Dwayne: Okay. Hi everyone, and welcome to another episode of the Metaphysics of Physics.

Narendra: Hi.

Today I have my friend Narendra with us from India, via the magic of the internet. Say hi to our audience.

Narendra: Hello everybody!

Dwayne: He teaches English studies. And he likes to use holistic education methods. And he has a Bachelor's degree in Civil Engineering and an MSc in Economics.

We are going to learn about some issues in science and science education.

We'll be focusing on physics, but a lot of other branches of science, particularly mathematics, will come up as well. Narendra has given me lots of good questions beforehand.

Narendra: Yeah, they've already given. And so, thank you, Dwayne, I would like to say something.

I am happy that I've come on live with you. I've been watching your posts and the way you over-explain. I really love that. So, I thought we'll connect, and thanks for agreeing to that.

And thanks also for the fantastic preparation you have done. Because I gave these questions much earlier, almost, I think two weeks back. And he wrote the answers down. So that's very unique. People don't do that.

Dwayne: Well, I like to be prepared.

Narendra: Yeah, I know, I know. I'd like to tell the audience that these questions have already been given. So, there's no need for me to ask them. He will be telling the question.

And I will be adding things. If I think that there is anything if I feel a general audience needs it. If they need some clarification or if I need some clarification, I'll butt in. But I would like Dwayne to talk.

Dwayne: Yes.

Narendra: Okay, then we go ahead.

Dwayne: Okay, let's get started with the first question. And this question is whether it is difficult to learn physics. And here's what I have to say on that.

Now, of course, physics is a very fundamental subject. Some people might have the idea that this should make it easy, but I do not think that should be the case. Fundamental is not the same as easy.

The subject matter of physics is essentially all of physical reality. You can take the view that that is looking out at all of physical reality and seeing how all of this works. Basically, everything that is physical is something to do with physics.

But in practice, this is not actually easy. Once you start doing physics, you will very quickly find that you need math, lots of math, to do much of anything.

Narendra: Yes.

Dwayne: You need to be able to quantify the things like velocity, and acceleration and forces and how forces lead to motion and stuff. You need mathematics to identify, quantify, understand all these relationships. We will go into the role of math in a later question, and so we won't go into that too much now.

Narendra: Yeah.

Dwayne: But the math can get really complicated, really fast. And not everyone is good at math. Certainly not in my experience. It is a very abstract subject, and it's very difficult for some, even if it is taught properly. And in my experience, it seldom is.

Add to that the fact that you're dealing with some very abstract things like energy. We don't know what energy is really and Feynman himself said we don't know. And he was one of the greatest physicists of his time.

Narendra: He did not know; you can imagine it was undefined.

Dwayne: Yeah, that was a perfectly valid point. So, in other words, energy is not easy to intuitively grasp. And then there's light. We don't know what light really is. They say it's a particle and a wave. But, well, no.

Even trying to visualize an atom can be hard. Remember the show the Big Bang Theory? You have that picture of the electrons orbiting the nucleus like little moons.

This is an okay way of visualizing an atom. It is good enough for high school physics, maybe first-year college physics. But according to quantum physics, this is wrong. But how do we visualize it?

Narendra: Exactly.

Dwayne: We don't know, quantum physics has not given us an answer. It doesn't give us any answers.

So, you could say that the subject matter of physics is non-trivial to understand. It can get quite abstract. But there is another problem.

Many of the problems of modern physics make this a lot harder than it should be. You see, there is a "shut up and calculate" approach that is widely taken.

Narendra: Shut and calculate.

Dwayne: Yeah.

Narendra: Shut up and calculate. Yeah, that is funny. Shut up and calculate.

Dwayne: Yes, exactly. That is an exact quote, although I cannot remember who said it offhand.

Narendra: Oh, my.

Dwayne: With the advent of quantum physics, physicists have largely given up on the attempt to present physical theories which can be connected to observable reality.

Indeed, when it comes to the things they talk about, like atoms and electrons and photons and stuff, they do not believe that reality is not knowable.

In fact, a lot of physicists will tell you that the microscopic world, the atomic world is not knowable. And maybe the rest of the world is also not knowable.

They talk about electrons not really having definite properties. They say that a photon, that light, is both a wave and a particle. And other nonsense.

This is just a projection of anti-realist epistemology, of their philosophy. As if reality is fundamentally unknowable. But that is not true.

You can't justify that, even though they will try to use quantum mechanics to justify the philosophy they've already assumed.

Narendra: Exactly.

Dwayne: They will say, oh, that physics is fundamental and not philosophy and that philosophy just has to give way to physics. But that is not how it works.

But Bohr and the like, they were a bit more honest. They kind of admitted that philosophy was the motivation. But physicists of today do not want to admit this.

So instead of dealing with reality, which they do not believe that you can know anyway, they came up with a lot of mathematics. And they stopped there. That shut up and calculate thing. The mathematics is all they offered. You have to be able to somehow understand it without being able to tie it to tangible, understandable physical reality.

Take string theory, it is all about little strings on a quantum scale.

Narendra: Little strings and they pull the strings.

Dwayne: Ha! What are the strings? What? Are there any physical, real things? What do they represent? No, I don't know. It's just a bunch of really complicated math.

