Francis Su:

What does it look like to be a mathematical being and what does it mean to do mathematics well?

Joanna Meyer:

You're listening to The Faith and Work Podcast, where we explore what it means to serve God, neighbor and society through our daily work.

Hey, welcome to the Faith and Work podcast. I'm Joanna Meyer. I'm the Director of Public Engagement here at the Denver Institute, and I'm joined today by Abby Worland, our VP of Operation and Finance. Hi Abby.

Abby Worland:

Hey, Joanna. Good to be here today.

Joanna Meyer:

We're having a fun Friday as we record this episode and to get us started, I'm curious, Abby, do you consider yourself a person that enjoys math?

Abby Worland:

I would say yes. I have always liked math. I grew up around math and as our finance person, I use math every day, and so I think I've usually thought of math as something I enjoy and find really useful in everyday life.

Joanna Meyer:

I am not that person. I did not learn to appreciate math until college. In fact, it was a deep struggle for both my sister and I who are very literary minded people. We just did not take to math in the way it was taught. But recently I had a chance to discover the work of a mathematician named Francis Su, who's a professor out at Harvey Mudd College, who has this beautiful vision of mathematics as a tool for human flourishing. He is a Christian who's deeply integrated his faith and his work and it shows in his teaching and also in his public life and his writing. And both Abby and I had a chance to devour his book, Mathematics for Human Flourishing, and we were just enchanted. I loved this beautiful vision of the way mathematics introduces us to the breadth and the scope of the order of the universe and to know God better. And it's a real gift that we get to interview him on the podcast today. I think you're going to enjoy today's episode. Abby, will you introduce this to our guests?

Abby Worland:

We're excited to welcome Francis Su to the podcast. Today, Francis writes about the dignity of human beings and the wonder of mathematical teaching. He's a professor of mathematics at Harvey Mudd College and of former president of the Mathematical Association of America. His work has been featured in Quantum Magazine, Wired and The New York Times. His book, Mathematics for Human Flourishing, was the winner of the 2021 Euler Book Prize and it offers an inclusive vision of what math is, who it's for, and why anyone should learn it. It's an excellent book. Francis, welcome to the podcast. We're really excited to have you here today.

Francis Su:

Thank you so much. It's great to be with you all.

Abby Worland:

You're an award-winning mathematician and educator, but the road to mathematics for you wasn't necessarily an easy one. How did you fall in love with math in the first place?

Francis Su:

That's a great question. I guess when I was a kid, my parents gave me some books on math, started teaching me math ideas and puzzles, and I became captivated with math because I saw some of the beauty of math in some of these attempts to solve these puzzles.

Abby Worland:

I think that's a good reminder that math isn't always about numbers, it's more about solving puzzles and thinking about math in a more expansive way.

Francis Su:

And I like to talk about math as good thinking. It's the process of being able to think well, and anytime you're doing that, you're exhibiting some mathematical virtues.

Abby Worland:

That's great. Thinking about early on in your PhD at Harvard, you received some feedback that you might not have what it takes to be a mathematician, that you might not be cut out for

this, and I'm sure that was hard to hear. How do you think that experience has shaped the way you approach your work moving forward?

Francis Su:

I guess what you're referring to this experience I had where a professor basically said, "I don't think you have what it takes." And it's an interesting thing because when I went to grad school, normally when you go off to grad school, you're already, in some sense you've established yourself as being capable of mathematics. Being told that suddenly that you don't have what it takes is a jarring thing to hear. And I guess it makes me worry and wonder about all the people who at earlier stages in their mathematical pursuits or growth, get that kind of feedback. We have this tendency to try to categorize people as either math people or not math people. And I think it's a very limiting view. It's like saying to somebody, "You're a music person," or, "You're not a music person," but all of us have the ability to appreciate music, to enjoy music.

Maybe not all of us are going to perform at the highest levels, but that's not the point of music, actually. Part of the point of music is to enjoy it even if we don't necessarily create it. And I think people should view math the same way. Part of the wonder of thinking is that it helps us have a new perspective on the world, and in some ways, sometimes it can be enjoyable to think through things and understand things. It's way more enjoyable to try to understand something than it is to just memorize things and not understand or enjoy.

Joanna Meyer:

As I was preparing for our interview today, I was telling my sister about the book and we spent the next half hour talking about how painful it had been for us to learn math in elementary school and junior high. We both had moments where we felt like we had been shamed by a teacher or we simply couldn't figure out the math that was being presented and didn't have a way forward to be able to understand it. And some of the themes in your book touch on that experience, that people can be wounded by their experience of learning math and that as a result they really miss out on the richness and the critical role that it plays in human flourishing. And I'm wondering if you could elaborate on that a little bit. Why do we have such a hard time teaching math in a way that really connects with people at a heart level or conveys the beauty of what it is?

