



Science Fictions: Low Science Knowledge and Poor Critical Thinking are Linked to Conspiracy Beliefs

The State of Critical Thinking
September 2022



Introduction

In the classic TV series Star Trek, the character Spock is beloved for his fidelity to logical reasoning above all else. “It is dangerous,” Spock says, “to be ill-informed about facts.”

The last few years have done nothing to disprove him, particularly when it comes to science. From COVID-19 and climate change, to the growing popularity of outlandish conspiracy theories, a widespread disregard for knowable facts is fueling divisions around the globe, with life-or-death consequences.

Instead of reasoned, solution-orientated debate around scientific and science-related issues, what too often emerges is an amalgamation of “[alternative facts](#),” fear mongering, and conspiratorial thinking. The negative consequences of scientific illiteracy are hard to overestimate. It poisons political debate; worsens existing crises; and contributes to what some have called an “[epistemological crisis](#),” where a shared grip on reality itself seems to be slipping.

In order to better understand the state of science literacy and its impact on our social and political lives, [the Reboot Foundation](#) devoted its annual survey to this topic. The result: A concerning lack of basic science literacy among our survey takers; a number of startling connections to beliefs in conspiracy theories; and – helpfully – a shared trust in the power of education to help solve these problems.



Overall Findings

When it comes to conspiracy theories, 25 percent of the survey participants said they were open to believing conspiracy theories. People who said they rely heavily on social media and informal networks for their information were more likely to believe in these theories. Conspiracy believers also tended to be more politically conservative.

At its most extreme, distrust can clearly aid in the spread of conspiracy theories, which have become more prevalent in American political life in the last decade. Although a minority, our survey documented a significant number of respondents expressing beliefs in conspiracy theories related to scientific issues:

- 25 percent said it was certainly true or probably true that “COVID-19 is a biological weapon released intentionally by China.”
- 22 percent said it was certainly true or probably true that “the trails left in the sky by high-flying aircraft are actually toxic chemicals.”
- 21 percent said it was certainly true or probably true that “5G mobile Internet is substantially harmful to human health.”
- 15 percent said it was certainly true or probably true that “climate change was a conspiracy by the left to hurt the economy.”

These beliefs tended to be correlated with decreased science literacy and a heavier reliance on social media and friends and family for scientific information. Poor information consumption, of course, is far from the only reason for the spread of conspiracy theories. Also playing roles are social alienation and disaffection, fear of uncertainty, and legitimate problems with how science information is developed and disseminated.

Survey participants who demonstrated higher levels of science literacy and who were exposed to critical thinking education in school were far less likely to believe in conspiracy theories.

There is a significant difference between rhetoric and reality when it comes to critical thinking. Many who reject mainstream information or narratives believe themselves to be “critical thinkers,” but they have confused cynicism and blanket distrust for genuine critical thinking. Real critical thinking is much harder to achieve, but our survey suggests it can have a real impact. Those who scored higher on Reboot’s science literacy quiz were nearly 40 percent less likely to believe in one of the conspiracy theories we tested. Participants who reported having studied critical thinking activities and media literacy while in school were 26 percent less likely to believe in a conspiracy. But those participants who self-identified as being “critical thinkers” who lacked formal training? They were 63 percent more likely to believe in conspiracies.

Participants who reported having studied critical thinking activities and media literacy while in school were 26 percent less likely to believe in a conspiracy.



Science literacy was low among our survey takers, but especially among those who said they rely on social media for their news. Meanwhile, trust in mainstream sources of scientific information was mixed.

Our survey discovered a concerning lack of science literacy in the general public, in line with similar assessments given by the Pew Research Center and National Science Foundation. For example:

- 12 percent of our survey participants answered this question wrong: True or False, the Earth is a sphere.
- 15 percent said that “the Sun travels around the Earth” (In reality, the Earth travels around the Sun.)
- 78 percent said the climate is hotter at the equator because the equator is closer to the Sun. (The equator is hotter because the Sun’s rays are almost directly overhead.)