What does it mean? Who knows? Does it describe observable physical objects? Not that I can tell. Not that anyone can tell. They say: well, it is our best guess. Take our word for it, it works!

It works, even though they can't make any predictions!

Narendra: Yeah, it works? How does it work? Hahaha!

Dwayne: They cannot even make any predictions. So, what use of it?

Not that science is all about making predictions. It is about understanding the world. But they think if they can predict things, then that is just as good. But that's not what science is about.

But anyway, none of this gets us closer to understanding how the physical world actually works. And it just makes people think that physics is not about the world. As if it describes some Platonic mathematical universe.

Who wants to do that? No sane person, I think.

Narendra: What you are saying, Dwayne, is that it need not be this difficult?

Dwayne: It should not be this difficult, no. It should not be this difficult.

If we have understandable mathematics, then we can take the mathematics and figure out what it is talking about. If we could look at real objects, if we could understand what it is what the mathematics was really telling us, we might be able to understand any of it. It wouldn't just be a bunch of equations, a bunch of math, which is basically all string theory is.

Instead, they just memorize a bunch of meaningless mathematical equations that we cannot tie back to reality.

But let's suppose that we fixed all of this. Let's suppose we tied physics back to reality. Made all of this rational again. Is all of this going to become easy? Is all of this going to be something you can master in high school? I don't think so. I just do not think it will ever be an easy subject, at least not for everyone.

Narendra: Even if you make it all connected to reality, it takes a little longer time to get the facts together.

Dwayne: Yeah, there's a lot of complicated abstractions like energy. Even if we knew what energy is, it's a very high-level concept, I suspect. Okay, energy is defined as the ability to do work. But what does that mean? We don't know. But, but even that's kind of a high-level abstraction.

And there were things like atoms and if we had a rational quantum theory it is still a quite long involved chain of knowledge required to really understand how this works.

Narendra: The chain is long, even if you connect it to reality, the chain has to be gone through, step by step.

Dwayne: Yeah, it is a very complicated subject.

Narendra: And the physics is very abstract, yes.

Dwayne: And there is still the complicated math. I do not think that all of the complicated math is just going to go away. We might be able to understand it, but you still have to learn a lot of complicated math.

Narendra: Basic math and then higher math and still higher math…

Dwayne: Calculus, group theory, all kinds of complicated math.

Narendra: Differential equations.

Dwayne: Differential equations, yeah. My wife majored in physics. She did, I don't know like half a dozen different math papers or more.

Narendra: Half a dozen courses on mathematics so you can imagine how really complex physical reality be.

Dwayne: And I think she did two different papers on differential equations. And that is before we get to the really hard stuff, which string theory is made up of.

I think if we got rid of string theory, we could get rid of a lot of this crazy mess.

But the main point is that even if we fixed physics, made it rational again, I think it would be a pretty complicated subject There is still a lot of math and a long… a long…

Narendra: Chain of reasoning, right?

Dwayne: I think yeah, I think it's always going to be somewhat difficult for some people. And I think that makes sense.

Even if you look up say only 19th-century physics, say Maxwell's equations. They take some differential equations and methods to really understand that.

I don't know about four different math courses to understand Maxwell's equations properly. A couple of calculus papers, a couple of differential equations papers. Lots of math any way you put it.

Narendra: But, Dwayne, doesn't this indicate the enormous thought that has gone into creating this different stuff. And even if you can't understand it, if you just know this much that it is difficult.

And that it requires so many courses, that gives us an indication of how much has gone into this kind of thing. It's not just technical as they say it's not as simple as a lot of people say.

Dwayne: Well, the subject of physics as we know it has existed 400 years and if you look at if you think about it, we've made a lot of progress in the last 400 years. And you could say that a lot of that stuff we know now is only possible because we have the mathematical tools.

If we didn't have Newton, if he had not discovered calculus, we wouldn't have a lot of physics we know now. Because we need that math to identify the relationships and to study these things.

I don't think it's any coincidence that physics and calculus arose about the same time with Newton. A lot of modern physics even the good stuff has a lot of calculus. And of course, all the other math which we have discovered since then has a lot of calculus and this linear algebra stuff too.

So, that is about all I have to say on that. Do you have any comments, anything to add?

Narendra: I will just underline the fact that you know, you have already touched upon this and you will again touch upon it later in the last question. But you are touching on that point that that maths has been a great help for physics and there could have been no physics if not for math.

I'd like it stated for the audience and shared with you, that it is not a view held by people who study. I'm not talking about professionals. But they think mathematics and physics are separate. And this is very unfortunate.

Even the lowest levels are taught with a separation of physical reality, it's more abstract, even from the basic level.

Like they go into this equation, little things, you know how the people study it. But it'd be very interesting if they could connect it, then it will be easier for more people to become scientists.

So, the difficulty remains education is difficult. The subject is difficult, and there is a really a link between maths and physics. So that's what you're stressing, and I am underlining that fact.

Dwayne: Okay, I think to highlight that, we'll skip to this question. This was one of the last questions, but I think we should skip to that to highlight the relationship between math and science. That will explain some of what we just covered.

Narendra: Yes, what is the relationship between math and science.

Dwayne: Mathematics is, of course, a science. Not a physical science, but it is a science. It is a science of method. A study of methods of doing things. It studies methods for performing all kinds of measurements. The kinds of measurements that are difficult or impossible to perform using, say, a ruler, or scale or whatever. It's basically the science of measurement.

