But Why: A Podcast for Curious Kids

Who created math problems?

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Jane 00:19
This is But Why: A Podcast for Curious Kids from Vermont Public. I'm Jane Lindholm. On this show, we take questions from curious kids just like you, and we find answers. I had a math teacher for a parent, so for as long as I can remember, Math has been a part of my life. My stepdad made me and my brother do math games on long car rides, and he still gives us math riddles whenever we go visit him now, even though we're adults. He wishes us a happy Pi Day every March 14, and suggested we use the Fibonacci sequence for our essential passcode numbers. Don't know what the Fibonacci sequence is? You will by the end of this episode. Math and numbers are fascinating, but I also know it can sometimes get difficult to wrap your head around big math concepts in school or on long car rides with a math-loving adult. So today, we're going to demystify math. You've sent us a lot of mathematical questions, and our guest today loves all of them. Dr. Melania Alvarez is the Outreach Coordinator for the Department of Mathematics at the University of British Columbia in Canada, and she's the Education Coordinator for the Pacific Institute for the Mathematical Sciences.

Dr. Melania Alvarez 01:35
So my job is to go all around, showing people how wonderful and interesting and exciting mathematics really is. If you invite me to your school, I go to your school and bring some interesting games and puzzles and things like that to show you, you know, how much fun you can have doing mathematics.

Jane 01:54
Can you give me a puzzle?

Dr. Melania Alvarez 01:57
Oh, there are many, but one, one that I have. So there's a farmer, and he sells chickens. So he goes to the market, and in the he's going to go to three markets. And so there goes to the first market, and he sells half of his chickens plus half a chicken, okay?

Jane 02:16
Okay.

Dr. Melania Alvarez 02:16
And then he goes to the second market and he sells half of his chickens plus half of a chicken. And then he goes to the third market and sells half of the chickens that are left, plus half a chicken. And that's it. And then he has zero chickens, right? That's it. After that.

Jane 02:32
He sold all of his chickens.

Dr. Melania Alvarez 02:34

He sold all of his chickens, so yeah, no chickens left. So how many chickens did he have? When he sold the chickens, they were all alive.

Jane 02:44
I don't know.

Dr. Melania Alvarez 02:48
He sold all live chickens,

Jane 02:50
All of his chickens,

Dr. Melania Alvarez 02:51
All the chickens were alive. Yes, half a chicken cannot be alive, right? So how many chickens did he originally have?

Jane 02:58
I see, okay, I feel like I need to write it down on paper, though. So while, while I'm working on this, let me ask you some of the questions that kids have sent us about math, starting with some kids who want to understand, who created math?

Sophie 03:12
Hi, my name is Sophie, and I'm eight years old, and live in Arlington, Virginia. Who invented math?

Oonas 03:18
My name is Oonas, and I'm six and a half years old, and I live in Brooklyn, New York. Who invented math?

Dr. Melania Alvarez 03:27
Math is something that grew through thousands of years. It's like a magical tree that was planted by many, many people, by the Chinese, the Mayans, you know, so ancient people needed to, needed to count, at some point, when populations started to grow and we started to have cities, we people needed to count. We needed, people looked at how much property they had. There are some cultures where they only have one, two and many. But you know, the more you have, you need to, you know, to count. You need to measure. You need to trade. So we started inventing numbers. Humans started to invent numbers and systems and symbols and rules and but here is the twist. So we started to invent that. But at the same time, math is not just invented, it's also discovered. There are also things there that are there and we and we discover, like a triangle has three sides. We didn't, you know, invented that. You know, it's that's something that is true. So there are things that we created in order to make sense of a lot of things, and with that invention, we also discover a lot of things. So who invented math is we humans started to observe, started to look for patterns out of need, and we created systems that allowed us to describe what we were seeing, and that's what math is.

