Science Is Valuable, Science Is Not Settled

This article is from the "Among Friends" section of the Church of God Big Sandy's website, churchofgodbigsandy.com. It was posted for the weekend of Aug. 1, 2020.

By Dave Havir

BIG SANDY, Texas—In the past six months, it has been natural and beneficial for people to discuss various aspects of the coronavirus. Unfortunately, it has been all too common for people to argue about various aspects of the coronavirus.

I want to mention two statements that often cause disruptions when people talk about various aspects of the coronavirus.

- "While you are free to have your opinion, I am following the science."
- "The science is settled."

Science is valuable

One dictionary definition of science is the following: Science is a process of discovery that allows us to link isolated facts into coherent and comprehensive understandings of the natural world.

Another definition is: Science is a way of discovering the laws of the universe—how they worked in the past, how they work today and how they will likely work in the future.

It is a wise approach to include science when analyzing the coronavirus. Scientific research is an ongoing benefit to mankind. We should cheer the fact that many men and women are directing their attention toward scientific research about the coronavirus.

But I want to remind you about something. People who disagree about aspects of the coronavirus (lockdowns, masks, ventilators and the like) may be both following scientific research.

- You could be greatly mistaken if you conclude that people who have different opinions from you are not following scientific research.
- You want to be careful to avoid being condescending toward people with different opinions.
- You don't want to be questioning the intelligence of other people because their scientific research doesn't agree with your scientific research.

■ People sometimes make this mistake when they erroneously believe that "the science is settled."

Science is not settled

It is shocking to hear an "expert" say that the "science is settled." To be honest—when I hear an "expert" say that science is settled, I lose trust and respect for that so-called expert.

Science is continually refining and expanding our knowledge of the universe. As it does, it leads to new questions for future investigation. Science will never be finished.

Four articles

The rest of this article will be a compilation of four articles to show basic information that science is not settled.

Here are the headlines of those articles.

■ January 2020—"Nature of Science"

Although I edited out some material from the statement called the "Nature of Science" (to shorten it), it is still long. It wouldn't surprise me if you disagreed with aspects of this statement (especially when considering quantum physics and quantum mechanics), but this statement obviously shows that science is not settled.

■ January 21, 2019—"Physicist: Don't Fall for the Argument About 'Settled Science' "

■ April 6, 2020—"Science Has No Clear Answers on the Coronavirus; Face Masks Are No Exception"

■ May 1, 2020—"No, Science Can't Tell Us How to Respond to the Coronavirus"

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A statement by the NSTA (National Science Teaching Association) Board of Directors titled "Nature of Science" was adopted and posted at nsta.org in January 2020. Following are excerpts of the lengthy statement.

Why Learn About Nature of Science?

Understanding of Nature of Science (NOS) is a critical component of scientific literacy. It enhances students' understandings of science concepts and enables them to make informed decisions about scientifically based personal and societal issues.

Declarations

The National Science Teaching Association makes the following declarations for science educators to support teaching NOS.

■ Scientific knowledge is simultaneously reliable and subject to change. Having confidence in scientific knowledge is reasonable, while also realizing that such knowledge may be abandoned or modified in light of new evidence or a reconceptualization of prior evidence and knowledge. The history of science reveals both evolutionary and revolutionary changes. With new evidence and interpretation, old ideas are replaced or supplemented by newer ones. Because scientific knowledge is partly the result of inference, creativity and subjectivity, it is subject to change (AAAS 1993; Kuhn 1962).

■ Although no single universal step-by-step scientific method captures the complexity of doing science, a number of shared values and perspectives characterize a scientific approach to understanding nature. Among these are a demand for naturalistic explanations supported by empirical evidence that are, at least in principle, testable against the natural world. Other shared elements include observations, rational argument, inference, skepticism, peer review and reproducibility of the work. This characteristic of science is also a component of the idea that "science is a way of knowing" as distinguished from other ways of knowing (Feyerabend 1975; Moore 1993; NGSS Lead States 2013).

■ In general, all scientific knowledge is a combination of observations and inferences (Chalmers 1999; Gould 1981). For example, students of all ages pay attention to weather forecasts. Weather forecasters make observations, and their forecasts are inferences. All science textbooks have a picture of the atom, but the picture is really an inference from observable data of how matter behaves.

■ Creativity is a vital, yet personal, ingredient in the production of scientific knowledge. It is a component of science as a human endeavor (Bronowski 1956; Hoffman & Torrence 1993; Kuhn 1962).