Suppose we want to measure the circumference of the Earth. How might we do this? Well, I don't think you will be likely to want to get a big measuring tape and walk around the Earth.

We don't want to walk around the Earth and do it that way. So how do we find the circumference of the Earth?

Well, you probably know the story. There's a really easy way to estimate this to within the accuracy we get about 10 to 15%.

And this great guy, Eratosthenes…

Narendra: Amazing.

Dwayne: About 2000 years ago, this Greek guy Eratosthenes figured this out using sticks and a little bit of math. With sticks and a little bit of trigonometry, he calculated the size of the Earth.

He knew that on noon on the longest day of the year, the Summer Solstice, that the Sun was straight overhead. In the Egyptian city of Syene, a stick stuck in the ground would cast no shadow.

But in the nearby city of Alexandria, which lays north, the stick would cast a shadow at an angle of about seven degrees, I think it was.

Now, he knew the distance between these cities of Syene and Alexandria. I forget the distance, but the exact distance doesn't really matter that much.

So, he used some trigonometry, and he was able to use the seven-degree angle and distance between these two cities to estimate the circumference of the earth. I think he was accurate to within about 10 or 15 percent, as I said.

Narendra: Yeah, really accurate even for today's calculations. Real close to the proper value.

Dwayne: Yeah, really close to the actual value. And this is just using two sticks. And knowing the distance between two cities and some simple trigonometry, I won't go into the math. I can't recall exactly how it works. But yeah, it's pretty simple.

Narendra: I would like to underline that there was trigonometry there and that there was a seven-degree angle. And there was a little bit of trigonometry as mentioned for you to connect the physics and the math there.

Dwayne: It was math, simple stuff you do in high school, basically, I think. I think that they should cover this as it would be a good lesson for trigonometry class.

Narendra: Excellent lesson, I have done that.

Dwayne: But anyway, this shows us the power of math. Using the science of measurement. He obviously couldn't walk around the Earth using a big ruler or something.

Mathematics is a science of measurement which allows us to perform measurements that we could not otherwise perform. And it allows us to expand our ability to measure beyond that which is directly measurable or perceivable.

In the words of the philosopher Ayn Rand:

“Mathematics is a science, i.e., of establishing quantitative relationships. It is a cognitive method that enables men to perform an unlimited theory of integrations”.

Narendra: Oh my, very powerful.

Dwayne: What does it mean for it to be a science? It means that mathematics is a study of abstract methods used for the purpose of performing measurements. In this case, measurements which as I said would be which would be difficult or impossible to perform otherwise.

Narendra: Of integration and unlimited quantitative relationships.

Dwayne: Yeah, it basically allows us to measure anything, pretty much anything that we have a mathematical method for. It can be complicated, but in theory, we can measure anything using mathematics.

Narendra: It's like a method, a method, an approach…

Dwayne: Yeah, that is what mathematic is, a science of methods for measurement.

Narendra: Yeah.

Dwayne: Take integral calculus. It is used to perform complicated measurements, like finding volumes of irregularly shaped solids. Like if you have a really oddly shaped container, you can use integral calculus to find the volume.

Actually, integration is essentially definable as methods of finding the area under a curve, but you can use it for 3d shapes and stuff as well.

Well, okay, so what is the connection to the other sciences like physics, chemistry, or whatever?

Narendra: Yeah, well, we could talk about that.

Dwayne: Well, you need to measure things in the other sciences, I think we know that if you need to measure the size of the Earth, if we need to measure the distance to nearby galaxies need to measure the size of atoms, you cannot measure these things directly. It's pretty hard to measure an atom with a ruler, obviously. But you can use mathematics to measure these things.

Narendra: A method of measurement.

Dwayne: And using mathematics we could quantify the relationships between things. How is force related to mass and acceleration? Well, math will tell you this. Newton has equations for these kinds of things. force equals mass times acceleration.

Narendra: And the famous G=mr^2. Again, that's very powerful.

Dwayne: What does the number of electrons in the outer shell of an atom tell you about its chemical properties? Well, mathematics will help you there.

How do we identify how similar chimpanzees and humans are? It is about 95% to 99%. Mathematics will allow you to estimate that.

Mathematics allows us to perform lots of measurements that we otherwise could not perform. It allows us to identify relationships, relationships between things and quantify these relationships.

Narendra: Relationship between one property or variable with another. And to quantify it.

Dwayne: Yes, it's important. And this allows us to make scientific discoveries. Once we can quantify the relationship between mass and acceleration, we can conclude that force is a product of mass and acceleration.

Or once we end up with the math to describe gravity, we can figure out that objects with mass predictably attract each other. And therefore, we can discover a theory of gravitation. Einstein's Relativity supposedly supersedes the Newtonian idea but yes, nonetheless.

Narendra: With refraction, you have the refractive. It is a prediction of how it will vary you know. You don't have to show hundreds or thousands of lines you can just get a simple equation at any angle how it will refract. Exactly.

Dwayne: You do not have to give a thousand different examples. You can say well, this is how all of these things work. This is the way the relationship between all these kinds of things is, it is a powerful tool.