Jane 04:45

So Leilei wants to know who created math problems, and if we needed to know how to do math as humans, especially as you say, as we started to have communities and use money or barter for things. But maybe Leilei is asking, morelike, who created the study of math, or this idea that we teach people math and do math problems, not just learn how to count, because we have to know how to count.

Dr. Melania Alvarez 05:12
Well, what happened is that the moment we are faced with a situation like, okay, I need to get to school, but first I need to have breakfast, I need to wake up, I need to brush my teeth. So then you start thinking, okay, how much time I'm going to take for breakfast, and how much time do I need to get from here to school? So natural events that happen to us, and these are problems that we solve in order to be able to deal with some realities in life. So who created problems? Well, yes, sometimes you have your teacher creating tons of problems so that you suffer through them and stuff like that. But math problems come from the world. When we start to wonder, you know, the Egyptians, it's like, Okay, how do I build this pyramid so that it doesn't fall down, or it doesn't crumble, or a bridge as well, an engineer, I'm going to build this bridge. How do I build this bridge so that it will resist trucks going on top? Or how, if this young girl likes chocolate and she has to divide it equally with siblings, how do I divide it in a way that is fair for everybody, you know? Or I strategize perhaps. How do I do it so that I can get more chocolate than others. So this is where math, where really math problems come from. Now that sometimes we create ridiculous problems, like my mother bought 300 watermelons and divided between me and my siblings. Well, those are weird problems that sometimes I made for school. But real math problems really come from the world.

Jane 06:43
Leilei also wonders, why does one plus one equal two and not 11?

Dr. Melania Alvarez 06:51
We have this system of writing numbers that is called place value. So it depends where the number is. So one one means that the one to your right, the first one, is a one, but the next one is not the one. It's a 10, you see. So for example, the number 245: in that number, the two is a 200, the four is a 40, and the five is five. So it depends where you position the numbers that it changes. So one plus one is two and one one does not represent two, that one represents a 10 and then a one, so 10 plus one is 11.

Jane 07:33
Yeah, it's just interesting to think about. We've created these systems that are supposed to make it easier for us and easier for us to do these kinds of problems with other people, so that your brain and my brain can match up, and we both understand what one plus one equals. I think I see where Leilei is coming from in that it can be really interesting. It can kind of blow your mind when you start to think about like, oh, we had to make this work for all of our brains.

Dr. Melania Alvarez 08:00
For everybody, exactly.

Kai 08:02
My name is Kai. I live in California, and I'm four years old. Why is there so many numbers in math?

Dr. Melania Alvarez 08:12
Oh, what happened is, as I said, when counting started, we had very few numbers. You know, it was 1, 2, 3, many, and then somebody, instead of having three sheep, now tomorrow, they have four sheep or five sheep, and then they have to add that. So we needed a system that the more we have, the more needed to be accounted for. And we have a very, very nice system where, you know, we just basically can go on forever and ever and ever and ever and ever.

Jane 08:39
Well, some of the kids want to know why.

Lily 08:40
My name is Lily. I'm nine years old, and I live in Portland, Oregon. Why don't numbers end?

Isla 08:48
Hi, I'm Isla. I live in Clearwater, and why do numbers stop?

Nicholas 08:54
My name is Nicholas. I'm five years old. I live in Washington, DC. Why do numbers go off forever and ever.

Jane 09:01
Why don't numbers end? Why do we never stop adding numbers? Is there really infinity numbers?

Dr. Melania Alvarez 09:08
Yes, yes. You can give me a number and I can add one to that number, then now you have more numbers. You know, for example, there's the googol which has a one and 100 zeros afterwards, right?

Jane 09:21
That's right before we all knew what the internet was, googol was just a number. That's googol spelled G, O, O, G O L. Google, the internet search engine is G, O, O, G, L, E. Googol, the number, as Melania said, is a one followed by 100 zeros.