The survey also found some notable, if unsurprising, correlations. Those who stay informed by reading materials from higher education, newspapers, and magazines tended to perform better on the science literacy quiz than those who reported consuming information from TV or social media. Furthermore, while more mainstream sources of information, including from higher education and government, are generally more trusted than social or independent media, there is a significant amount of distrust of these sources. Similar research has traced long-term declines in trust of institutions, including scientific institutions, which was exacerbated by the fallout from the COVID-19 pandemic.

Blame for the rise in conspiracy theories was distributed widely, but the leading reason cited was a lack of critical thinking. Most respondents said that better education was the best solution to these problems.

The public is well-aware that the lack of critical thinking contributes to the prevalence of conspiracy theories in public life. There is widespread recognition of the need for better critical thinking in schools and support for requiring such courses – 90 percent of respondents agreed that courses that develop critical thinking skills should be required in schools. But despite this support, too few resources are devoted to teaching critical thinking well and integrating it into the K-12 curriculum. Related topics, such as media literacy, which is gaining ground in states around the country, are widely supported as well.

A wide swath of the American public is unwilling to engage in the fundamental aspects of critical thinking

Polarization appears to be solidifying.

In [Reboot's 2018 survey](#), 37 percent of respondents said they “seek out people who tend to have different opinions than me to engage in discussion or debate.” This year, however, that number fell to 28 percent – a 26-percent drop. Additionally, 30 percent also said they rarely or never “seek out people who tend to have different opinions than me to engage in discussion or debate.” Perhaps driven, in part, by people’s fragmenting media habits and an overall distrust in public institutions, these statistics do not bode well for a democracy. It also shows how a wide swath of the American public is unwilling to engage in the fundamental aspects of critical thinking – an ability or willingness to gather evidence, to engage with new ideas, and to look at problems in different ways, and from different vantage points.

Methods

The survey was conducted through Amazon’s Mechanical Turk (MTurk) from May 2 through June 9, 2022. Participants were recruited using methods that ensure high data quality. Before taking the survey, participants first were asked to answer a screening question which asked them to read a short paragraph and explain the information it conveyed. This was done to ensure a basic level of literacy. Additionally, participants were compensated at a fair rate equal to at least \$12 an hour.

Participants completed five sets of questions: first, to gauge their scientific knowledge; second, a survey module on their education and scientific background and news consumption habits; third, a module on their beliefs in certain conspiracy theories; fourth, a module on critical thinking opinions; and last, a set of demographic questions.

Forty-three percent of our sample self-reported as female, 56 percent as male, and 1 percent as non-binary. Participants reported ages ranging from 19 to 81, with an average age of 41, and modal age of 31. Sixty-five percent of our participants had completed a bachelor’s degree or higher. All participants were located in the United States.

To maintain consistency with the prior survey and to explore relationships across time, many of the questions remained the same from earlier versions of the survey. In some cases, following best practices in questionnaire design, we revamped questions to improve clarity and increase the validity and reliability of the responses.

The survey was completed by 541 respondents. The complete set of questions for each survey is available upon request.

Scores on the Scientific Literacy quiz were computed as a percentage equivalent to the total number correct out of the total number of items on the quiz (12).

To create a composite of overall Belief in Conspiracy Theories, an average of belief in each of the 11 different theories participants rated was taken. Items showed good internal consistency with each other.