So, without being able to quantify these, without being able to identify these relationships (mathematics allows us to identify relationships and to quantify them), we could not do that. Probably most scientific discoveries would never be possible. Because a lot of these discoveries require us to identify these relationships between things.

Narendra: Are you saying all mathematics helped us to discover things also?

Dwayne: We need math to make most of these discoveries. If you look at the history of science, you will find that, especially for physics.

Narendra: The inclined plane experiment is a good example. Otherwise, we would have known how that all worked.

Dwayne: Yeah, he used math there.

Narendra: He did not know where it would lead, but it led to Newton.

Dwayne: So, this is why mathematics shows up all the time in the sciences, especially physics. Because all of the sciences need to quantify relationships.

And at one point or another, they're going to need mathematics to do these things, to make these measurements. Because a lot of things you cannot easily measure without mathematics.

So, some people think that it is weird that mathematics is so effective. They talk all about the “unreasonable effectiveness of mathematics”. Like why is math so useful anyway? Why do I need math to do anything? Why does math keep turning up in physics all the time? It's a big mystery. Well, it shouldn't be. You need math to do most of the stuff to measure things.

Narendra: If you properly use the tools, you can get a lot of data and get a lot of relationships and we do that routinely right?

Dwayne: Yeah, I mean you can study the relationship between supply and demand mathematically. And if you graph those kinds of things, you can get some insight.

Narendra: Insight via mathematics, you are saying. Using the tools of mathematics.

Dwayne: Yeah. Okay, so you must measure things, you have to quantify things. Without, without mathematics, it wouldn't be possible, so of course, mathematics is useful. You need it to do physics. So really there is no mystery there.

Narendra: So, you are saying it fantastic, it's powerful, inevitable, and inerrant.

Dwayne: You need it, as I said. It is no mystery that physics and calculus came along at about the same time. It is a mystery to some people. But it shouldn't be. It should be obvious if you understand what mathematics is.

Narendra: It is made a mystery in the world, but it is not.

Dwayne: That is because most physicists and mathematicians don't understand what mathematics is. Even if you ask them to define it, I don't think they could. At least not the way I did, or Ayn Rand did. Or the way lots of people I know would define it.

I don't know if they would give you any sensible definition other than to say it's the study of numbers or manipulating symbols.

Narendra: Yeah, yeah. I think that every first-rate scientist knows that there is a deep relationship, and he knows it.

Obviously, you know that because he is first-rate, though they might not be able to teach it, or they might not be interested in teaching others. But they do know it otherwise they can't practice whatever a good scientist would do, right?

Dwayne: But a lot of scientists I think a lot of the good scientists know there is a relationship I don't know if they will be able to explain it. I mean, I don't think they'll explain it as well as I did.

But maybe that's why it seems that it is such a mystery. They know something is going on there, but they can't explain it.

Narendra: They are awed, you know. They are like this is amazing.

Dwayne: What is going on here? They have weird philosophies that they can't answer these kinds of questions.

So yeah, that's what mathematics is. Anything to add there?

Narendra: No, I think we have got our points out very well I think, yeah.
The point that you have pressed and made is very clear is that there is no mystery. There is a link between maths and physics in two ways. Maths is used in physics, but maths is also difficult because it is very deep. They were given examples of gravitation and refraction; those are good examples.

Dwayne: The *deep* reliance.

Narendra: Somebody interested would feel freer, now I think surely. Okay. Do not be afraid. Surely that there's something there.

Dwayne: Yeah. Okay, the next question is why people don't concretize. Why people do not think in terms of concretes and why people do not try to reduce abstract ideas to concrete reality.

Narendra: Yeah, why is it like that?

Dwayne: Well, many people are actually very bad at this. Rationalists, especially. These people think in terms of rationalism. That is, they hold ideas as separate from reality. As if they are within some kind of superior realm.

People are told that science is a very abstract subject, and yeah, that's true. It is fairly abstract. But people think that abstract means that it is equivalent to some kind of Platonic super realm that is divorced from reality.

Remember, according to Plato, ideas live in a realm separate to and superior to physical things. Ideas are separate from reality and in a divine place. He talks about things called Forms, or at least, that is how we translate that idea.

According to Plato, ideas are the ultimate, true reality. Physical reality, all the things we see, are imperfect, ghostly reflections of these ideas. Reflections of this world of Forms, which live in a higher dimension. That you only really see if you are a wise philosopher King or whatever.

That's what he thinks philosophy is all about basically learning to train your mind to look into this high dimension of Forms where all of these ideas live.

Narendra: It is like religion, it is.

Dwayne: Well, Christianity took that up with divine revelation. That is Plato.

Narendra: Not many people know that he actually says that. That his cave was about looking at the shadows of reality, not really reality.

Dwayne: Yeah. This is how many people read things, in a very Platonic way. They may have never heard of Plato or his world of Forms. But they are influenced by his ideas all the same. They treat ideas as if they live in a higher, superior realm separate from reality. Separate from physical reality, separate from all these things around us.

So, when they study something like science, they do not bother trying to connect ideas down to physical reality, down to concretes. Why should they? Science studies ideas and ideas are floating abstractions.

Narendra: They have that really bad habit of, you know, just holding rationalistic ideas.

Dwayne: I should define what a floating abstraction is. A floating abstraction is an idea that is basically not connected down to observable reality. This idea about something separate.

