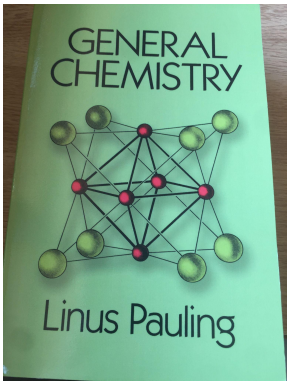
13. How can we know that current knowledge is an improvement upon past knowledge?

This prompt is explored by focusing on scientific developments. Currently we judge the "goodness" of science based on peer review, however in the context of this question this is a tautology as we are using current knowledge to determine the validity of current knowledge. As well, in science we cannot know anything, but rather we are making supported guesses. Thus, this exhibition will explore other ways that we can "know" that current knowledge is better.



My first object is the textbook *General Chemistry* by Linus Pauling. This is a chemistry textbook aimed at first year undergrads with the intent of increasing their knowledge, published in 1970. It has a brief description on what we know now as elementary particles, as they had just been discovered around that time. It describes the number of quarks to be three, whereas in our current understanding there are actually six. As well, it does not include a description of the Higgs field, which is now considered to be the key tenet of modern particle physics. We can compare the past knowledge of the book versus our current knowledge. Our knowledge includes the Higgs field and more quarks, but this does not necessarily mean that our models are correct, but rather, they allow us to make more accurate predictions. In science, especially in particle physics, we cannot know anything since elementary particles are too small to be seen so we can only create theories and models. We create these theories and models based on our observations and thought experiments, and we can confirm with them with real experimentation. As technology advances, we can make more accurate and in-depth observations; so if we are making models based on more accurate observations, then we can say that hence, the models must be more accurate. Also, the book is a snapshot of the leading science at the time; with the benefit of hindsight, we can see where we have made improvements and what has stayed the same. Notably however, we don't look back and see what knowledge has decreased, because we consider current knowledge to be better[1]. Our knowledge right now is built off of previous knowledge that has stood the test of time and experimentation. Obviously not all current knowledge is correct, but as time progresses, humans become more accurate with their knowledge, thus improving it.

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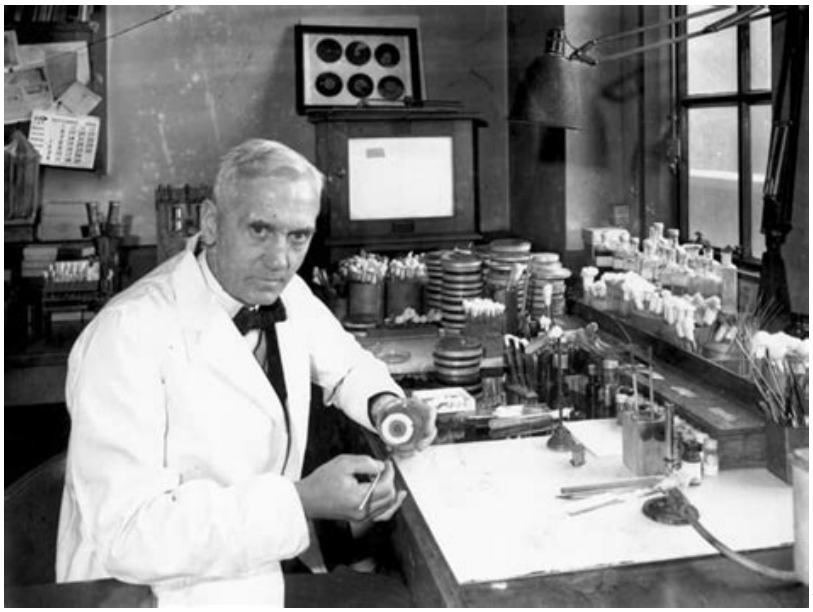
[1]Brod, Garvin. "Toward an Understanding of When Prior Knowledge Helps or Hinders Learning." *Nature News*, 19 Aug. 2021, www.nature.com/articles/s41539-021-00103-w.

 [2]

My second object is a picture of the discovery of penicillin. Penicillin is the first antibiotic discovered by Alexander Flemming. Penicillin was discovered by accident in Flemming's lab, but once discovered, the antibiotic allowed doctors to save lives by removing bacteria from wounds and preventing deadly infections.[3] Prior to the discovery of penicillin, minor cuts and injuries may have been fatal due bacteria being impossible to kill in wounds. Past knowledge on how to cure diseases ranged from flowers to clean the air to literal genocide.[4] Obviously, this "knowledge" was not very effective in curing disease. After the discovery of penicillin, countless lives were saved with the knowledge of how to make and use penicillin. We can thus measure the effect of the newfound knowledge with statistics and how many lives were saved. If the present knowledge were not an improvement on past knowledge, we would not see any positive impact to society. As well, we can determine if knowledge is better if it allows further knowledge to be built upon it, especially since a lot of knowledge in science is interconnected. Penicillin allowed for the discovery of many other antibiotics, whereas "cures" such as "making the air smell better" did not allow us to advance scientific knowledge. Even if the new knowledge isn't necessarily better or more helpful than the previous knowledge, if it is a waypoint and allows us to advance our knowledge, then it would be better as it has a more positive impact on society.

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[2]"Mould from Penicillin Discoverer Auctioned off | CBC News." *CBCnews*, 2 Mar. 2017, www.cbc.ca/news/health/pencillin-1.4006565.

[3]"Penicillin." *Encyclopædia Britannica*, 20 May 2023, www.britannica.com/science/penicillin.

[4]"How Diseases Spread: Ways People Have Tried to Explain Pandemics through History." *History.Com*, www.history.com/news/how-infectious-diseases-spread-myth-superstition-theories.

 [5]

My third object is a depiction of Galileo's experiment to determine whether the masses of objects determined their speed of free fall. He dropped two balls of different masses at the same time from different heights; the result was that they landed on the ground at the same time.[6] He did this to counter Aristotle's prevailing belief that heavier objects fall faster; this thought experiment was incorrect but was deemed to be leading scientific knowledge for over 2000 years. Galileo did not prove anything when he dropped the balls, nor did he measure any value for the gravitational constant, which would be helpful in calculations and making predictions. These would happen centuries later with the experiments of Henry Cavendish. However, what he did was directly disprove Aristotle and added new knowledge to society. It is obvious that this knowledge was an improvement on past knowledge since it *directly and irrefutably disproves the past knowledge*. One key point is that it must be almost certain that it is the current knowledge that is correct. If there are large uncertainties, then we cannot be sure that it is an improvement, until we become certain one way or another. As well, similarly to the other objects, this development created a paradigm shift which allowed for future science to be built upon it. The old knowledge, which might have potentially been developed to a limited extent, would have led to a model that would have made our understanding of nature more difficult and less useful. Galileo's experiment changed the way people thought about science for the better, as similarly to the quarks, it allowed them to create more useful models and predictions which have helped them in the real world. It should be apparent that new knowledge that is more accurate and allows us to make better predictions would be better than the knowledge it replaced.

[5]"Evidence for Universal Acceleration." *The Flat Earth Wiki*, wiki.tfes.org/Evidence_for_Universal_Acceleration.

[6] "6.3: Galileo's Falling Bodies." *Physics LibreTexts*, 1 Nov. 2022, phys.libretexts.org/Bookshelves/Astronomy__Cosmology/Astronomy_for_Educators_(Barth)/06%3A_Exploring_Gravity/6.03%3A_Galileos_Falling_Bodies.