting in people developing non-Euclidean geometry dot dot dot you get to general relativity or pursuit of Fermat's last theorem builds up all of this beautiful theory around algebraic geometry and things like elliptic curves. Those in turn end up unexpectedly being useful in cryptography. Lots and lots of examples, people love to list them.

[6:22] Another component of the value of math though is not so much at the societal application level, but at an individual one where the practice of doing math and going through part of the training to be a mathematician leaves you with a bunch of problem-solving skills that it would appear are very transferably useful. So we have tons of other portions in the economy of people who go into computer science or machine learning research or right now AI safety or finance or cryptography or all of these things where people had a lot of training in math. Maybe it was just a few classes in a math department. Maybe it was even that they got a Ph.D. in math, but they didn't end up becoming mathematicians. They used all of those skills elsewhere. It would appear there is something generalizable here. There is something about the way of engaging with finding the right abstractions or this kind of problem-solving that makes people more valuable elsewhere. And the third category for value here, which is often underappreciated but I think will become ever more and more worth appreciating, is just something aesthetic.

[7:21] There is a joy simply to doing math. Personally, I feel like there's this very specific emotion. It's like a clicking in my head that I'll get if I'm engaging with a good problem. And I see this way that it's going to be solved. Or if I'm holding a certain new theory that I haven't engaged with in my mind and I see how it fits together and it just gives me this completely different way of thinking. And I think there's a lot of different parts of math where it has that feeling of reshaping your thought. Anybody who's taken a linear algebra class starts speaking a little bit differently for the rest of their life. They use words like orthogonal in talking about ideas or people who engage with category theory sometimes

Sometimes feel like their brain has been turned upside down for a very new way of thinking that's just satisfying. It's just nice. And if you talk to mathematicians about what motivated them to go into the field, not everyone, but I think for a lot of them, this is actually the reason. There is a certain joy, a certain artistic pleasure to doing it. And I also think this helps explain some of the reactions you're seeing now to AI and math being such a strong echo of the reactions from artists about AI and art.

[8:24] hard, because in some sense it feels like it is infringing on a certain art form. But if we're thinking of this as a career, not a hobby, none of this matters if there's not a source of funding. So where does the money for math come from? One big component is teaching. A lot of mathematicians are math professors, they're at a university, they teach in a math department. Math departments themselves often teach many more people than just the math majors, so they have an outsized influence on credit hours and tuition. Yeah, public funding, of course, like in the U.S. we have NSF grants. We have certain private funding as well from various institutions, things like the Simons Foundation, and then sometimes there will be industry funding as well. And of those categories, by the way, teaching is the biggest one as far as the source of funding is concerned, which is a little peculiar to math compared to other sciences because the research is comparatively cheap and the scope of students coming through the math department is relatively broad. abroad. All right, so we're about to go through the exercise of imagining what happens if AI gets better than human mathematicians at various parts of this research stack.

[9:22] But first, it might be worth being clear about how the value stack and the funding stack relate to each other. For example, these second two sources of value, the problem-solving chops and the aesthetic joy, are individual goods. They are experienced only by the person doing the mathematics. The public funding is not there just to support some prestigious and aesthetically pleasing hobby for those in the inner circles practicing it. I think a better way to think about what's going on here is that those second two sources of value flow through the money chain basically through the teaching. The students walking through the halls of math departments at universities around the world are largely there to develop technical problem-solving skills that they hope will be useful elsewhere. Some of them are also there for the aesthetic joy of it. I know that I was. I mean, to be clear it was comforting and validating to have the other benefits of math, the fact that it exercises a muscle for a generally useful skill set. But an honest depiction of a lot of the value I was getting out of that math department is on that aesthetic side.

[10:19] The benefit to society at large of course comes from the downstream applications. Although I think there is more shared benefit worth acknowledging. For instance, math popularization, like what happens on this channel or Numberphile or when mathematicians give talks, really is a way of trying to share that aesthetic joy more broadly among society. And also, in terms of what justifies public and private funding, even though everyone writes their grants around the downstream applications, I think an even more significant positive externality is that you have this institution training up a bunch of people with a certain kind of problem solving ability. You know, attracting them from around the world to come to prestigious universities where they can do that. And then most of them don't go in to become mathematicians. They spill out into other very useful parts of the economy using those transferable skills. Just that component alone, I think, is a very meaningful ROI on dollars pointed towards that institution, at least insofar as it genuinely trains up good problem solving skills and those problem solving skills are

genuinely transferable.