Narendra: Not concretized, not concrete.

Dwayne: Yeah, non-concretized, Platonic things. That's why a lot of people in the sciences are rationalists.

Some people want to concretize but they don't know how to do it. Because the ideas they hold are floating abstractions. They have not learned what these ideas mean. They have not connected these ideas back to physical reality.

Narendra: Okay.

Dwayne: As I said, a floating abstraction is an idea that you cannot tie back to reality. An idea like mathematics is a study of numbers. They say that is how you define math. That it is simply the study of numbers.

But what does that mean? Are you able to tie that to reality? What are the numbers? If that's all your idea of mathematics is, it is a floating abstraction, and you can't tie that back to reality. If that's all you think it is.

Narendra: If you don't bring in the method and measurements and relationships, then what is it? It is just floating numbers in the air.

Dwayne: Yeah, mathematicians seem to think numbers are things that are pulled out of thin air. As if they do not really have any basis for anything, they say. It is just a bunch of arbitrary mathematical constructs.

Let's say quantum physics. In quantum physics, they say that light is a wave. How do you get that back to reality? How do you visualize what light is if you can't connect it to reality?

You can't. You cannot understand it. If it is a floating abstraction. It's just an idea floating there, which you can't connect to anything.

Narendra: And you just shut up and do the math.

Dwayne: Just float around with this idea, just play around with it. It does not mean anything, who cares?

Or take the way most people understand evolution. They think evolution is simply a process of change over time. Well, what does that mean? What is changing? How? What does it mean? What are its consequences? What is a process of change over time? Most people cannot adequately answer these questions and they don't know what any of this means.

So why all of these floating abstractions? Do people not care to tie their ideas back to reality?

Narendra: That is a good question. Exactly.

Dwayne: Some of them, the rationalists we talked about earlier. They don't care. But other people are not able to do it. They do not understand and have not been taught how to properly learn something.

You don't come out of the womb able to learn things properly. You have to learn how to learn. You have to learn how to learn things properly, learning is not automatic.

Narendra: Man is a student, and he is curious, and he really wants to learn and he is not able to because there is no way he can learn to learn. Learning is not automatic.

Dwayne: Yeah, you have to know how to learn things properly. You have to know how to properly study things. You have to know what knowledge is. You have to believe knowledge is possible in the first place.

To be able to say that you know something, you have to be able to show it. You have to be able to tie it back to reality. And if you cannot do that, it is not knowledge.

You have to be able to connect it back to reality in some way. If you know something, you can show what the facts show is true. And you can derive that knowledge from reality.

Let us take calculus. You read all about calculus and you learn how to manipulate equations to get the right answers. You get 100% in all of the tests, and you say that you are therefore smart, really smart.

That doesn't mean you know calculus. Getting the right answers to all the questions is not knowledge. In this case, it is mainly the correct manipulation of mathematical symbols.

If you want to say you honestly know calculus, you must know how it works, why it works, and what that all means. What are derivatives? How do they tie back to rates of change?

And that is what differential calculus is, of course, the study of the rates of change of variables. How do you show that the symbols in your textbook tie back to reality? How do they tie back to rates of change? How does this connect to anything?

Or take evolution. It is often defined as a change in allele frequencies. What is an allele and how do they connect to reality? What are genes? And how do they operate? And how do they explain how organisms work? What does it mean for the frequency of an allele to vary?

What does this all imply? I don't think a lot of biology students can answer all those questions adequately.

But you have to be able to answer all these kinds of questions to connect things back to reality, to concretize the subject. And then and only then can you really claim to have knowledge of the subject.

So yeah, I think those are the two main reasons why people cannot concretize even if they want to. And that is a big if, sometimes. Comments?

Narendra: Yeah, I think that's true. No, because they're not able to concretize because nobody is doing it around them. Doing it is natural. It would mean more to a normal man than all these floating abstractions, all of Platonism.

But it is there in the culture of education or in the world. But I think knowledge has become very elitist in some way. Only some people have knowledge. And you cannot get it. It has led to this kind of elitism that only some people have knowledge, because of this lack of concretization.

So, it's a chicken and the egg thing. The egg says you can't have knowledge. And the chicken comes on and says there is no knowledge. And it goes on, you know and that is how I look at it.

And I think you made the point quite clear that concretization is difficult even for a sincere person. No, that is a harsh point, a harsh fact of our world.

Some people don't care, but even those who care, give up because they just don't understand it. And then at that point, they say, Okay, this is beyond me. I think they blame themselves. That's how it is. Yeah.

Dwayne: Okay. And the next question is this. Can we really concretize physics and the other sciences?

Yeah, we can. If you want to understand the world as it really is, we have to do this. If we want to understand what you're talking about, we have to do this. We need to learn how to think, and we need to learn how to learn, as I said.

And many people have little idea how to do either of these things. A lot of people don't know how to think, even educated people unfortunately often do not know how to think properly. They did not understand what knowledge is, what qualifies as knowledge.

Of course, you have to accept there is a knowable reality to even want to gain knowledge. We need to understand that rationalism holding floating objections is evil because it prevents us from understanding reality. Rationalism really is evil, especially wilful rationalism.

We need to learn how to connect things back to reality. We need to know how to abstract properly. We need to learn how to abstract in a proper hierarchy, in the proper order.

