

MITOCW | Investigation 1, Part 1

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MARK HARTMAN: An observation is when you look at a model and you try to explain what you see in words.

Whereas over here, I see a hypothesis based off of a model that can be used to compare to the actual tested experiment. So does the observation come from the model? Because that's what that's saying. Or does the prediction come from the model? Because that's what this is saying. You can't have it both ways, or can you?

Let me think. What's the relationship between-- we're looking at models. What did we look at to get our predictions here in this case?

AUDIENCE: The pictures.

MARK HARTMAN: Go ahead. Say it nice and loud. We'll just have a conversation. You don't have to raise your hand.

AUDIENCE: Pictures.

MARK HARTMAN: OK. We looked at pictures to make predictions?

AUDIENCE: Yes.

MARK HARTMAN: Really?

AUDIENCE: No, we used the model [INAUDIBLE]

MARK HARTMAN: What did we look at to draw the prediction? Did you look at those to draw the prediction?

AUDIENCE: No.

MARK HARTMAN: No, you looked at this. You looked at the model to make the prediction. What did you look at to make the observation?

AUDIENCE: The pictures.

AUDIENCE: Pictures.

MARK HARTMAN: The pictures, right? And what are those pictures of?

AUDIENCE: The model.

AUDIENCE: The [INAUDIBLE] model and the experiment.

MARK HARTMAN: Ooh. Is that the model? Is that the experiment? Is it a hypothesis? Maybe it's a law. Let's just throw them all out, right? This, that thing up there, that picture is an observation, but it is an observation not of a model, but of reality.

Yeah, that is a model. It's a kid's model that you put together. But that was a real thing. Somebody set that up in a photo studio, and they took pictures of it. That was a real thing.

We were trying to get our model to represent that reality. So you've got reality that you look at and you make observations of. And I like this. "An observation is when you look at something"- - reality, the real thing-- "from one angle instead of looking at it from all angles."

An observation, you can't capture the whole thing. You're only capturing part of it, whether that's-- if I wanted to make a measurement of the length of this thing, that's not the whole thing because I could also measure the mass. I could measure the density. I could look at the color.

But it's when you look at something and you don't see it all, but you do see some of it. I like this. "Observation is looking at something." I think that's "looking," right? Observation is to look at something.

AUDIENCE: Yeah.

MARK HARTMAN: Now let's think about this. If we've got reality to this, "analyzing what we see in one image and putting them together to make a conclusion"-- uh-oh. Now we've got a conclusion in things. Where are our conclusions?

AUDIENCE: At the end.

MARK HARTMAN: At the end? What was our conclusion from this activity?

AUDIENCE: Our predictions.

MARK HARTMAN: Our predictions were the things that came out at the end. But what are we hoping about this model now?

AUDIENCE: We can fix it [INAUDIBLE].

MARK HARTMAN: So that we can fix it based on the results of all those predictions that we then tested by looking

at reality to figure out is this really right or not. Do we think that these models represent the reality of that situation pretty well now?

AUDIENCE: Somewhat.

MARK HARTMAN: Somewhat. I mean, we still had some problems with those last predictions, right?

Now, if we went to this photo studio and actually looked at that object, it would be real easy to then, OK, well, let's take some measurements of it. Let's recreate this and measure the distance in between. But we can't do that. We only have these observations to go by.

One other thing that I wanted to point out. So what is the thing that's related to the predictions? The model. From the model, you get predictions. From reality, you get the observation. Your ultimate goal is to try to get your model to be as much like reality as possible so that when you make predictions using the model, it makes sense.

So let me-- one other thing that I really liked, because I really like this. Not that the others are bad or wrong, because they're there. "A model is an example that predicts observations in future instances." We predicted something that we hadn't quite looked at yet, and then we took another picture of it. And that made sense.

Let me ask you one other question. Here, somebody wrote, "a prediction or hypothesis that can be proven as either true or false based on the facts of the experiment." And then over here, somebody said-- what was it?

Well, let me put it to you this way. What do we prove? What are we trying to prove here?

AUDIENCE: Predictions.

MARK HARTMAN: We're trying to prove what?

AUDIENCE: Predictions.

MARK HARTMAN: We're trying to prove the predictions?

AUDIENCE: We're trying to prove observations.

MARK HARTMAN: We're trying to prove observations?

AUDIENCE: That our model is right.

MARK HARTMAN: We're trying to prove that our model is right, right? We are trying to prove that the predictions our model makes are actually correct, but that helps us to know that our model is a good representation of reality.

So what I want to say to you, and I want you to discuss with the person next to you based on all of this stuff-- these ideas are still kind of floating around in our heads, and that's fine. And I want you to try and put those things together.

But I do want to point out one other thing. "A model is a representation of the objects from the observations"-- so we went from the observations to the model-- "to make the big picture. What is the big picture?

AUDIENCE: The actual model.

MARK HARTMAN: The actual model, the whole thing, hopefully, that represents reality. So the big picture is the model. In going from the observation to the model, you could say, "analyzing what we see in one image." Stop there. The putting it together to then test it comes over here with the model.

So what I want you to do is to talk with the person next to you about is it easier to prove a model correct or incorrect, and why? And we're going to kind of blend all these together. So I'm going to write a perspective that I think what each one of these things is, and we'll add that to our group dynamic. And we'll see, eventually, if we can kind of put all these together.

So I'm going to say an observation is a description of what happens in a situation. And that situation is reality. So it's a description of what happens. The model, which, for us, we're going to say a model and a theory and an explanation-- we're going to say all those are kind of the same thing, the way that we use the word "model."

And we are going to say that a model is an explanation. And that could be a 3D, physical model. That could be a mathematical representation. It is an explanation of why something happens or looks a particular way.

So the observation is the what-- what happens, what does it look like, how big is it, how far away is it. The model is, why does it look like that in the first place? Because if we can understand that, then we really understand reality.

And our testable prediction is a description of what will happen that you can then go observe. It's a prediction of what's going to happen. It hasn't happened yet. It's not an observation, but

it's going to be. We can go look at it. That's why it's testable.

If there was a non-testable observation-- like if I said, I think there's a small, tiny city of aliens that lives inside this block, you can't test that by taking pictures from the other side. Oh, but the aliens are inside. They don't come out.

That's why there are people who think that sometimes in science, you can have all these crazy ideas. But if there's no way to test them, all you're doing is making things up. However, if I could chop that block in half and look, then I might be able to see the little aliens.

So a testable prediction is a description of what will happen. And I always throw this in because everybody always asks, well, what's a law, then? Because what do you think a law is?

AUDIENCE: A prediction that has been proven as fact.

MARK HARTMAN: Say that again, nice and loud.

AUDIENCE: A prediction that's been proven as fact.

MARK HARTMAN: Oh, you're wrong.

AUDIENCE: I'm wrong?

MARK HARTMAN: This is-- no, I don't mean to pick on you, [INAUDIBLE]. But a law is not a model or a theory that stands up. You can throw stuff at it. Man, it's always right. They're two fundamentally different things. A model or a theory is an explanation of why something happens.

A law-- like, if you think about the law of gravity, things always fall down. That's an easy way to say it. We still have no idea why things are attracted to other things, but we can say that it always happens that way. So a law is a statement of what always happens in a situation.

And you'll notice the fundamental difference between a law and a theory is that this theory deals with why. A law doesn't deal with why. A law is just a statement of, this is always going to happen. It doesn't say why. It does not say why. So think about that.