[11:18] All right. So let's get into the meat of this. What happens if AI gets good at various parts of this research stack?

A proof machine

[11:27] As we step into this first block here of presuming that machines are better than mathematicians at proving theorems, it might actually be worth stepping back and summarizing what just happened. So like I said, I've been thinking about this for a while. Actually, a quiet project that's been happening in the background of Three Blue and Brown is that since like mid-2025, I've been recording interviews with mathematicians just to hear their take on what they're feeling with respect to the presence of AI in math. And one of my broad conclusions is that at any given snapshot, snapshot in time, the position is overrated but the velocity is not. It's So for example, back in 2023, I want to say, I remember getting a text from a friend saying, you know, did DeepMind just crush Olympiad-level geometry? And he was referring to a certain model that DeepMind had put out that could answer IMO-level geometry questions. And at the time, the answer was like, yes, I guess, but it's also clearly not in the spirit of what we would mean by solving IMO-level problems. It felt very bespoke and brute force, but a lot of these problems are supposed to be solved.

[12:23] They're supposed to require an element of kind of creativity and imagination. But if you fast forward a couple years, the natural language models, not even bespoke ones, could solve IMO-level problems by any reasonable definition of what you would mean by solve. Or earlier this year, you were starting to see proofs come out for these things called Erdős problems, where a great mathematician named Paul Erdős had posed a lot of different questions. He had a good taste for what constitutes a good conjecture. And there's an enumeration of them which naturally meant the model companies enjoyed using it as a kind of benchmark and whether or not that's a good benchmark you started to see more and more machine generated proofs of these. Now in the early days a lot of people were saying yeah yeah yeah but if you look closely at these a lot of them are just low-hanging fruit they're problems people hadn't tried before or the problems had been solved and it just hadn't been well documented and the model was basically just repackaging that but without without credit attribution, which is of course a whole thing. But if you fast forward to this point in time, nobody is saying that the problems whose solutions we're seeing were just low-hanging fruit.

[13:22] These are a lot of very serious problems that mathematicians had tried really hard to find proofs for where the LLMs are outputting proofs. And here I also want to be very clear, this is true and has been worth discussing even if you set aside any of the headline-making results, you know, the recent stuff from OpenAI, like the Navier-Stokes things or the hundreds of problems. problems they dropped. If you were talking to mathematicians on the ground, seeing the way that they're interacting with these models, for some of them at least, what you'll hear is that they pose a serious research question to one of these reasoning models, and what they get back is something that they find insightful. Of course this varies a lot from field to field and from person to person. The frontier is spiky at a fractal level and it is not at all uniform. There is also an immense amount of controversy around the way some of these proofs are presented, and not to downplay the significance of any of that, I think the broad ten thousand high-foot

view here is four years ago, these things couldn't even add numbers. They came to be able to do contest level math much faster than anyone anticipated. They jumped from that to doing anything relevant to research much faster than a lot of people anticipated. So even if it's an exaggeration to say that theorem proving is solved now, even if it's the case that most of the proofs that we're seeing are short hops away from contributions, often very recent contributions, from human mathematicians, even if it's not even well defined what we would mean by theorem proven being solved, given the pace of progress over the last four years, for the sake of argument, for the sake of that first year PhD student trying to look ahead and speculate about what is stable in their future, let's just presume that machines are categorically better at the proof generating side of math.

[14:55] What happens? In short, I think it has almost no influence on the value stack, and therefore also the funding stack, but it has a very massive influence for the culture and credit assignment system of the institution of math. So just looking at that value stack side, the applications, like I said before, almost always stem from the theory building side of it. It's not the proof of the unsolvability of the quintic that matters, it's the creation of group theory, which in turn has effects like like having people postulate that quarks might exist. It's not the yes or no answer to Fermat's last theorem, it's all of the math that sprung forward from it and its applications. Sometimes you could say that the statement of a theorem just on its own has some utility. An example here might be that if you're pursuing nuclear fusion and you want some system where the magnetic field is non-zero everywhere, the hairy ball theorem tells you you couldn't do this with something that has spherical topology. That always kind of feels like a stretch to me, though by and large the applications come from the theory building side.