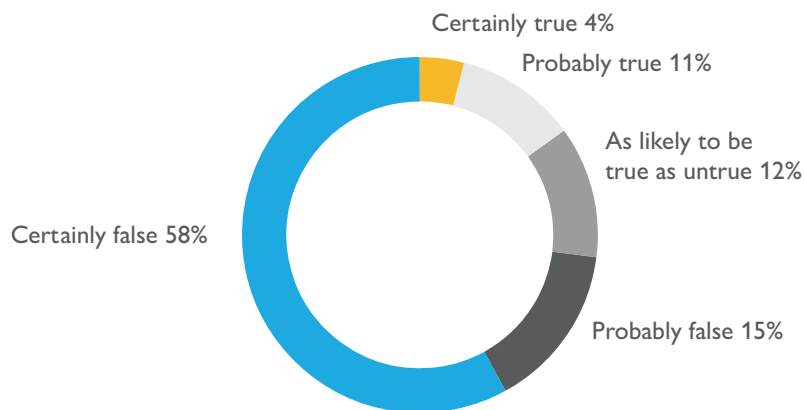
The data analysis of the survey results was conducted by Tessa Benson-Greenwald, a postdoctoral associate with the Learning Research and Development Center at University of Pittsburgh.

Detailed Findings and Discussion

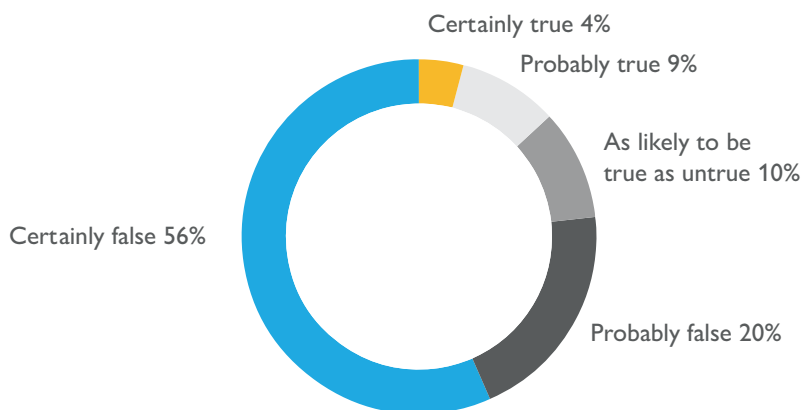
A significant segment of our survey’s respondents – roughly 25 percent – acknowledged being open to believing at least one blatant conspiracy theory. Groups more likely to believe in these theories include those who rely on social media and informal networks for their information, and those who demonstrate an overall lack of science literacy. They also tend to be more politically conservative.

The crisis of trust in scientific, media, and political institutions leads naturally to conspiratorial thinking. Our survey suggests that this thinking is already quite widespread in the United States. For example, 15 percent of respondents rated the statement “Climate change is a conspiracy by the left to hurt the economy” either “certainly” or “probably true,” while another 12 percent thought it was “as likely to be true as untrue.” And almost a quarter were at least open to the idea that “Governments add fluoride to drinking water in order to keep citizens apathetic and to lower the IQs of children.”

Climate change is a conspiracy by the left to hurt the economy.



Governments add fluoride to drinking water in order to keep citizens apathetic and to lower the IQs of children.



Given [research](#) indicating that people tend to underreport belief in conspiracy theories on these kinds of surveys, it is likely that beliefs in conspiracy theories are even more prevalent. Respondents also indicated that they have seen more conspiracy theories circulating among friends, family, and acquaintances. Seventy-one percent of respondents reported an increase in conspiracy theory belief in people they know, and 74 percent said they knew at least one person who believes a conspiracy theory.

These views tended to be concentrated among those already moving away from mainstream sources of information. The survey showed that people who got scientific information from social media believed more in conspiracy theories than those who did not. And those who considered social media, independent media sources, and family and friends to be reliable sources also tended to believe conspiracy theories were more likely to be true. Meanwhile, those who found government sources, newspapers and magazines, and higher education sources more reliable, were less likely to believe in conspiracy theories.

People who got scientific information from social media believed more in conspiracy theories than those who did not.