Dr. Melania Alvarez 09:43
It's a huge number. And then there's the Googolplex, which is even larger than that. And you say, so there's a Googolplex, and I can add one to that, and it's bigger than the Googolplex. And then I can add one to that one. And I can keep going on and on, adding 1, 1, 1, 1, 1, and 1. And I just go on, you see. But also infinity can be kind of also small. Like, for example, I have a mile to go, okay? And so then I can go half a mile, and then I go half of half of the mile, and then I get half and half and half of that, and that, do I ever get there? No, never. And I can go infinitely, going and the steps are smaller and smaller and smaller. Eventually, in real life we get there, but mathematically, we just can be stuck there, trying to get there. But if you always do half, half, half, half, half, we will not get there. This is what is amazing about mathematics, is that you can go on with your imagination, and math is a great companion for that.

Jane 10:44
Yeah.

Dr. Melania Alvarez 10:44
And it shows you ways that you never thought that were possible. And that's what is so wonderful about it.

Jane 10:51
It can kind of make your brain hurt when you try to think, think, you know, all the way out on those things, but hurt in a good way. I mean, it's just cool.

Dr. Melania Alvarez 10:59
So it is true. You talk about the hurt and about the struggle and all of that, but what happens when you are able to solve a problem that is really, really hard? How do you feel about that?

Jane 11:11
Really good. Proud of myself.

Dr. Melania Alvarez 11:12
Really good.

Jane 11:13
Yeah. Like, I figured it out.

Dr. Melania Alvarez 11:15
You get this big high, isn't it? You get like, wow, I'm really smart. I'm at the top of the world. You know, that's what we mathematicians live for. Do you know we were working, we struggle, and then when you finally solve it, and not just solving it, is the beauty sometimes of those solutions that are just like, how can this be so perfect? And that's why. And there are mathematicians that spend a year, two years, eight years, you know, 10 years, trying to solve a problem, but they think that it's worth it. So that's another thing. You don't need to be fast to be a good mathematician. Many kids think that they have to be really fast problem solvers to be really good mathematicians. That's not true. You know, you can take your time.

Tryphon 11:59
Hi, my name is Tryphon. I'm nine years old, and I live in Winnipeg, Manitoba, Canada. Why do people hate math so much?

Jane 12:09
Why do people hate math so much? And we should say, certainly not everybody, but math has a reputation, and people sometimes seem to feel comfortable saying, Oh, I'm not good at math, or I hate math, in ways that you wouldn't say about other things.

Dr. Melania Alvarez 12:24
That's right. First of all, many times, is the way that math is presented to us. It's just like a series of rules, and you're to solve this problem, and that's it. And that's not math, actually. That's just something that we call practice. Real math is not that you need to know the tools. You need to know how to add and subtract and all of that, yes, but it's like you need a hammer and you need nails to build a house. So that's what that is. But math is thinking. Math is strategizing. So math is not just the solution. It's the way to get there and how and your thinking to get there. So it's, so many times is how math is... if it is just rote learning and just memorizing all the time, which we have to do sometimes. But if that's the only thing that we learn and the only thing that we do, then is really boring. I'm telling you, if that was math, there wouldn't be professional mathematicians, because no, come on, we're not that boring people. We really like, we're explorers. That's what it is, math is about exploration. It's about questioning. It's about doing all that. If you start to dislike math, and this is also something that happens, is perhaps along the way, and I find that many people say I like mathematics, but at some point I start disliking it, because I got lost. So what I tell kids is this: if you are in class and you understand that everything and all of a sudden you don't understand something, go and ask your teacher, but soon. Don't wait a month or two months afterwards, go immediately and ask your teacher, Hey, I didn't get this. Could you explain it to me again? Because math builds on top. You know, it's something that you it's a structure where you... So if you miss the first floor, then the rest of the floors are going to be all wobbly and you're not going to understand. So don't be embarrassed about asking, and if you're embarrassed in front of the class, then ask after class. But don't leave something that you don't understand and say, well later on, I'll catch up. No, no, no, no. So don't get lost. Go for help as soon as possible.