[15:53] So downstream to the funding that means the public funding is still very much rational. If anything the mathematicians are now more leveraged to do their theory building, likewise for the private funding. For the next item on the value stack, building up those problem solving muscles, this is essentially unaffected by whether or not machines are better. Like there are probably lots of humans who are better than you at generating proofs. proofs but it is nevertheless helpful to go through the exercise of creating proofs yourself for the sake of building those problem-solving muscles. The analogy here is basically that of going to the gym where yeah sure machines can lift heavier weights than you do but that does not negate the value that you get out of lifting those heavy weights and this is going to be true by the way for pretty much every item as we let AI get better and better at it this portion of the value stack building up those problem-solving muscles Principles always requires that you the human are engaged with it. Now you could ask in the sci-fi futures that we're going to get to here, implied by AI taking off more and more of these abilities, do we need problem-solving abilities in humans? We can postpone that question for now, but as long as there is value to that, this then flows through the funding channel through the teaching side of it.

[16:56] It's still very valuable to have human experts capable of generating proofs so that they can train students. to be capable of generating proofs so that you get those spillover benefits. The aesthetic joy side gets a little bit more nuanced here, because I've seen both sides of it. One sentiment I've seen a lot, especially online, is that theorem-proof coming from machines completely sucks away the joy of it. You know, often if it's a mathematician who is maybe pushing forward towards a particular result, and then that result was one of the hundreds that OpenAI kind of dumps down, they'll say that just takes all of the wind

out of their sails. And I get that, and it's important to talk about that part. For what it's worth I've also seen especially in person the other side of this where some mathematicians are completely exhilarated. They have these questions that they've always really wanted to know the answer to and now they have this interaction with models where they're coming to see the answers of it and especially when they care not just about the proof but about the theory building it feels like they've been unlocked.

[17:56] Just to give you one little taste of this I want to share with you a sample of a conversation I had with Konstantin Kogler at the Institute of Advanced Studies. and study, where he was talking about a very important problem from his field, one of the most important, and throughout the last year he would just try to pose it to the state of the art models that were available to him. And this was his commentary on it. So I had two, I would say very very serious successes. So on Sunday uh I had made maybe the major open problem in the field solved. Uh and I had one other success with what which were these irreducible polynomials uh that were that we were telling you about. So it was absolutely marvelous. And it was simple, that was there already saw on Thursday, so it was simple. It had a simple powerful idea. First I felt incredible excitement because about the math, about the power, about the truth I would learn, about the power of ideas I saw. Mm-hmm. So and then I thought about the math and that made me sleep less and then I thought about the excitement because I had the insights that I really was craving for. Yeah. Hmm.

[18:52] And this dichotomy by the way where there's a tendency to see more negativity on online while there's the tendency to see more joy in person is of course not unique to AI and math. That's just the nature of discourse in today's world. And I don't want to downplay the reality or the legitimacy of those negative feelings. In fact, I want to dig into it in a moment. But I do think this has an implication for that central question of the PhD student asking what to do tomorrow. Again, I promise to give you a concrete answer at the end of this video. But the first portion of that answer is to be social. Close the laptop. Go on a long walk with your fellow PhD students. As to the topics for discussion in that long walk, trust me, we'll get there. I know we're spending a lot of time on this one item, but it is where most of the present discourse is, and I do have just a couple more things to say here. For example, what does the practice of doing math actually look like if the machines are better at the proof generation? Well, if we take that optimist's perspective, the one who's exhilarated by it, it basically looks like leaning into the theory building. You are no longer rate limited by how quickly you can solve certain problems along the way. You can ask all of the questions that you want. You can much more quickly see what the solutions to them are.

[19:57] You can try to parse that and just understand how does this fit into a bigger narrative, what are the elements of simplicity among all of the proofs that I'm looking at, and how can I weave this together into a fabric of a new kind of theory, where Galois was introducing group theory or Grothendieck was developing algebraic geometry. What is it that you as an individual get to entirely grow out? Maybe your PhD thesis is not a handful of a few proofs, it is that entire theory building. An analogue here would be that It's like going through a textbook where you can come to understand that material so much faster in part because you have this answer key at the back of the book. That's not to say you should always look at it, you should still do the problems and engage with them. But if you are stuck, having that more coherent presentation of the answers does help you to get

unstuck. It makes you move faster than you would if it was totally terra nova. Now you do have to be thoughtful in how you do this. For example, a lot of machine generated proofs will Use ideas that have their origins in a human-written publication, and at present the attribution of that is not always automatic, so that's obviously a problem, meaning you have to put in that extra step to make sure the credit is given where credit is due.