Prior research has identified a number of factors that seem to contribute to the prevalence of conspiracy theories. Historical analysis has suggested that conspiracy theories, while circulating at a relatively high volume throughout history, tend to proliferate even more at points of [crisis](#), as one report suggests. “Since people have a fundamental need to understand why events occurred,” the authors write, “particularly in the case of negative or unexpected events [...], crisis situations often elicit sense-making narratives among citizens that become part of their representations of history.” JFK’s assassination, 9/11, the 2008 financial crisis, and, of course, the COVID-19 pandemic are all examples of events that seem to have led to a rise in conspiracy theories.

The rise of the Internet and social media have also likely heightened a psychological environment of confusion and chaos where conspiracy theories tend to thrive. [Research](#) suggests that people are driven toward conspiracy theories, in part, to solve a psychological need for certainty. They also seem to be [more prevalent among individuals who feel themselves marginalized or powerless](#). For example, those who feel themselves, legitimately or not, to be on the losing side in the political process are more vulnerable. The survey found conservatives believe in conspiracy theories at higher rates than other political groups.

Conspiracy theories also offer a way to soothe feelings of anxiety and a lack of control, though, in reality, they serve only to make those feelings worse. Additionally, they can also act as a community-building function, which is further enabled by social media. Conspiracy theories become a means of generating positivity about an in-group that feels themselves excluded from the mainstream.

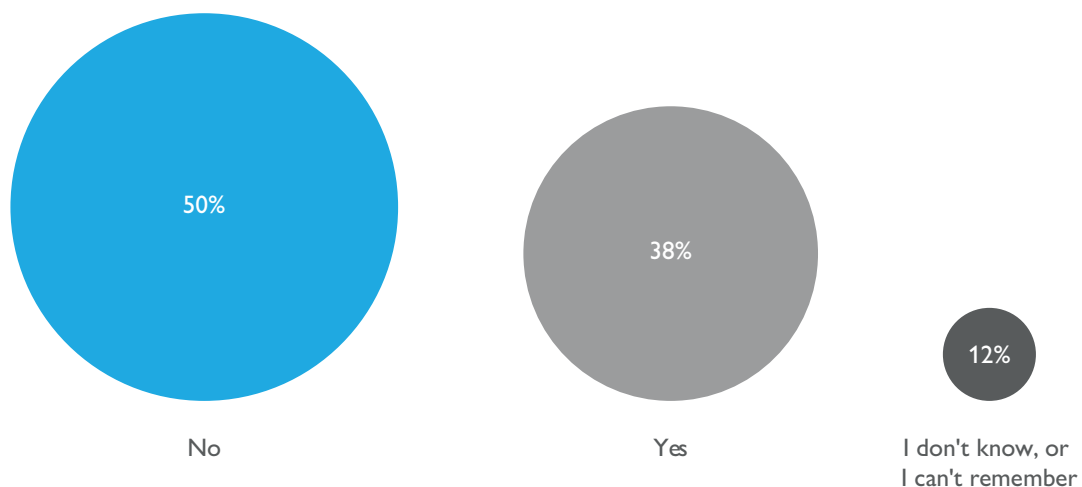
This might help explain why conservatives in the survey seemed to be particularly open to conspiracy theories. Among our respondents, those who identified as conservatives were 65 percent more likely to believe in conspiracy theories relative to self-identified centrists, and they were 70 percent more likely to believe than those who described themselves as progressives.

Conspiracy believers tend to self-identify as “critical thinkers” even if they’ve never had any formal education on the topic. In contrast, respondents who had critical thinking and media literacy education in school were among the least likely to believe in conspiracies.

Deficits in education are also typically associated with belief in conspiracy theories. The survey’s questions on science literacy and critical thinking suggest similar correlations. Those who scored higher on the science literacy quiz tended to eschew conspiratorial beliefs, as did those who reported that they were taught in high school to analyze science news stories and to reflect on media messages. This education in media literacy seemed to give participants the skills and background to reject conspiracy theories, and to better think critically about them. Participants who reported having studied critical thinking activities and media literacy while in school were 26 percent less likely to believe a conspiracy.

Unfortunately, only 42 percent reported learning to analyze science news in high school, and just 38 percent reflected on media messages.