Jane 14:23
That's always good practice. If you don't understand something, ask a question, get some help. Math is complicated, and if one explanation of a math concept isn't working for you and your brain, you can always say, Could you describe it to me a different way? Or maybe you need someone to write it out for you, or help you work backwards from the answer back to the original question. You can ask for different kinds of help to make sure you understand the math you're working on in school or at home.

Jane 14:52
Coming up, why are the numbers in the order they are, and is there really math in everything? And of course, I still have to solve that puzzle Melania gave me about the chicken farmer. Stay with us.

Jane 15:08
This is But Why: A Podcast for Curious Kids. I'm Jane Lindholm. Today, we're talking about numbers and math with mathematician Melania Alvarez. We're going to solve that puzzle about the chicken farmer in just a little while. But first, some of your questions about how numbers are ordered and how they help us count.

Kai 15:26
I'm Kai, and I'm six years old, and I live in Saint Paul, Minnesota. Why is the numbers in order? Why are they in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, why can't they just be like in different orders?

Dr. Melania Alvarez 15:41

Well, so numbers are like a step ladder. We make one number, and then we go to the next, and when we go to the next, and then we go to the next. So, so that's why it keeps an order, and that order helps us to count. If the numbers were all over the place, imagine we have here one, and then comes 25 and they call 36 and how can we count like that? We can't! So it is like a ladder. We go step by step by step, and we gave them numbers those names, right? Because we need them to track things. We need them to trade. We need them for things in real life. And if we didn't have that order, we wouldn't be able to do that. We'll be lost in confusion in the jungle of numbers. So, so that's why there's a rule, why we have an order. You know, it's like why don't you build a house upside down? Because then it wouldn't make sense. So that's exactly the same thing with this.

Miles 16:37
I'm Miles and I'm five years old. I live in Quebec, Canada. Why are numbers for counting?

Dr. Melania Alvarez 16:45
Why are numbers for counting? Well, the numbers are counting because, actually, that's where math began. Math began with counting, long, long, long, long time ago, over 20,000 years ago. So this is something that helped people to survive.

Jane 16:59
And you can think about, let's say, you had to get through a winter, and you're, you needed to have enough crops for your whole family to get through the winter. Well, you have to know how many people are there that I'm trying to feed. So let's say there are four people in my family. How much do we eat every day? How many days do we need to get through to get through the winter before we can grow more food. So you need to be able to count and add and multiply to know how much food you need to store for the winter, which will take you to how much you need to grow in the summer, which will take you back to how much you need to plant and how many plants you think the animals are going to eat before you get to have them. So how much more do you actually need to plant to be able to have enough to harvest... and, uh oh, there's a new baby in the family. Now you have to do that, but for five people, so you have to be able to do that math in order to survive, and even if we're not thinking about growing all of our own food now, as families, we have to figure out how to budget, how much money we need, how much money we need if we also want to go on vacation to the beach at some point. So math is really important, and we do like it because it helps us get the things that we want and need, even if we think, or some people think they don't like math in school.

Dr. Melania Alvarez 18:18
You're absolutely right.

Jane 18:20
Zoe lives in California and is seven and wonders, why do you need to do math? We already said math has helped people survive, but what are some of the other ways math is needed?

Dr. Melania Alvarez 18:30
Well, you need to do math for for so many things. You need to do math to go to the supermarket. You need to do math to trade with people. You need to do math, to build a house, to build a pyramid, to

study chemistry, to read graphs about how, who's going to win the presidential election. So we also need to know, like, for example, if you are in class and you want to go to recess and you want to know how many minutes are there to recess? So you can count them. Oh, it's almost almost five minutes to recess, I want to go there. Also, if you, if you like, to trade cards. How many cards should I trade for this card? That card is worth three of these cards. And now, for example, all this technology, the phones, the TVs, everything, all of that was created thanks to math.