■ Subjectivity is an unavoidable aspect of scientific knowledge. Because "science is a human endeavor," it is subject to the functions of individual human thinking and perceptions. Although objectivity is always desired in the interpretation of data, some subjectivity is unavoidable and often beneficial (Chalmers 1999; Gould 1981; Laudan 1977).

■ Science, by definition, is limited to naturalistic methods and explanations and, as such, is precluded from using supernatural elements in the production of scientific knowledge. This is a component of the recognition that scientific knowledge is empirically based (Hoffman & Torrence 1993).

Theories and laws

A primary goal of science is the formation of theories and laws, which are terms with very specific meanings.

■ Laws are generalizations or universal relationships related to the way that some aspect of the natural world behaves under certain conditions. They describe relationships among what has been observed in the natural world. For example, Boyle's Law describes the relationship between pressure and volume of a gas at a constant temperature (Feynman 1965; Harre 1983; National Academy of Sciences 1998).

■ Theories are inferred explanations of some aspect of the natural world. They provide explanations for what has been stated in scientific laws. Theories do not become laws even with additional evidence; they explain laws. However, not all scientific laws have accompanying explanatory theories (Feynman 1965; Harre 1983; May 1988; National Academy of Sciences 1998; Ruse 1998).

■ Well-established laws and theories must be internally consistent and compatible with the best available evidence; be successfully tested against a wide range of applicable phenomena and evidence; and possess appropriately broad and demonstrable effectiveness in further research (Kuhn 1962; Lakatos 1983; Popper 1968).

■ Contributions to science can be made and have been made by people the world over. As a consequence, science does not occur in a vacuum. It affects society and cultures, and it is affected by the society and culture within which it occurs (AAAS 1993; Showalter 1974).

■ The scientific questions asked, the observations made, and the conclusions in science are to some extent influenced by the existing state of scientific knowledge, the social and cultural context of the researcher, and the observer's experiences and expectations. Again, scientific knowledge is partially subjective and socially and culturally embedded (Lederman & Lederman 2014; NSTA 2000).

These premises combined provide the foundation for how scientific knowledge is formed and are foundational to nature of science.

NSTA recommends that, by the time they graduate from high school, students should understand the following [eight] concepts related to NOS.

■ Scientific Investigations Use a Variety of Methods.

■ Scientific Knowledge Is Based on Empirical Evidence.

■ Scientific Knowledge Is Open to Revision in Light of New Evidence.

■ Science Models, Laws, Mechanisms and Theories Explain Natural Phenomena.

■ Science Is a Way of Knowing.

■ Scientific Knowledge Assumes an Order and Consistency in Natural Systems.

■ Science Is a Human Endeavor.

■ Science Addresses Questions About the Natural and Material World.

Concluding remarks

NOS (i.e., the characteristics of scientific knowledge as derived from how it is produced) has long been recognized as a critical component of scientific literacy.

The research clearly indicates that, for students to learn about NOS, it must be planned for and assessed just like any of the instructional goals focusing on science and engineering practices, disciplinary core ideas, and crosscutting concepts (Lederman 2007; Lederman & Lederman 2014).

All aspects of NOS cannot and should not be taught in a single lesson, nor are all aspects developmentally appropriate for all grade levels.

For example, understandings of the differences between theories and laws or the cultural embeddedness of science are not developmentally appropriate for K–5 students.

Nevertheless, NOS should be included at all grade levels as a unifying theme for the K–12 science curriculum. All too often, NOS is only taught explicitly at the beginning of a science course, independent of any of the science content that will subsequently follow.

Instead, NOS should be taught as a unifying theme with the expectation that students' knowledge will progressively become more and more sophisticated as they progress through the K–12 curriculum.

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Looking back to 2019, an article by Michael Guillen, Ph.D., titled "Physicist: Don't Fall for the Argument About 'Settled Science' " was posted at foxnews.com on Jan 21, 2019. Following is the article.

I am dismayed to hear that NBC's "Meet The Press" is actually blaming science for its decision to shut down any intelligent, meaningful discussion about climate change.

"We're not going to give time to climate deniers," the show's host recently said, referring to people, including Nobel laureates, who disagree that humans are mostly to blame for altering Earth's climate. "The science is settled even if political opinion is not."

Neither denier or alarmist

■ For the record I'm neither a "denier" or an "alarmist."

■ I'm a physicist who does his very best to seek the truth, the whole truth and nothing but the truth.

■ I'm also a journalist who's been covering the complexities of the climate-change story since the 1980s, even reporting directly from the north and south poles, where much of the climate research is done.

Science is not settled

My point here is not to debate the merits of today's resolute scientific consensus that humans are having a decisive, apocalyptic impact on the climate. It might very well be correct.