Francis Su:

I think one of the things we tend to do with almost any educational subject, but especially in mathematics, is to try to reduce it to something that is easily measurable or easily defined. And in math, this often looks like teaching kids to know their number facts, which is actually important. Kids should know number facts, but somehow we've reduced it to just memorizing facts rather than understanding. And it's easy if you give an exam, a math exam, to just see if someone can do a bunch of calculations. It's harder to actually measure whether they really understand or whether they're really creative or whether they're really persistent in problem solving. And I think part of the reason that we've reduced mathematics this way is because it's easier to measure. We think we're measuring math ability when we are measuring

whether people can calculate. But in this day and age, if you think about it, actually, we don't need better human calculators.

I like to say what we need are people who are good thinkers. We have calculators to help us calculate. Now, what's actually way more important if you want to reflect on this a little bit, is we need people to be able to say, "What I just calculated on my calculator actually can't be right," because you just thought about it and you realize the answer's not reasonable. You made a calculation error somewhere that actually is way more important and is going to be way more important in an era when computers, calculators and AI are going to be doing a lot more stuff for us than ever before. We need people who actually have the virtues of being able to think critically and to be able to say, "That answer doesn't seem quite right," or, "That algorithm is not performing like we expect it to be." We need, as I argue in the book, people of virtue, people who are actually able to cut through the fog and be able to think for themselves.

Joanna Meyer:

I wanted to know, I got to tell you, my teenage niece was eavesdropping on that conversation and I had said a phrase that I quoted from the book, I'm going to paraphrase it badly, but you talked about teaching mathematical processes that prepare people for careers they want to have. And my teenage niece looked at me and she said, "Totally. That's how I feel about math. There's no joy in this. I'm being taught it because it's a necessity and not because it contributes to flourishing." It was funny just to hear her react in that way. But you talk a lot about flourishing the book, and I'm wondering if you could tell us what you mean when you say that mathematics can be for human flourishing.

Francis Su:

I often think about human flourishing as, what does it mean to live life well? Sometimes people think about flourishing as living up to one's potential. I think with human flourishing, you often have both a being aspect and a doing aspect. A being aspect is some aspect of character that shapes the way you act in the world, and that character leads to good actions. For instance, if someone who is flourishing is someone who has both the character but also the actions that follow from that character that enable them and others to flourish. And flourishing doesn't necessarily mean having an easy life. You can be in very difficult circumstances, but also be flourishing, living well even in difficult circumstances. And the way I think about mathematics I think is more of an expansive view that thinks about what does it look like to be a mathematical being and what does it mean to do mathematics well?

And the being aspect is a lot of the things we do in the world, that we do in life are actually mathematical. We're all mathematical beings by nature. My son, just to give an example, he's three years old and he's learning words and saying lots of cool things. The whole time my wife and I have been married, we never actually unpacked our TV. And one day we decided we're going to have friends over, and we need something to entertain the kids so the adults can actually have a conversation. And we unpacked our TV and my son had never seen a TV before and he was just mesmerized by this thing. And the next day he said to us just out of the blue, he said, "Shall we turn on big phone?" And we were like, "Big phone? What? Big phone."

And for me that was a moment where they were two things that didn't seem like they were the same thing. They're not even the same category for me, a TV and a phone. But for him,

they were the same category. Even from a very early age, kids like my son have this ability to, I call it abstraction. They abstract. They're able to say, "This thing is like this thing." Even if they're not exactly the same thing, that's what they do when they look at two different dogs. You could have a little chihuahua and a big great Dane, and somehow my kid is able to say they're both dogs. Why is that? It's because he actually was born with a natural ability to abstract. That, for me, is an example of mathematical thinking. It's not what a lot of people necessarily see. When they think of math, they often just think of the calculator.

But he's doing a lot of that. Another example of a mathematical virtue is visualization. Being able to visualize, to imagine something in your head and being able to describe it in some visual way, that's a mathematical virtue as well. Those kinds of things are actually very valuable. They're going to serve you well the rest of your life, but they also enable you to enjoy the world.

That's the flourishing part. They enable you to see the world in a different way and to understand the world and to derive some satisfaction or joy. Of course I laughed at this incident with the phone and the TV, but there's also just the delight of being able to look at a creature and categorize it. That's part of how we're meant to, I think enjoy life as well. And that's a flourishing aspect and we want all of our friends to be able to do that as well. There's some of the actions that would follow from this, seeing the world different ways that we'd wish everyone else would open up their eyes to see the world differently as well. And that's part of how we communicate what's meaningful in life.