And using proper methods, we need to learn about the proper rules of deduction.

Most of us need to rediscover induction because we don't know what it is. Even though we need to use it.

Narendra: With math and all these laws, which takes a lot of effort to do, it ends up with only some people getting knowledge. And they also don't have a philosophical bent of mind.

Knowledge has, again I repeat, become very elitist. In the world, only a few people have knowledge. Only a few people have the power of knowledge, but knowledge is power. But only if you have that power.

Dwayne: So yes, we need to learn proper thinking and studying in order to gain knowledge. Before we can properly concretize and think.

Because here's the thing: if you are a Platonist or a Kantian and believe that reality as studied by the senses, is unknowable, then that will become a self-fulfilling prophecy.

If you reject the possibility of knowledge and the means of acquiring it, you will not know anything. If you reject the possibility of knowledge, then you will exile yourself from the sunlit fields of knowledge and retreat into the darkness of Plato’s cave.

I don't know about other people, but I think their cave does not sound very nice. I wouldn't want to live there.

Narendra: We have been living in a cave, in a room in COVID times. But it is worse than a room, it is a cave. How can a cave be attractive? I don’t know, attractive the shadows on the wall?

Dwayne: Yeah. Okay, any comments?

Narendra: Yeah, I think it's clear what you're saying. Yes. So, one thing is that you know, once you have accepted that reality is something obscure, then you just latch on to rationalism. And at a certain point end up saying okay, this is not important or not real. You give yourself excuses, because you have to, and you go on about your business of life.

So only a few people, by their own, let us say, innate ability, get through and break through the big barriers all around. And they get to have the taste of knowledge in their own field.

Maybe that is why we have such few people who have knowledge. And why they are the ones who are using it in various fields. It is such a rare commodity because knowledge itself is a very obscure thing that's how I understand it and that's how it is.

Dwayne: Okay, so the next question is; how can we concretize some of these things? Well, a lot of people say that this is going to be really hard.

How do we concretize something like calculus? Which is about rates of change of variables. It studies math itself, basically, which is very abstract.

Well, we can make some progress here. It helps if you derive these concepts from observable facts. We should study calculus in the way that its founders discovered it. Newton derived calculus from observable facts of reality, and it is not hard to follow how he did this. We can follow what he did and see that yeah, given what he observed, we can derive it.

Narendra: That is, we must rediscover it or read it.

Dwayne: Or suppose you want to understand what makes something a cephalopod such as an octopus.

Well, you can read some books and memorize the definition of a cephalopod. Which is something like this: something that with bilateral body symmetry, a prominent set of arms and or tentacles modified from the primitive foot of an ancient mollusc and so on.

What does that mean? What is bilateral body symmetry? How the hell do you use any of this to identify a cephalopod? What does this mean?

Well, if I wanted to teach you how to do this, then I will show you a cephalopod. I would show you an octopus or squid or cuttlefish or any other cephalopod.

I would define a mollusc and show how you how we distinguish a mollusc from something else. And I will show you what bilateral symmetry is. I will show you the prominent heads of some cephalopods. I will show you how this is derived from ancient molluscs.

I will show you all of this. I will show you concrete things. And I'll show you some of the histories of the evolution of cephalopods.

And I will show you how we tell cephalopods apart from other molluscs and how we discovered all of this. I would you show all of this very concrete stuff. And if I did it this way, you would understand what all this stuff means.

Narendra: You show them step by step. Show them things like bilateral symmetry for example, but we're showing it in concrete form.

So, you said you can show bilateral symmetry you can show the features of the cephalopod. That you actually show many things so that the person can get the abstraction in terms of your concrete things. Which actually makes a lot of sense, doesn't it?

Dwayne: Yeah. Let's take things like calculus. You have to understand algebra and some geometry and arithmetic. What is more, you need to learn all of it in the correct order. This is about the hierarchy of knowledge, learning things in the right order. If you learn things in the right order, calculus is understandable. But it is difficult if you miss too many steps.

Narendra: Then you won't have an idea. I didn't have an idea when I learned mathematics in my classes. I got the game of it, it's like a video game. I got the game of doing math. I just got habituated to learn that and most of the students in the world are habituated to learn calculus.

Dwayne: But all of that requires effort. The teacher has to know how to teach. Which is part of the problem. A lot of teachers do not know how to teach. Writing things on the blackboard is not teaching something. There is a lot more to it than that. Memorizing things is not learning.

Narendra: Not at all.

Dwayne: Teachers have to know how to teach, and the students have to know how to learn.

Narendra: And for the student and the teacher to have their own knowledge it becomes a huge chicken and the egg again. So, it's like the whole world is having these institutions pretending to have knowledge.

Dwayne: Yeah. Now, this is all hard work. It takes a lot of time and effort by which we will learn how to do this. But it is worth it because then you actually understand the world around you, and it makes it a lot easier to learn.

Narendra: This can come only if you follow two things. One is that you show concretes. The other is you go step by step; you start with the proper steps. You start with addition and subtractions and algebra and then you go to the higher levels then you finally go on to calculus. For any particular field, there are steps you have to take from it you implement correctly or play the game.