Saanvi 19:21
My name is Saanvi. I'm 10 years old, and I live in Bothell, Washington. Is there math in everything?

Dr. Melania Alvarez 19:27
Math is not just in everything. Math is also a way to see everything. We can see it in patterns from nature, flowers. There's a sequence called the Fibonacci sequence that goes one one, and then what is one plus one, is two. And then one plus two is three. And then if I add two and three, so I take the last two numbers and add them up, and then I get the next sequence. And what's interesting is that that sequence represents a lot of things that happen in nature, the petals in flowers, they usually, they are Fibonacci number. So the really math is like this invisible thread that connects everything around you, and it is the spiral in the shell. We have the rhythm in music, when you bounce a basketball, too. The trees in the branches. But the secret about this is you can see this if you are curious. You have to be curious, okay, to see it. So math doesn't necessarily scream for attention. It whispers to you, says, hey, hey, come check it out. Well, you have to be curious. You can notice a lot more if you're curious, and you can have a great time if you're curious.

Jane 20:44
Well, you came to the right place, because anybody who's listening to this podcast is a curious kid. It's in the name of our show. So all of the kids who are listening, that's something that we all have in common all around the world. We are curious kids who want to know more about the world. So if you have us convinced. Let's wrap up with Alistar's question.

Alistar 21:05
Hi, my name's Alistar. How do you become a mathematician?

Jane 21:10
How do you become a mathematician? We all want to do it now, Melania, how do we become mathematicians?

Dr. Melania Alvarez 21:15
So first of all, we are all mathematicians. You know babies, they immediately can recognize patterns. When we are playing and we're putting cubes on top of each other and trying to measure if it's going to fall or not fall, you know, and how to build things when we're little, we are all mathematicians, all of us. When we like to say, How many cookies I need to bake for everybody in my family, I look at cool pattern, I say, Oh, how does that grow? How can I continue this pattern, all of that. Now, mathematicians, a real mathematician, not just answer the questions, they also ask questions. A mathematician is always asking questions about how things work, and then tries to answer it. So this is

what it is. Everybody, you know, everybody can do math, and we all can be mathematicians. Now, if what you want... asking is, how I become a professional mathematician, usually, most mathematicians, I mean, there are some who don't, but most of them go to university, and they... they have become undergraduates in math or a math related thing, and then they go for a PhD in mathematics, and they solve problems. Now there are two types of mathematicians, mainly. The applied mathematician and the pure mathematician. So I am an applied mathematician and my husband is a pure mathematician. So an applied mathematician people come with problems to me, like I have worked with problems in anthropology. I have worked with problems in engineering. So engineers come with a problem and they want, you know, they want someone who does all the calculations and who creates a model of what they're seeing. So I do that. So people comes with their problems, and I take care of their math problems, only their math problems. So that's right. The pure mathematicians, they ask questions if some really abstract thing can work or not work, you know, and then they start, they start working on the on this abstract mathematics that it looks like they are useless, that who cares, doing this math, that there doesn't seem to be real application. And lo and behold, 10 years from now, 200 years from now, 3000 years from now, all of the sudden we find the application. Isn't it.. it's like magic, and that's what is so exciting about math.

Jane 21:15
That is so cool. Okay, so before we end, I want to go back to the problem, the puzzle you gave us at the beginning, and let's recap it. So the question was, there's a farmer who goes to three farmers markets and he has chickens for sale. And at the first farmers market, he sells half his chickens plus half a chicken. And at the second farmers market, he sells half his chickens plus half a chicken. And at the third farmer's market, he sells half his chickens plus half a chicken.

Jane 21:15
Yes.

Dr. Melania Alvarez 21:15
And he has no more chickens. And you gave me a really great clue, which is that no chickens were harmed in these transactions.

Dr. Melania Alvarez 21:15
They were all alive.

Jane 21:15
They were all alive.