[21:04] But acknowledging that very real loss of joy that I was referencing, I think a lot of mathematicians would look at what I just described and say, God, that seems awful. I don't want to be sitting there trying to like parse through a bunch of machine-generated slop, just understanding questions that somebody else has already answered. I want to find the solutions myself. My whole joy in pursuing math was to do it myself and to come to my own understandings of things. And I do think addressing that feeling is maybe one of the more important questions for the community as a whole to grapple with right now. But I suspect at least some of that feeling is referable to 2 different things. things. One of them is that at present the explanatory quality of what's coming out of the models often leaves a lot to be desired and no one wants to just parse through a bunch of slop. I suspect that'll get better. I think this might be a temporary blip in history when you have proof generation, which is also just almost incomprehensible. The model companies have a huge incentive for their models to be able to explain things well. If you look at the trajectory of code, I think early on a lot of the code generated if functional was still quite sloppy and the trajectory has been towards cleanliness.

[22:10] People might argue with me on that front. They certainly over comment. But by and large, I do think that's the trajectory. The deeper issue, though, I suspect is one of cultural inertia around what the mathematics community values and where credit has been assigned. Because one of the things that sucks is if it feels like you were pursuing a problem and then a model finds the answer, especially if it's coming from the model company and not like your interactions with it, and then it feels like that problem is solved and you're just kind of sweeping up after. after it. And for so much of the history of math, we have used proof as the proxy for understanding. It is the north star to shoot for where to prove something means that you understand it. We have these grand open problems and we consider the moment that a proof is created to be the moment they are solved. Now of course that's not everything and everyone's always known that's not everything. If you submit a paper to a journal and it's poorly written they'll just send it right back. If you were proving a very important theorem in that and it was poor It was poorly written, they would be frustrated because they would know that they should care, but they would still send it back and the onus is on you to explain it well.

[23:11] I think at this point we should consider proof to be kind of the same as numerical calculation, which is to say it's a form of raw data that is helpful for theory building, but it is certainly not the end in and of itself. This is not my own thought by the way, other people have framed the idea of these machine-generated proofs as being treated a little bit more like data. But I think very broadly, there is something liberating in thinking of theory building as being the goal, not proof, and proof as being a kind of raw data that you can plug into that. For example, I do not care about the forced blow-up to the Navier-Stokes problems. What I would care about is if somebody understands the ideas that went into that proof and the kind of mathematics that can flower out of those ideas into a beautiful coherent theory. And if someone puts in the work to doing that, Give them the Millennium Prize problem. That's the reason that we care it in the first place. The

proof is just data, it's like giving me more digits of π . This also influences how you do research. Maybe sometimes what you need is one more proof and interacting with the model is the best way to do that.

[24:10] But often it's probably not and what's better is to close the laptop, scribble through your own understanding of it, and ask, what's blocking me right now from developing a deeper theory for what's going on? Is it one more proof? Or is it something about my understanding of the existing proofs? Pulling up again our portions of math research, if the machines generate proofs but they don't communicate them well, that does mean you still need human mathematicians to make them understandable. Frankly, that's probably not the most fun part. It probably depends on your perspective, though. In either case, I assume that's relatively transitory, and let's just say the machines also get better at communicating their ideas. Incidentally, that's just written communication. A equally valuable form of communication is and is the more social side, which often happens through oral presentation. And I think throughout this whole future trajectory, the relevance of oral presentation capabilities It just gets higher and higher. The machine can't understand it for you, and a big part of math is getting other people to understand and care, and we're social creatures. So even if the machine's better at explaining it, a big part of what makes us care is seeing someone else who actually cares.