Dwayne: Remember, knowledge exists in a hierarchy of knowledge. Knowledge depends on a lot of earlier knowledge. To know this and you got to know this other thing. And for that, you have to know this other thing and so on. To understand all this, you can't just skip steps. At least you shouldn't.

Narendra: Yeah exactly.

Dwayne: People skip steps and then they wonder why this makes no sense. Well, it is because we don't know this other thing that would make all of this make sense. You need the context of that other thing. Like if you try to do calculus without algebra or arithmetic. Well, what is x and why is there an alphabet in my math?

Narendra: A small thing like why is it x squared? A simple thing like that is a relationship. People find this difficult.

Dwayne: It would also be helpful if you gave him a good definition of math in the first place. I think if people learn what math actually is, they will find it easier to understand.

A lot of people ask what math is good for. Why do they need it? It is about quantifying things and identifying relationships. It is not just a bunch of numbers. It is not just for people who want to be physicists. That is why mathematics is useful everywhere. It is not just for physicists or accountants and the like.

Narendra: It is a good idea. If you know the nature of Mr. Mathematics if you know Mr. Mathematics, what he is and that insight is God, then you will be careful about how you use it, how you learn it. Yeah, that's a good idea.

Dwayne: Why ask why mathematics is universal. It is because it is a universal method of cognition. We are focused on mathematics and science, but it is not just useful to them. It comes up all the time. You need to be able to quantify, you need to be able to measure things in everyday life. That is why mathematics is universal, and it's a universal method of cognition applicable to basically everything.

Narendra: The universal method of cognition applicable to everything is a fantastic statement, Dwayne. I like it. And I think, if something is not measurable, it cannot exist.

We can even talk about human love, how we can measure it, there are notions of measurements in love. Although we don't give exact quantifications. To be something has to be measurable. If something can't be measured, it can't exist. I thought that was a really powerful statement.

Dwayne: If you can't measure it, you probably cannot learn much about it. In the sciences, we made progress by learning how to measure. By learning the methods of mathematics, we needed to measure things and quantify relationships. If we could not do that, science would have gotten basically nowhere.

If we could not measure things, we would not be able to understand forces. We would not understand gravitation. We would not understand evolution. We would not understand chemistry, we will not understand anything.

Narendra: Mathematics is everywhere actually, such as in business transactions. Like I had to get those glasses and they had to use math. But if there was no math, I would not be able to see today.

Dwayne: The problem is, is that they understand something of why mathematics is useful to them. They don't understand why mathematics seems to be universal to everything in the physical world. To them, it's just convenient to understand certain things. They do not understand that is a universal cognitive tool applicable to basically everything.

Again, they do not really know what it is. I don't think many of them would define it in the way I did. I do not think they could give a good definition at all, actually. I haven't tried it, but I should ask them to define mathematics for me to see what they say. I don't think it'd be very satisfying.

Narendra: Mathematics. And if you know it will be perfectly clear. And you are also saying that even good scientists may not be able to give me a definition of mathematics. Somebody on the inside actually, frankly. You're becoming conscious of the nature of mathematics. Yeah, correct.

Dwayne: Yes, even though we've been doing it for 1000s of years. I think maybe some of the ancient Greeks kind of knew, but I don't think many people today do.

Narendra: We have math, but we do not know how to teach it. we don't know what it is. How strange.

Dwayne: Yeah, you get nonsense like the Incompleteness Theorem. What that tries to say, is basically, that mathematics has no foundation. That is basically the whole point of this theorem. That there are no axioms of mathematics and there is nothing that makes mathematics all true, that it is all arbitrary.

Narendra: Subjects I don't know fully, but many areas of mathematics which has gone a little out of the rational.

Dwayne: Well, there is a lot of stuff like that. Let's say they take infinity minus infinity. They think that infinity is a number. Infinity is not a number.

Anyway, they say if you take it as a minus infinity, you get pi. Now, infinity is not a number, you can subtract it from itself, and you certainly do not get pi or any other number.

This is something they get all awed about. Oh wow, it's fascinating. It's not, it is stupid, and it does not mean whatever they think it does. Infinity is not a number; it is the potential to progress within a sequence. I will go into infinity another time.

It is nonsense. They like things that are really weird and things that do not make any sense. and they go: oh, is really beautiful and mysterious. Again, it is stupid. It's not worth thinking about.

Narendra: I think we can go to the next question. I think we have answered that. I think that we have become conscious of mathematics, of hierarchy become conscious of concreteness. That the clarity that knowledge is not

known by people. That we don't know. I think definitely a door will open if you at least know that you don't know.

So, we are living in obscurity, but it need not be like that. Of course, it is still tough, but you are emphasizing is tough to climb Mount Everest, but people have climbed it. And I'm sure this is not as tough as that, but it is a big hill. And if you follow the hierarchy, if you follow concreteness? Definitely. So, if you go to the next question, Dwayne.

I think the final question is that of the beauty of the sciences.

Dwayne: Now yes, science is beautiful. But not in the way people some people think. Some people think that the mathematics of string theory is beautiful. I think that that is an ugly perversion. It is ugly and it is unintelligible.

Narendra: Yeah, it is nothing more than that, yeah.

Dwayne: They say that their interpretation of the quantum theory is beautiful. It is not, it is nonsense, and it cannot be tied back to reality properly and it is stupid. It does not make any sense, it is ugly.