■ My point is that if you are absolutely, 100 percent convinced it is—as evidently the producers of the aforementioned news show are—you have a right to say your mind is settled, or your politics are settled.

■ But never say the science of this or any equally complex subject is "settled."

That crucial lesson was learned centuries ago, when something far simpler than Earth's mercurial climate was being hotly debated. Back then the scientific community was convinced beyond any doubt that our planet was at the center of the universe.

Nicolaus Copernicus

In the sixteenth century, Nicolaus Copernicus—a "geocentric denier," to use today's pejorative labeling—was derided for believing the sun was at the center of everything.

Mainstream scientists and university professors of the day proclaimed the science was settled and justified their "evidence-based" derision of Copernicus by citing the mountain of observational data in favor of the geocentric consensus.

Tragically, if NBC had been around, the good Mr. Copernicus would not have been allowed to argue his case on "Meet The Press."

Galileo Galilei

Ditto for that other notorious geocentric denier, Galileo Galilei. In the early seventeenth century even the Catholic Church—which had long since reconciled scripture with science's earth-centered consensus—condemned Galileo for his wayward thinking.

Declaring that both science and scripture were settled, Pope Urban VIII's chief inquisitor sentenced the aged astronomer to house arrest—but only after shaming him into publicly recanting his denial of geocentricism.

The list is long and sobering of examples in history where resolute scientific consensuses have been disproven. And, worse, disproven only after "deniers" had been crushed and even destroyed for touting nonconforming interpretations of available evidence.

Always open to debate

Altogether the lesson should be crystal clear: science—which I believe to be the most brilliant discipline we have for understanding the physical universe—is fallible and, therefore, always open to debate.

The "Meet The Press'" policy is pointedly and dangerously unscientific. And so are the calls by like-minded individuals to not just silence but punish anyone who dares to challenge the consensus of human-caused climate change—all allegedly in the name of science.

Comedian, commentator and actor

"I think that denying climate change is a crime against humanity," says comedian Eric Idle, not joking. "And they should be held accountable in a World Court."

Bill Nye—another commentator, but with an undergraduate degree in mechanical engineering—agrees, saying, "this extreme doubt about climate change is

affecting my quality of life as a public citizen. So I can see where people are very concerned about this, and they're pursuing criminal investigations . . ."

"The scientific consensus is in, and the argument is now over," proclaims actor Leonardo Di Caprio. "If you do not believe in climate change, you do not believe in facts, or in science or empirical truths and therefore, in my humble opinion, should not be allowed to hold public office."

Albert Einstein

Albert Einstein once faced a similar kind of repulsive, benighted lynch mob. In his day, the scientific establishment resolutely believed that time and space were absolutes and cited as incontrovertible proof a vast literature of peer-reviewed, published studies.

Collectively, mainstream scientists mocked Einstein's belief that space and time were relative—some calling it "Jewish science," a particularly hateful way of smearing the young space-time denier.

Yet, as everyone now knows, Einstein—like Copernicus, Galileo and scores of other vindicated "deniers" over the centuries—ultimately disproved the vaunted scientific consensus.

By all means, vet your guests carefully—avoid the uncredentialed nut jobs and purely political partisans. But, above all, heed Einstein's wise words about how science really works.

"No amount of experimentation can ever prove me right," he observed, "a single experiment can prove me wrong."

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Looking back to April, an article by Maggie Koerth titled "Science Has No Clear Answers on the Coronavirus; Face Masks Are No Exception" was posted at fivethirtyeight.com on April 6, 2020. Following is the article.

Over the course of the last week, America somehow went from being a country where very few people were willing to wear masks for health . . . to one where regular people are trading mask-making patterns like sourdough starter.

But the messaging about mask usage remains muddled.

That's true for the Centers for Disease Control and Prevention, which updated its public recommendations to include wearing masks whenever you go out in public on the same day President Trump announced he would not be wearing one.

Dueling experts

It's also true in the scientific community, where dueling experts both urge widespread public face mask usage and dismiss face masks as useless and potentially dangerous.

Meanwhile, those of us with sweet, loving mothers who like to craft their way through anxiety are rapidly accumulating stockpiles of homemade masks. (I currently have 10 masks, and I have been told that another boxful is on the way. Thanks, Mom!) So what are we—the suddenly cloth-mask-owning people of America—supposed to take away from this?

Is it a good idea to wear a mask in public?

That's a trick question, experts told me. And we actually need to be asking something altogether different. "I would say there's a lack of evidence to support either position," said Benjamin Cowling, professor of epidemiology and biostatistics at Hong Kong University. "When we have a lack of scientific evidence, then we have to use our judgment on what might be the best thing to do and what's at stake."