A conjecture machine

[25:15] One item on here is asking questions, deciding which theorems are the ones worth proving. At present, that remains an incredibly vibrant and highly levered area for mathematicians to spend their time. But let's just imagine, again for the sake of argument, machines get better at that too. Your interaction with a model doesn't just like asking it to prove a particular theorem, but it comes back saying, here are the other questions worth asking which might yield fruitful math, and by whatever way we're defining it, they are better at asking those questions than the mathematicians are. There's obviously a very blurry line between this one and theory building, but at least to engage with it for a second, let's suppose the humans are still better at that theory building side, actually making sense out of this broad set of theorems and how they were proven. That is what's most relevant to downstream applications and therefore from the perspective of funding math not only does it still make sense to do so you are much more leveraged in doing so because each individual mathematician is able to push forward theory much faster than they were able to previously. On the side of building up problem solving muscles, as always it's like weights in the gym.

[26:15] It does not matter if machines are better at it. You still want a practice of humans being trained in how to do that, assuming that human problem solving is at all relevant. than anywhere else in the world. On the aesthetic joy, I think we continue to see a little bit of a split there. Some people will not find it very fun to have a model both ask its own questions and then answer them. I know I myself am probably going to spend my whole life trying to think of interesting questions in my own head and find my own ways to answer them kind of irrespective of what the models are able to do. But you'll also have those people who are exhilarated, who feel less and less rate limited in building up theories, coming to understand those theories. And maybe even starting to see how they're applied at a cadence that doesn't look like waiting decades or centuries for some downstream application, but to maybe seek them out a little bit earlier than that.

A theory machine

[27:02] But what if, the grad student today might ask, the theory building side of it falls as well, and the most effective way to push forward theoretical math in some abstract sense is not just to have the machines generate the proofs or to ask what theorems they should prove, but they're also digesting all of those proofs, finding the elements of simplicity in it, understanding what truly novel fabrics you need to weave in order to come up with a coherent theory around it. It would be the analog of giving it all of math up to the... up to the 1500s and then having it not only solve cubic equations but come up with the right notation for how to even represent it come up with the theory of complex numbers you know all of the downstream things like that Maybe you don't think that's likely and that level of genuinely novel thinking is implausible from present LLMs given their reliance on human knowledge and their training data. But again, for the sake of hypothetical exploration, if nothing else, what does the field of math look like in that world? Well, insofar as we want to generate applications into the real world, by the assumptions of this hypothetical, the model is better at doing all of the theory generation.

[28:05] But you would still need somebody to understand all of that theory well enough to see how it gets applied in surrounding fields. Is any of this stuff relevant to curing cancer, or to making nuclear fusion a reality, or to high-temperature superconductors? That's where all the rubber is really meeting the road. On the individual problem-solving side, same deal as it has been throughout this story, you're at the gym. Does not matter if the machines are better, if problem-solving muscles in humans are relevant at all, you still want the practice of them going through all of that. On the side of aesthetics and joy, I realize I've actually been conflating two separate things here. So one version of the joy I'm talking about is that which is experienced by anybody doing math at whatever level. It's the part where seeing a clever solution and feeling how it clicks in your brain brings about a very unique kind of satisfaction or where coming to understand a new topic can change the way that you think in a way that's really desirable. It's everything that you and I are doing on this channel, for example. And then separately, there's the joy experienced by the researcher at the frontier for the feelings of pushing forward that frontier.

[29:05] Now in the first category, that one feels to me more or less unaffected by whether or not AI is better at certain tasks on this list. It's entirely analogous to the problem solving slot. And for the same reason, in order to experience this part of the value, you have to be the one who is actually doing the math and engaging with it in your own head. Now the existence of models capable of doing math probably has some influence on that for some people, but I also think this side of the joy is much more intrinsically communal or social, or at the very least it benefits from being communal and social. I think it's a lot easier to feel passionate about something when you are with others who are passionate about it, or if you're seeing someone else who's passionate about it. It can happen in isolation, it does, but that social component is always going to be an amplifier. For my part, I'm always going to want to engage with more pieces of math, come to terms with them in my own head, and share them with you, and spend my life sharing them with you, regardless of the capabilities of any machine. As to the joy experienced by the researchers... Here again, I think that split I've been describing just gets put into a sharper and sharper focus.