Abby Worland:

Hearing you talk about what math actually is making me think that before we can see math as a key to flourishing, we have to have a much bigger definition of what math is. And I think a couple of things that you said, bear repeating, that idea that your math ability is not the same thing as your ability to calculate and count things up. That math ability is like your son, his ability to categorize things or abstract things. When I was an elementary school teacher in math, you want them to get to the correct numerical answer. That's part of it. But it was more about flexible thinking. Can you get to that same answer multiple ways? Can you come up with different strategies? Can you be creative?

And I think that if we think about math as a way of thinking instead of a set of number lines or counting objects, I think that's the key, or at least that's what I was understanding as I was reading your book. I was like, "I like math. And it pushed me to think about math in a totally different way as a way of being and as a way of thinking." And I think that idea that there are virtues in that thinking. In your book, you have chapters called, Exploration or Play, that if we approach math, if we approach life with a spirit of exploration or a spirit of play, those are things that make our lives enjoyable and just delightful. And that really helped me.

Francis Su:

What I try to do in the book is to help people see the connection, the tight connection between math and all the basic human desires we have. We have a basic human desire to play. We have a basic human desire for beauty, for truth, for freedom. All these desires we have in some ways can be met through math and in some ways not unique, in some ways, unique ways.

There's a unique way to experience mathematical beauty that I would hope everybody would have some chance to enjoy, just like I might hope everyone have a chance to hear a symphony, to experience that or to experience hip hop or experience some other kind of musical beauty. The same thing happens in math, being able to see the world differently. You asked a little bit, a question about defining what math is, and one way that mathematicians like to describe math is being able to see patterns or understand patterns. And I like that. Sometimes we call math the science of patterns, but there's also the very human aspect, an artistic side to mathematics, which is there's an art to seeing those patterns and understanding those patterns and appreciating and enjoying them as well.

Jeff Hoffmeyer:

Hi, I'm Jeff Hoffmeyer, Vice President of Advancement here at Denver Institute for Faith and Work. And I'd like to invite you to become a part of our new monthly partner community. Whether it's a monthly commitment of $25, $50, or any amount, your generosity will support Denver Institute's ongoing efforts to help men and women love God, their neighbors and society through their daily work, including this podcast. To say thank you, as a monthly partner, you'll receive a welcome box. You'll have exclusive access to private digital content, personalized vocational coaching, and discounts for Denver Institute content and experiences. To become a monthly partner, simply visit denverinstitute.org/give or see the show notes in today's episode. Thank you in advance for your generosity.

Joanna Meyer:

I wanted to pick one of the themes from the book that caught my eye and was very counterintuitive. It's not how I would usually describe math, and that was the theme of

beauty. I guess we think of A Beautiful Mind, the movie, and we saw mathematician

portrayed in that. But tell us how math invites us to see beauty.

Francis Su:

That's interesting that you asked that. If you ask a mathematician or a number of

mathematicians why they do math, often the biggest reason is beauty. And again, part of why

I wrote the book was to try to help people see a side of math that not everybody sees, but is

often a big motivation for those of us who do math professionally. And why is that often

missing from our math experiences? That's a question to ponder, but an example of beauty is

being able to look at a pattern and appreciate something about that pattern that enables us

to enjoy it. Maybe it's easier just to give an example.

Joanna Meyer:

Geek out on us a little bit.

Francis Su:

Give an example. This may have been one of my first experiences of math beauty was when

as a little kid, one of my parents' friends came over to the house and they heard that I was

interested in math. And they said, "Do you know how to add up the numbers from one to a

hundred in your head?" And of course, I didn't know how to do that.

I was like, "That seems hard, one plus two, plus three plus four. It would take forever to do

that." And he said, "No. Let me show you a better way."

He said, "Think about the numbers all lined up in a row. And if you imagine how many numbers you have, you have a hundred numbers all lined up in a row, and imagine grabbing the first thing and the last thing on that list, that's a one and a hundred. What do those numbers add up to? 101. One plus a hundred is 101. If you take now the second thing on the list, and if you move in from the ends, you move to the second thing and then second to the last thing, that's two and 99, those also add up to 101. And if you grab the third thing and the third from the last thing, that's three and 98, those add up to 101. And at some point you realize that whenever you move in from the ends, one at a time, you're grabbing pairs of things that add up to 101 always add up to 101, and there are 50 pairs of those things. That's really just 50 times 101, which is actually a lot easier to think about. That's 5,050."

