



## **Transcript: How To Do a Science Fair Project: Step 4**

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Ota Lutz: Now that your experiment is done, it's time to examine your results. You want to look for trends and draw conclusions. You also want to examine your data for possible influences from factors you didn't consider at first. Now to help us do that, Serina's going to take another example from the original drawing that she identified as something she could ask a question about.

Serina Diniega: So I brought up the example of an experiment looking at how you can improve someone's jogging. For instance, let's consider the science question of how the amount of water that you drink before a run impacts how hard you have to run. The measurable we're going to use for the output is your pulse rate and then the input variable would be the amount of water that somebody drinks. So, again, we just want to be testing one variable, the effect of one variable on someone's pulse rate, so you want to make sure that you have people drinking water the same amount of time before the run and the only thing you're varying is the amount of water. So let's assume that you collected all of that information, you've put it up on a plot, you've had several different people drink, for instance, maybe half a cup of water 10 minutes before running or one cup of water 10 minutes before running, and then you had them run a certain distance and then you took their pulse rate at the end. There might be one person, that when you look at the results, doesn't quite fit the trend. You expect a certain trend and as you look across these people, there's one person that stands out. So then you have to ask the question, 'Were they particularly tired during one of the runs? When you took those measurements was it at a different temperature perhaps?' As much as we try to keep the experiment just to one variable, other things can come in and complicate the results, so hopefully you've collected enough data that overall you see something that explains and either confirms or shows that your hypothesis was wrong. But that anomalous data, you need to make sure you can explain it.

Ota: Alright, and so it doesn't really matter if your hypothesis is proven or disproven, it's a matter of whether you have looked at all the facts, all the data, and examined some of the external factors to explain your data.

Serina: You definitely want to have collected enough data to actually try to answer whether or not your hypothesis was correct or wrong. But even saying, 'No, my hypothesis was wrong,' that is a result and that's a perfectly acceptable result as long as that's what your data shows and then just if there's any extra little bits, a data point that doesn't quite fit when you graph it up, you just need to have an explanation for why that point doesn't quite fit in with everything else.

Ota: So, Arby, you mentioned this free-throw machine. I don't have any idea how that would look. Can you explain that to me? Definitely. The way I would build it is first get some plans, draw it out. You'd have a wood frame, you'd have a couple springs to provide the energy needed to launch the basketball, you'd need a lever arm to cause the action of shooting a basketball. It's a pretty basic build, so it's mostly important to get it down on paper first so, when you go to the hardware store, you know what to buy.

Ota: Now, would you build a full-scale basketball shooter for the basketball hoop on the side of the building or would you build a small one?



Arby Argueta: That's the great thing about designs, they're scalable. You can start out by building one out of popsicle sticks at a small scale, make sure it works, make sure you like it, and then you can move on to bigger and better things with wood and larger springs.

Ota: You could enlarge your design by using different materials, could you also improve your design by using different materials?

Arby: Yes. One of the big things in engineering is always wanting to make things bigger, better, faster. So once you move from popsicles to wood, the next thing you want to do is performance. Maybe you start out shooting at 50 percent with this free-throw machine and you want to get it up to 90-100 percent. So there's a lot of different things you could do to improve the performance. One of the crucial things is the movement. How much force is the basketball going to be launched at and at what angle the ball's going to be released. There's a couple different ways to change that. The more you compress the spring, the more force you'll get out of it when it's released. So one of the things you can play around with is at what level of compression do you get the basketball to actually reach the hoop.

Ota: There are different types of springs out there. Different springs, would that make a difference?

Arby: Yes. Different springs, the amount of springs you use. The important thing in this is to run several tests. You want to keep the basketball holder at one position, then with one spring do about ten shots.

Then switch out for another spring, repeat the task. If you want to do two springs, then run the test with two springs and then that way you'll have data that compares only spring against spring. One way to improve the free-throw machine is to move the basket that's holding the basketball up and down the lever arm while maintaining the spring constant throughout the experiment. This way you can isolate which position of the basketball holder is the best.

Ota: So you're only changing one thing at a time so you can tell what it is that affected the performance.

Arby: Yes.

Ota: Okay, very good. Now, you're probably going to make notes of this in a log book?

Definitely. Because what might happen, and it always happens in engineering, is you think you're making an improvement, but in fact you're actually making things worse, so you might have to revert to a previous design.

Ota: In this redesign process, you have design one, design two, design three and at some point you might go, 'Oh, wait, design three was better than design five.'

Arby: Yeah.

Ota: That's this whole cyclical process.

Arby: Yes, it's a very cyclical process. It never really ends. You'll never reach the optimal design,



so you have to be the decider of when your design has met your requirements. If you want to get to 100 percent, chances are, there are other little variables that might cause it not to reach 100 percent. It could be a windy day, maybe the ball is less inflated. So, keep your goals realistic and know that it's a cyclical process and only you can decide when to exit out of that process.

Ota: And that is how you examine your data and draw conclusions related to your hypothesis for your presentation.