Science's endangered reputation

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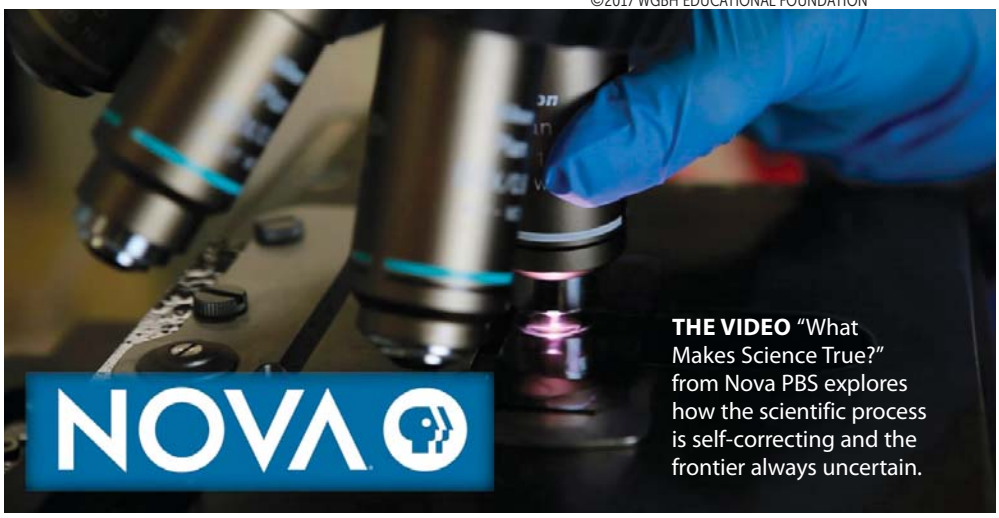

THE VIDEO "What Makes Science True?" from Nova PBS explores how the scientific process is self-correcting and the frontier always uncertain.

For many people, science is no longer an indisputable enterprise that builds knowledge and defines the progress of our society. Highly publicized cases of scientific misconduct, misrepresentation or oversimplification by the media, and the low reproducibility of research results have created an impression that science in general cannot be trusted. A YouTube video with the title "Is There a Reproducibility Crisis in Science?" has more than 300 000 views, "Is Science Reliable?" has more than 400 000, and "Is Most Published Research Wrong?" has more than 2.4 million; other online publications and videos with similar titles abound. For comparison, the NOVA PBS video "What Makes Science True?," which explains the ability of science to eventually correct misleading results, has only 39 000 views on YouTube.

Scientific research does not take place in a vacuum; it is directly connected to the politics of society because most research is funded with taxpayers' dollars. The general public and members of the US Congress are increasingly asking, Why should money be wasted on unreliable and, consequently, useless research?

Scientific misconduct has been discussed extensively by federal funding agencies, and in 2000 the White House Office of Science and Technology Policy adopted a specific definition for research misconduct to be applied across all government agencies. According to that definition, research misconduct means "fabrication, falsification, or plagiarism (FFP) in proposing, performing, or reviewing research, or in reporting research results." A published analysis of data on FFP and the reproducibility of research results shows that although physics and related sciences are definitely not immune, they fare better than biology, medicine, psychology, and other branches of science.[1–5]

The most likely reasons for that difference are that physics is a quantitative science and is governed by a set of major laws. So, it is especially sad to see some research papers include statements and conclusions that directly violate those laws and misuse scientific terminology. For example, I know of papers reporting solar cells, LEDs, photodetectors, and other devices with efficiency over 100%. Interestingly, soon after those results were published came new reports that claimed 250%, 60 000%, and even higher efficiency.

An important question is, What separates good science from bad—is it a narrow line or a gray area? These days, one can find physics and engineering papers stating that a presented result, approach, or method "has opened the door for a revolutionary device design," or "offers an unmatched portfolio of properties," or "leads to fabrication strategies not possible with traditional technology," or "will find use in widespread technological applications," and so forth. Definitely, such statements cannot be considered FFP. At the same time, they cannot be proven. Many of my colleagues consider exaggerations and overstatements to be a first step into the gray area that separates honest science from everything else.

Physical constants are universal; it does not matter when, how, or by whom measurements and calculations were performed, as long as they were performed and reported correctly. Similarly, scientific definitions are useful only if they have been applied properly, and any deviation from the established norm should at least be explained. Overstatements, misuses of scientific definitions, and exaggerations of research results, often due to the pressure to publish and the competition for funding, do not fall under the umbrella of FFP. Nevertheless, they do harm the reputation of science (as well as the reputation of the authors) and should not be tolerated by the reviewers and editors of research journals.

It is well known that reputation is hard to build and easy to lose; however, it is even harder to rebuild. We still have a chance to rebuild the reputation of science, but we have to start as soon as possible.

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More thoughts on physics pedagogy

John Winfrey's thought-provoking letter in PHYSICS TODAY's April 2020 Readers' Forum (page 10) makes two points regarding the physics curriculum and teaching materials. First, he notes that gaps in understanding originate in the undergraduate curriculum and persist into faculty teaching; second, he suggests that they are part of a problem with physics textbooks and pedagogy not ad-