Whoa, mind blown. For me, that was just a moment of seeing something that you could appreciate because it was a simple idea that made a hard problem seem now suddenly doable.

And that's built on the idea of symmetry. If I look at the numbers one to a hundred, they have a certain kind of symmetry around the middle that enables you to take advantage of that symmetry and see something and do something in a way that you might not have seen before. I don't know how easy that is to follow over on a podcast. I am doing all these hand motions as I'm trying to explain that, but you see this pattern that it enables you to do something pretty nifty. A lot of mathematical math puzzles are like that. Often they're constructed to help you appreciate something beautiful, not always.

Abby Worland:

And that beauty can be found anywhere as long as you're on the lookout for it. I think in your book, I want to read just a couple sentences from your book and go from there, but you're talking about this idea of beauty in your book and you say, "I see now why studying beauty matters even when it has no immediate application. The beauty of reasoning and the order we behold in patterns reflect something divine and are worth studying for their own sakes rather than for personal glory." And I think that that is an amazing idea. Your teaching and writing aren't necessarily limited to a Christian audience, but for those with the eyes to see it, if you're really looking for it, your faith permeates every aspect of your work. And I could definitely see it and feel it while I read your book. How would you say your study of math has shaped your faith and then vice versa, how would you say your faith has shaped your work in mathematics? Could you talk a little bit about the relationship between those two?

Francis Su:

Sure. One thing it's interesting about faith and math is that they're both, in some sense, journeys. You begin to see the world in a different way, and there's always stuff to learn and you're always growing. And I think that's also true, both in my math experience as well as in my experience of faith. I didn't come to faith until I was in college and I took a step, a leap of faith, which was to believe that God exists. And there was a whole set of things that come with that maybe I didn't quite understand at first. But over time, you begin to grow and understand. And these two kinds of pursuits are actually, I think, very similar in ways that are sometimes surprising. You often hear people who aren't people of faith, but are mathematicians, talk about math in very almost spiritual ways, talking about math as being

beautiful. One famous mathematician was well known for talking about the book that God keeps in which all the most beautiful proofs are recorded.

And this fellow's name was Erdos, was actually not a person of faith at all, but he imagined that there was some book somewhere that the most beautiful arguments were recorded. That's surprising and there are many reasons for that. But in my own growth as a mathematician, one of the things you learn in math is that there are different notions of sizes of infinity. And that in many ways helps me appreciate the richness of what it means when people in my faith life talk about God as being infinite.

As a mathematician, I actually have a richer view of what infinite means, that infinity is a rich, complex, beautiful idea, and I think I'm better off in my faith for having some understanding of that on the mathematical side. Think on the flip side, my faith helps me see aspects of mathematics that maybe others would just chalk up to beauty. But I guess I appreciate that God is a God of order and reason. And when I see beautiful mathematics, I don't worship mathematics itself, but it leads to have a greater appreciation and worship for God. And that in some ways enriches my study of mathematics in a way that's a little different than someone who isn't a person of faith. I think the inclination there would be to worship the math itself.

Joanna Meyer:

It reminds me of some of the early scientists who were deeply Christian, people who felt like the discovery of the order of the universe was revealing the truth and beauty of God. I think that applies to mathematics as well. I wanted to ask, and this is going to sound like two disparate values, but I actually think they're interlocked because your faith, as I read the book,

clearly shapes the way that you approach teaching in the classroom. One element is that you have a grace based approach to teaching and the others that you speak openly about areas of injustice in the mathematics world. And I think those actually go together in that sense of creating a space where people are free to be who they're authentically are, and also opening the door, people who have been excluded from opportunities in the math community are invited in. There's both this sense of relationship and healing and invitation, but I'm wondering if you could elaborate a little bit about how your faith speaks into those virtues in your teaching.

Francis Su:

I guess one of the things that's a deeply Christian idea is that our dignity, or our worth, is not dependent on what we do, that God grants us an inherent dignity and worth. That doesn't come because we're more righteous than anybody else, or because we are more intellectually sound or doesn't come from the color of our skin, thank goodness, that all of us as human beings are of inherent value and worth and dignity. And that idea, I think really helps me think about the way I teach. It's very easy for me to feel attracted to teaching just the students who seem to get it, who seem to care the most about studying math. And I think my lens, the lens that comes because of my faith is seeing everybody as inherently dignified and worthy means that I need to be teaching in a way that pulls everybody in, not just the ones who I would call, A students.

I think that's a very valuable lesson in the educational community. We try to motivate people to do well, to perform well, and it's good to actually learn stuff, that does enrich our lives. We hope that we're not just motivating people to study math to get a good grade, but because it'll

enrich their lives. The same thing is true in general for education. And not only that, but it is valuable to have people who have expertise. We want to put somebody on the moon, we need people who actually know math and physics and know how to use those tools well.