And judgment is subjective: It's influenced by personal experience, by how people view risks and benefits, and by how they weigh the balance between the two. Sometimes, we have to make big, serious decisions, even when research hasn't conveniently supplied us with absolute, unequivocal facts.

We're in the land of uncertainty—a place that the novel coronavirus pandemic has forced us to visit a lot lately. Masks are just one part of it. And the question isn't, "Should we wear them or not?" It's, "How do we make a decision when there isn't an answer?"

Uncertainty is hardly unfamiliar for people who work in public health. "That's a normal day in the life for most of us," said Lara S. Martin, a former program manager at Emory University's Center for Humanitarian Emergencies.

She's done public health research in the field of humanitarian response for over a decade. But making life or death decisions in the face of big question marks is not the norm for millions of average Americans, who are struggling to understand everything from how long they should wash their hands to how many people are likely to die from the novel coronavirus this year.

Big picture of uncertainty

The mask debate is part of that big picture of uncertainty. We just don't have data, even for the efficacy of medical-grade masks in protecting against the transmission of a fluid-based virus like Ebola.

The more specific the question becomes, the more hazy the data.

- What about cloth masks?
- What's the best filter?
- How airborne is coronavirus, exactly?

There are studies on these issues, experts told me, but there's not enough data to be conclusive. About the best anyone can say is that, depending on several variables like the type of mask and how well it's used, there's probably a small benefit to wearing masks—in preventing the wearer from spreading the virus to others.

Contrasting points of view

But that still leaves plenty of space for reasonable experts to reasonably disagree. Martin and Cowling come down on opposite ends of the face mask debate.

■ Martin, who said she has watched misuse of masks and gloves spread disease in emergency situations, believes masks can create a false sense of security. After all, we know of other times where safety measures have led people to take more risks—not fewer.

■ Meanwhile, Cowling—who said he has lived through multiple epidemics in Hong Kong and seen successive waves of public health campaigns improve the way the public uses masks—believes the very limited evidence of a small potential benefit to public health means it's worth doing. To him, the risks of wearing masks can be mitigated, and every small benefit stacks on top of the last.

Cowling asked two questions.

■ "Why do it with no evidence?"

■ "Why wouldn't you do it if there's no evidence?"

Sometimes—pretty often, actually, in medicine—people have to make decisions even when there isn't enough data to tell them what to do.

There are even situations where finding more evidence can, itself, be harmful, said Michelle Driedger, professor of health sciences at the University of Manitoba.

Take lower-back pain, for instance. Faced with a patient who is in pain and wants to know what's wrong, a doctor might be tempted to order some kind of imaging test, she said. "But sometimes that's a soft tissue issue, where rest is better than exposing ourselves to X-rays, because they can't necessarily identify if there's really a problem, anyway," Driedger said.

Comfortable with changing answer

Common sense doesn't always apply. And you have to be prepared to update your choices as more information comes in. Be prepared, in other words, to get comfortable without knowing the correct answer right now, and get comfortable with knowing your answer may change in the future.

You also have to accept that changing your mind about how to fight the pandemic doesn't mean you've failed. "It will change. This is just the way we learn and adapt," Martin said.

At the end of the day, experts told me, when evidence is lacking, individuals and public health officials alike have to make a call based on what we do know, our personal experiences and our own understanding of risk and risk management.

Cowling and Martin agree that if Americans start wearing masks, it's vitally important that they are explicitly taught how to use them. We've gotten some helpful suggestions for how to make simple, cheap masks at home, which is crucial if we want to avoid encouraging people to snap up N95 masks that health care workers need.

But Cowling and Martin say Americans also need detailed information on how to make and wear masks in a way that maximizes the benefit to them and minimizes the risk. That's going to require videos, advertisements and an all-out push to teach and change behavior, they both said.

Until that exists, Martin's advice is to imagine that, every time you use a mask, there's something really disgusting that's gotten on it and that it's plainly visible.

"If you could see it, and it was gross, what would you do? You wouldn't touch it. You wouldn't wear it again. You'd wash it in the hottest water you can with strong detergent. Some of that can help," she said.

Ultimately, the expert advice on masks (and hand-washing, and death tolls, and the proper distance to keep between yourself and others, and . . . and . . . and) is to get comfortable with not knowing the right answer.

Same data, different conclusions

You can (and should) have some trusted advisers. You can (and should) read up on why certain things are or aren't being recommended.

But there are a lot of issues around this virus on which two experts can read the same data and come to different conclusions.

For the rest of us, that means accepting that, sometimes, we'll just have to do the best we can without a clear set of instructions. "That's one of the best gifts we can give ourselves," Martin said.