Dr. Melania Alvarez 23:19
So how many chickens did he originally have?

Jane 24:21
So I want anybody who's listening now who wants to solve it to pause the episode and see if you can figure it out.

Jane 24:37
Can we go through the answer and how one way that we might be able to solve it, because I was thinking about it while you were talking, and I think I have an answer.

Dr. Melania Alvarez 24:47
Okay, why don't you tell me what you're thinking about?

Jane 24:50
Okay, I think he had seven chickens at the start.

Dr. Melania Alvarez 24:54
And how did you solve that?

Jane 24:55
When you said all the chickens were alive and at the end he had no chickens, it made me realize that when he at the very end at the last market, he sold half of his chickens plus half a chicken, he would have to have one chicken to sell, because no chickens were harmed.

Dr. Melania Alvarez 25:15
Yes.

Jane 25:16
So then I sort of went from the very end to the beginning by sort of adding and multiplying rather than subtracting and dividing. And so I think he had one chicken at the beginning,

Dr. Melania Alvarez 25:29
Yes.

Jane 25:30
Three chickens in the middle and seven chickens at the start.

Dr. Melania Alvarez 25:34
And you got it absolutely correct.

Jane 25:36
Wow, phew.

Dr. Melania Alvarez 25:37
And that's actually, that's the way, working backwards, you see. So you work backwards. You said, Okay, I think that the first one is one, and then the next one will be three, because I will be, calculating what's half, you know, double of that, and then you calculate what will be sold, and then that. So you got absolutely right. So in the first market, he has seven chickens, and half of those chickens is three and a half plus half a chicken is four chickens. So seven minus four is three. So we're left with three chickens. He goes to the second market, half of those three chickens is one and a half chickens. And

then plus half a chicken, that's two chickens. Three minus two is one. So we're left with one chicken. And the last market is one chicken, and then it's half of a chicken is half, and then the other half is one. And there we are, and oh, there were no chickens hurt in this puzzle.

Jane 26:33
I was so, as you said, I was so pleased when I realized, oh, I can figure this out and get to the answer.

Dr. Melania Alvarez 26:40
So there are many ways that you can solve a math problem. You can you can guess, and you can do a systematic guess, not just random numbers, but little by little, guesses that will give you some information. So you go on. You can start backwards. You can draw a diagram, too. Sometimes you can draw a picture, and that will help you. There are many ways, and that's what mathematicians use. They have the different ways of approaching and see what work, what will work, and sometimes it works, and if it doesn't work, then you start again. And that's all there is.

Jane 27:09
Let's end this episode there. Did you figure out the answer to the puzzle? I will admit it took me a while, and I had to write myself some notes, and I did start to get really worried at one point that I wasn't going to get the answer right. And then my mind started to go blank, and then I thought of all of you listening, and I thought, oh no, you'll all be so disappointed in me, or think I'm not very smart. But as Melania was talking, I realized two things. The first was that I just needed to take a deep breath and start working backwards, and I could probably figure it out. And number two, that if I couldn't figure it out, that's okay. No one is supposed to just automatically know all the answers to things. And when we're learning math, part of what we're doing is learning how to solve problems. So I knew I could ask Melania for help if I got stuck, and she would steer me to the right strategy. Thanks to Dr. Melania Alvarez of the University of British Columbia and the Pacific Institute for the Mathematical Sciences for answering all of our math questions today. We're going to add some math puzzles and resources in the show notes if you want more. As always, if you have a question about anything, have an adult record you asking it on a smartphone using an app like voice memos, then have your adult email the file to questions@butwykids.org But Why is produced by Melody Bodette, Sarah Baik and me, Jane Lindholm at Vermont Public and distributed by PRX. Our video producer is Joey Palumbo, and our theme music is by Luke Reynolds. If you like our show, please have your adults help you give us a thumbs up or a review on whatever podcast platform you use, we'll be back in two weeks with an all new episode. Until then, stay curious.