Expertise is valuable on one hand, because it does enable us to flourish, to live well, to help others to flourish as well. On the other hand, we can't be idolizing performance and expertise in a way that calls one person more dignified than another because they have that expertise. And that's a tension that we often have as educators, and especially if you're a person of faith, you have to think through what this means. If you're not a person of faith, then of course performance seems to be everything. I think that was my worldview before I became a believer was, "My goal in life is to get a good job and to succeed," whatever that means. And now that I'm a believer, I see how limiting that is. I think it's more important to live a life of meaning and to see the world for what it is and appreciate it for what it is.

Abby Worland:

Absolutely. Many of our listeners, that are listening right now, work in secular contexts just like you do, and I'd love to hear a little bit more about how when you're at work, you don't necessarily hide your faith, but instead you find ways to authentically express your faith that are organic and appropriate to your work context. Can you just tell us a little bit about how you think about that and how you approach living out your faith in your workplace?

Francis Su:

I think a lot of this comes out of the fact that I didn't grow up in a Christian home, and it was only something that I came to later on in life as a college student. And one thing that I try

carefully to do is to not speak in jargon that oftentimes people of faith have a particular set of words that we use. And whenever I do speak about some of these ideas, I try to explain it in a way that would make sense to the previous me, the person who had no real faith knowledge or background.

And this concept of grace, the fact that we don't necessarily, we don't earn our dignity, that our dignity comes from outside of ourselves, that's a beautiful idea, and it permeates the Christian faith and Christian understanding. But it needs to be explained for somebody like previously who thought performance was everything. It can be both jarring. It can be freeing, but also jarring. It's jarring to be told when you've lived your whole life trying to perform, perform, perform. It's jarring to be told that your dignity doesn't come from your performance, just like it's jarring to be told, "You're never going to make it as a mathematician."

If I am idolizing being a mathematician and suddenly that's it, "What else is there to life?" It can be both jarring, but it's also deeply freeing to be able to say, "Thank goodness that I'm not judged by my performance, either my intellectual performance or my moral performance. Thank goodness. Thank God, Lord, thank you so much that I'm not being judged because of how good I am." And I see that a lot in the communities I walk in, where academics you can grow to idolize the performance instead of appreciating what the education brings to you.

Joanna Meyer:

As we wrap up our conversation, Francis, one thing we always like to do is just to invite our listeners into this life of greater integration and faithfulness as they live out their walk with God in their work. And I'm wondering if you would just have any final word of advice for our

listeners, just an encouragement towards that slow faithfulness of life or faith that's integrated into work.

Francis Su:

One of the biggest things that I do and that I wish I had started sooner or was more faithful about is keeping a Sabbath, reserving time one day a week, whether it's actually on Sunday or some other time of the week, where you practice the idea, Sabbath is an opportunity to practice the idea that your work is not everything, that it's not the most meaningful thing, and obviously that's a time to devote to spiritual health and worshiping God, but it's at the same time what you're doing is you're also denying the things that normally you feel give you dignity and maybe a misplaced sense of dignity and worth. I would say that's probably one of the biggest things is to keep a Sabbath, take a Sabbath. That's been very, very helpful for me.

Abby Worland:

That's such a good reminder. That no matter how meaningful and beautiful our work is, whether we work in math or not, that there's something more meaningful and more beautiful that we can worship and that's God and using the Sabbath to do that. And I think that's a good reminder for me and for all of us as well. Francis, it wraps up our conversation for today. Thank you so much for joining us on the podcast. And I feel like I need to go do some math right now, go find some word problems or some puzzles. You've helped me reshape my thinking about math, and I'm really thankful that you were able to join us today.

Francis Su:

Thank you. Thanks so much. It's been wonderful talk with you.

Joanna Meyer:

Was I right? Were you intrigued by what we learned about mathematics for human flourishing today? As follow-up In today's show notes, we will be linking to a few resources. One is we'll link to Francis Su's book, Mathematics for Human Flourishing. We also will link you to a free course in the Faith and Work Classroom called, Caring for Creation. It's another STEM related course that invites you to think about how God is at work in the sciences and creation care.

And finally, this episode airs at the end of the year, and it's a season of end of your giving. And if you've been encouraged by what we do here at Denver Institute and The Faith and Work Podcast, we encourage you to consider making a financial gift to the organization. And we'll have a link in the show notes that can direct you to do that, or you can find the gift-page at denverinstitute.org. Thanks for joining us today.

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