[30:06] You'll probably always have those who are exhilarated by a machine that offers them a very new kind of window into the world of math, and I think you'll always have

those who find that incredibly disheartening. Because let's be real, something is lost here. For so long you've had this tight coupling between advancing human understanding and all of these downstream applications, and in these hypotheticals we're talking about, about those are getting more and more decoupled and that probably means for some that that feeling of advancing human understanding just for its own sake loses a little bit of its oomph. Maybe you don't want to be reading a textbook that has an answer key at the back of it, even if you don't have to look at it, that defeats the whole pioneering spirit. A lot of the mathematicians I talk to, I think are not so interested in being, you know, at the frontier or being the first ones to discover something. They really do seem to find most of their joy in the community nature of it. And so undoubtedly you're going to see more and more subcurrents emerge within the math community, espousing the benefits of pushing forward a human understanding of math.

[31:05] math for its own sake as a worthy end in and of itself. So just to sum up its relevance in our diagram, insofar as there's always joy to be had in learning math, and that can flow through the teaching channel assuming people are willing to pay to learn it, that remains unaffected. Admittedly though, insofar as some of that joy was maybe coming from the hopes of being a pioneer, of being the first one to set foot in new kinds of theory. I mean, let's admit it, that would be a loss.

If AI is better at everything

[31:35] And just to play it all out, looking at the last one I have on this list, suppose the machines are not just better at generating proofs and not just better at posing conjectures whose proofs will yield fruitful mathematics, and not just better at understanding what that fruitful mathematics is and how it should be encapsulated into good definitions and good theory, but they're also just better than humans at seeing what applications those plug into and plugging it into science and engineering. Let's call this the anything you can do I can do better future. future. Here's where things start to get more interesting because for the first time on this value chain in theory all of the benefits that flow to application are better to happen just in the machine and so in theory insofar as the public and private funding was motivated by the downstream applications the most efficacious use of those funds would be to pour it towards some big blob of compute that just does math. It creates the theories, it plugs them into applications, it pushes things pushes things forward in that sense. If I had to guess, even though at this point that would be the rational use of funds, insofar as they are motivated by downstream application, I find it pretty hard to imagine that policymakers just flip the switch where the public funding no longer flows to humans but flows towards a big blob of compute.

[32:45] What I can imagine are certain individuals who have become highly wealthy from the AI itself starting private foundations that just pour towards a big blob of compute. that, you know, does math, seems like there's a good chance that will happen. What seems much more likely on the public funding side is that people will have been talking more and more about the other positive externalities that come out of math. For example, having this institution that trains problem solvers that spill out into the rest of the world, that is still incredibly valuable. That on its own gives positive ROI to any kind of public funding. Or if formal institutions do pop up that are around human math done for human flourishing. That's essentially embracing math as an art, which it always has been, and maybe at that point that's the nature of how the funding is even perceived. It is funded for

the same reason that the arts are funded, both publicly and also by certain channels of private philanthropy. But again, keep in perspective, those are not even where most of the money for math is coming from. Most of it is coming from teaching, and the value of teaching ultimately stems from these lower two elements in the value chain: training people to build problem-solving muscles.

[33:45] and instilling within them a very specific kind of joy by doing so. The future implied by this anything you can do I can do better future is so wild it's hard to even engage with seriously. And as a side note, all of this conversation is contingent on a branch where things go well and there's not something catastrophic. So again, maybe some people think AI safety is just a more important place for them to work right now. But while we're engaged with this and we're assuming that it's a good branch of the future. future, it seems likely to me that you'll still have something like existing university structures. Even if in theory the AIs are better at explaining stuff, people will still want to learn from humans because education is not rate limited by the clarity of explanation, it's rate limited by motivation. Do people actually want to learn the material, and what motivates people? Sometimes it's just the pure joy of learning in and of itself, but we're social creatures, and a huge part of what motivates people to learn is seeing somebody else deeply passionate about it, especially if that's somebody that they respect or care about.

[34:44] Teaching in general just feels to me like one of the most safe positions from a standpoint of AI job displacing because it's so relational, because it depends so much on a human-to-human interaction. No amount of clarity generated through a screen is going to substitute for that.

The best time to enter math

[35:01] So where does this leave us? I think for the foreseeable future, research needs to place more and more of an emphasis on the theory building side of math, which it always has, that always has been the point. But the main difference is that proof was a very valuable proxy for that, and it's losing its value as a proxy. At this point it's a form of raw data, it stands to be a useful form of raw data, and yes, undoubtedly we have to change how we measure human academic contribution. But that's probably a good thing. Proof in and of itself has probably been overvalued for decades. Similarly, insofar as the institution is valuable for sharpening problem-solving skills, it also does throw into question how exactly to do that, because previous methods for doing that training no longer apply. For example, assigning and grading problem sets on its own doesn't really make sense right now. And then even if you're worried about some sci-fi future where truly all of math can be mechanized, or even if you're worried that The training for problem-solving skills somehow won't be useful? Seems like a stretch, but, you know, let's engage with that. Math will always be valuable to humans insofar as there is joy in doing it.