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Looking back to May, an article by Rich Lowry titled "No, Science Can't Tell Us How to Respond to the Coronavirus" was posted at nationalreview.com on May 1, 2020. Following is the article.

If you thought the coronavirus presented difficult policy questions, don't worry—we have science.

■ Gov. Gavin Newsom tweeted the other day, "The West Coast is—and will continue to be—guided by SCIENCE."

■ Joe Biden has urged President Trump, "Follow the science, listen to the experts, do what they tell you."

■ Neil DeGrasse Tyson calls the crisis "a giant experiment in whether the world will listen to scientists, now and going forward."

Not ultimate authority

The invocation of science as the ultimate authority capable of settling questions of how we should govern ourselves is a persistent feature of modern Western life going back several centuries and has always been a mistake.

It is especially so in this crisis, when so much is still unknown about the coronavirus and immensely complicated and consequential public-policy questions are in play.

A wonder of our age

Modern science is obviously one of the wonders of our age. We owe it an unimaginable debt—for technological advancements in medicine, transportation, industry, communication, computing, and more. All honor to Newton, Turing, Curie and Einstein.

The world was slow to react to the coronavirus, and yet the genetic code of the virus was publicly posted by China on January 20, and South Korea had deployed a test kit by early February. It's possible we'll have a vaccine by the end of the year.

Limited competency

Science has a limited competency, though.

Once you are outside a lab setting and dealing with matters of public policy, questions of values and how to strike a balance between competing priorities come into play, and they simply can't be settled by people in white lab coats.

■ Science can make the atom bomb; it doesn't tell us whether we should drop it.

■ Science can tell us how to get to the moon; it doesn't tell us whether we should go.

■ Science can build nuclear reactors; it doesn't tell us whether we should deploy them.

Invoking scientists in this crisis is a little like saying, "My economic policy is going to be guided by an ECONOMIST." Well, good for you.

But is your economist on the left or on the right? Does he care most about inequality or dynamism? Is he Paul Krugman or Art Laffer?

Changing perspectives

An extraordinary feature of the coronavirus is how poorly understood it is. We don't know how many people have it, what the death rate is, or how best to treat it, among other things.

The models of how the virus would spread were invested with a certainty that they didn't deserve.

If we are going to unquestioningly accept expert opinion, we'd better prepare for whiplash.

■ At first, the elite consensus was that wearing masks was unnecessary. Now, we are told it's an essential piece of getting out of this mess.

■ We worried about running out of ventilators, but in recent weeks some doctors have been wondering whether they have been overused.

Bigger picture

Then, there are the big questions.

■ Science can't tell us how we should think about the trade-off between the economic misery caused by shutdowns and the public health risks of reopenings.

■ It can't determine the balance between shutting down a hospital's elective surgeries so it can prepare for a COVID-19 surge, and tanking its business.

Not a political weapon

The people in our political debate who most volubly insist that they are simply following "the science" tend also to be most resistant to nuance and prone to unscientific fervency. They are using "science" as a bludgeon and conversation stopper.

Obviously, science already has made an enormous contribution to our fight against the coronavirus, and may—through therapies or a vaccine—go a long way to solving this crisis. But life is not an equation, and neither is politics or policy.

We as a free people will have to decide the important questions raised by this crisis, not the doctors on TV or the researchers in the labs.

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Additional headlines

■ An article titled "Treatment With Hydroxychloroquine Cut Death Rate Significantly in COVID-19 Patients, Henry Ford Health System Study Shows" was posted at henryford.com on July 2, 2020.

■ An article by Gary Abernathy titled "I'm Not So Sure on Masks; but Here's Why I Wear One [Because I Care About the Peace of Mind of My Neighbors]" was posted at washingtonpost.com on July 23, 2020.

■ An article by Lauren Leazenby titled "Gloves May Do More Harm Than Good When It Comes to Protecting You From COVID-19" was posted at chicagotribune.com on July 27, 2020.

■ An article by Caterina Andreano titled "Dr. Fauci: Wear Goggles or Eye Shield to Prevent Spread of COVID-19; Flu Vaccine a Must" was posted at abcnews.com on July 29, 2020.

■ An article by Marc Preel titled "No Country for Face Masks: Nordics [Denmark, Finland, Iceland, Norway and Sweden] Brush Off Mouth Covers" was posted at afp.com on July 30, 2020.

■ An article by Chris Anderson titled "[Ohio] Pharmacy Board Reverses Ban on Hydroxychloroquine, Will Allow for Use in COVID-19 Treatments After Gov. DeWine's Request" was posted at cleveland19.com on July 30, 2020.