I think evolution is a wonderful theory. Partially because it is basically the foundation of modern biology. It is a powerful theory; it is really interesting and simple for people to understand, and it touches on basically every part of biology. And there is basically more evidence for it than then there is for gravity.

Really, if you look, you see evolution, inside your body. In everyone's body. Inside the body of every living organism. There is your tailbone and then some people have wisdom teeth, all these things. Every living organism contains lots of evidence for evolution. I think that all of that makes evolution a pretty wonderful theory. Especially since it is fundamental to biology.

Have you seen the Pillars of Creation? Giant fingers in space. Basically, plasma clouds. They are giant stellar nurseries where stars are born. And we can see detailed high-resolution images of these giant stellar nurseries. We know what we do about these because of astronomy.

There are a lot of really interesting things about space, and we understand it because we understand quite a lot about physics. Alright, there is weird physics like quantum mechanics, but we still know a lot of good physics.

Let us take chemistry. Chemistry is pretty interesting. Look at biochemistry, the way cells work it's pretty interesting. Every cell is a complicated tangle of chemicals.

People might say it is intelligently designed. It is very badly designed, it is badly improvised, it breaks all the time. It is an overly complicated, jury-rigged system. But it makes sense if you understand enough biochemistry.

If you look at DNA, it is really interesting. It works even though some DNA is actually virus DNA. About 8% of our DNA is virus DNA, I think.

Narendra: But Dwayne, suppose that you know, really know your body is evolution based and your body is biochemistry. Really know that, not vaguely, but actually experience it, doesn't existence certain beauty? And you know, it's very interesting, you see that space received people. Fantastic that things fall here and things float, they're such an experience.

Dwayne: These are the kinds of things I think are beautiful. And it is not just understanding these things. It is not just the subject matter, it's that all the subjects relate. Biology and chemistry, biology and physics are connected.

And of course, biophysics is a thing. But some people have tried to do weird things with it. They try to explain consciousness by quantum mechanics and stuff. But if you look at the physics of how it works, it is interesting. I think a lot of interesting questions can be answered.

There is of course mathematics in all of this stuff. Astronomy and biology are related.

Narendra: Wow, if you want to study the possibility of alien life, then you need to know biology.

Dwayne: Now there is technology. And for technology, you need to know lots of science. And this is where a lot of the stuff I think intersects.

Yeah, there's a lot of beautiful stuff in science. It is not just a bunch of really complicated equations or one long complicated equation. Or weird symbols and that is not what is interesting.

It's not the complex riddles of impenetrable mathematical mysteries. That is all some people have. They've given up on, really, on reality. So, they may think, well, this is nice. This is all we have. That's why quantum physicists are all like oh, look at all of this mathematics. Because that is all their field really is.

We need philosophy to teach people that rationalism is not a virtue, and that mystery is not a virtue, and that ignorance is not a virtue. Knowing stuff and being able to understand it can be a virtue and is what makes something interesting.

You should understand that you need science for technology and that technology is a vital key to human prosperity.

And we need to destroy the idea that we should know something for the sake of knowing things. I do not think that is rational. I do not think we should learn something just because it is there. Why do you want to learn it? You should have a purpose to learn it. Learning it should satisfy some value that you have.

But not learning it because it is there. There would be no end to that. I mean, to be consistent, you would have to learn everything. Even stuff that is of no use to you and does not help you in your life.

I mean, it's fine. If you're curious and it is something that you are really interested in. Okay, but you have to prioritize things you are interested in the order that they might best help you. You might not get around to everything.

Not just because it is there. Accumulating knowledge for the sake of it is irrational and is a waste of time.

Narendra: Knowledge is power, personal power if you really have knowledge like we discussed today.

Dwayne: If you really have it, which a lot of people do not.

Narendra: That is where they give up and they do something more compartmentalized.

Dwayne: Shall we stop here for now?

Narendra: I think we have covered all the questions.

Dwayne: Thank you. Thank you for this, excellent.

Narendra: That was wonderful. What should I say? It was a great experience, to have listened and to pick your heart and brain.

If I can say that is that there is something called knowledge. It is like climbing a mountain. Like climbing a mountain, there are some wonderful views out there not to miss.

Especially Mr. Mathematics. I think we covered that very well. Know the connections, the deep connection inherent in the intersection of mathematics and physics.

You can learn, anybody can learn it has just been obscured. We have started from Plato's cave, and we have really not come out of Plato's cave. Some of the people have come out of their own, but most are missing. And we know that there are reasons why today, why people are not able to get it.

I think it is a very good lecture because we have covered really critical points. Not only are those that want to learn are not able to, because you can see the shrouding of this whole thing. And also, it has become very elitist.

People know there is something called knowledge, knowledge of math, and knowledge of physics. But you said a very powerful statement today that no one knows what knowledge is. And what mathematics is, is also not known. This is good to know. Because unless we are in a state, we can't go beyond that.

So, I think it is unexpected, Dwayne, wonderful. We should have more like this. I'm hungry. Yeah, have more Manson. It is wonderful to link a very scientific, knowledgeable person like you to the general audience. So, we'll see what we can do. Thank you, everybody, who was listening or who will listen later.

Dwayne; Yes, thank you, Narendra. I think this will be very good. Thank you, everyone. We will see you later.