[36:02] And one of the reasons I'm most bullish on that last point standing to be kind of a supporting pillar even in these wild sci-fi futures is because of this channel. I mean, think about what's going on here. There are millions of you out there willing to engage here, but what we're doing effectively is just... Just wallowing in the beauty of math and finding elegant problems whose solutions are very satisfying or trying to instill new ways of thinking. Now admittedly it's not like millions of you out there are willing to pay for that, I mean that would be great, but thousands of you are and that makes all the difference. And looking beyond this channel, one of my favorite examples to point to for why there's

clearly a big public appetite for math is to consider all of the channels run by Brady Haran where among all of them, the most popular by far is the one that he... One that he does about math. Or stepping back in time a bit, if you look at Martin Gardner, godfather of modern math popularization, it was initially the case that his column showed up at the end of Scientific American, but then they had to shift it up to the beginning because so many people were getting their subscriptions specifically for his column.

[37:00] Clearly, once people get a taste for what math really is, there is an immense appetite for it from society at large. So I think the mathematics community would be wise to turn itself outward. word and lean into satiating that hunger. Now for most of this video I've just been laying out why I think the institution of math is valuable and will continue to exist, but I opened with a stronger claim. I said I think this is one of the best times to go into math and I'm guessing many viewers clicking on this video might have anticipated that what I mean by that is that AI will unlock new opportunities in math, but actually I'm not referring to any of that. The reason I think it's one of the best times to go in is because the community as a whole knows that it needs to change, and so many people are leaning back looking for guidance and examples on what that change should be. So you, as a new entrant into that field, stand to actually influence what it becomes at one of the most pivotal times in its history. I think that's incredibly exciting. So to that comment from the PhD student, tell me what to do tomorrow, I can tell you what I would do if I was a PhD student in 2026.

[38:01] 6, I would do 3Blue1Brown. I would do exactly this. If 10 years ago I had entered some math department and said, hey, I have this concept for explaining math in a highly visuals first way, and oh by the way, can you please make that a academically recognized PhD thesis, not just a hobby, I would have been laughed out of almost every department. I'm not positive my younger self could pull that off today, but if ever there was a time people would be open-minded to it, now would be it. Now I'm not saying that's what you should do. You should lean into whatever it is that makes you love math. I love explaining it. I love visualizing it. That's my passion. That's what I want to run with. But what's yours? What do you want to run with? If you love the theory building side, you want to be the next Galois or the next Grothendieck, great, run with that. You have a proof generating machine at your availability that's going to get better and better over the next four years. Maybe you can use that to create a PhD thesis the likes of which the world has never seen. machine forging a new territory that you never would have been able to in a previous world. If you don't like the models, you don't want to use them, they leave a bad taste in your mouth, great, lean into that.

[39:01] There are undoubtedly going to be subcurrents within the math community that want to establish what math by humans for humans would be and what that would look like. You can plant a flag in the sand. You can decide what a PhD thesis emblematic of that goal would even look like. The other thing I would do is recognize that if machines are better at Are better at any subset of that research stack. The most effective way to measure a human's understanding of the material and their potential to help push forward the field, whatever that means, is going to shift more and more towards the oral presentation side. So give talks, give lots of talks, get really, really good at giving talks and make that a very regular part of how you practice your math. Now, my most concrete suggestion for what to literally do tomorrow is to go on a long walk. Find a friend, maybe someone else. someone else from in your program, and reflect with them on what is it that

you like about math? Why is it that you went into it? And ask them, what is it that they love? Why did they go into it? And together brainstorm how exactly you want the next few years of your life to contribute to various different parts of this value stack.

[40:02] For my part, I still love math. I'm always going to love math. I'm always going to love finding ways to visualize it and share them with you on this channel. My biggest hope for you is that you can find a way Find a way to lean into your own passion. The community has never been more open-minded, and they'll be listening to what you have to say.