In highschool did you have an opportunity in class to reflect on media messages, such as in advertising or on TV programs, and how they might affect people’s thoughts, beliefs, feelings or actions?



These results suggest that efforts behind more media literacy and better science education in schools can have a positive effect at combating conspiratorial thinking. This aligns with [research](#) that suggests conspiratorial thinking can be undermined by education that teaches more advanced reasoning skills. Conspiracy theory belief tends to be correlated with less reflective thinking like a “general tendency to attribute agency and intentionality where it is unlikely to exist.”

[Other research](#) suggests that education can both provide the analytical skills and the feelings of empowerment that push people away from conspiratorial thinking. According to the study, education provides “cognitive complexity” that allows people to reject overly simplistic explanations of complicated events. That can lead to increased self-esteem and social standing, which also likely reduces the likelihood that people will be attracted to conspiracy theories.

Although genuine critical thinking certainly provides some amount of protection against conspiracy theories, simply believing one is good at critical thinking does not. In fact, the survey actually found that those who believed themselves to be critical thinkers were 63 percent more likely to believe in conspiracy theories.

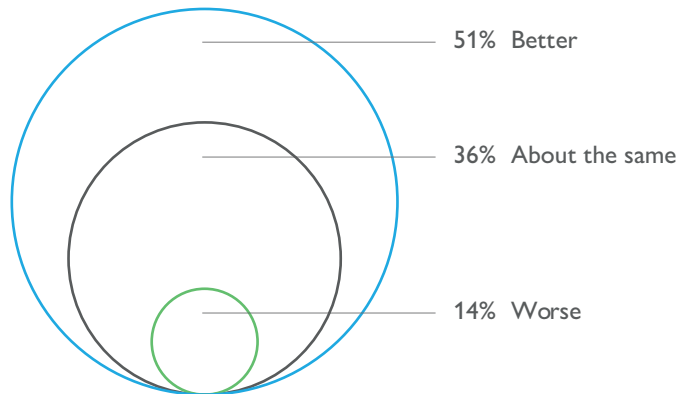
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This reflects a dissonance between rhetoric and reality when it comes to critical thinking, and it’s a gulf that has been made clear in public life of late. Conspiracy theorists and purveyors of misinformation often claim the mantle of “critical thinking” when in fact what they are doing is just the opposite. True critical thinking follows rules of logic, of research and of dispassionate thought. Football player Aaron Rodgers, for example, created controversy when he [claimed to be a “critical thinker”](#) as justification for his decision to forego the COVID-19 vaccination in favor of other unproven therapies. As Rodgers explained his research and decision-making process, it [became clear to critical thinking experts](#) that Rodgers’ thought process had few of the hallmarks of a true critical thinker.

People overestimating their critical thinking skills presents a challenge to those trying to elevate and encourage true critical thinking in society and in schools. It is vital to distinguish the reality of critical thinking—involving research and evidence from reputable sources, interrogation of multiple viewpoints, and recognition of one’s own biases and possible errors—from rhetoric that wields it to justify a person’s rejection of a mainstream consensus. Of course, this does not mean the consensus is always right; only that instinctive distrust is just as misguided as blind trust.



Do you believe that your critical thinking skills now are worse, about the same, or better than when you graduated from high school (or equivalent)?



Science literacy is low in general, but especially among certain groups, including those who rely on TV and social media for their news. Meanwhile, trust in mainstream sources of scientific information is mixed.

To assess respondents' science literacy, we administered a brief survey of science literacy. The survey asked true-or-false science questions such as "The Sun travels around the Earth" (false) and "An object's density determines whether it floats or sinks in water" (true). The average score on the test was 64 percent, or the equivalent of a D on a standard high school grading scale.

This finding was consistent with a number of other recent examinations of science literacy. The [Pew Research Center](#) conducted a survey in 2019 which found almost 40 percent of Americans "as having high science knowledge," while 32 percent garnered middling results, and 29 percent had low science knowledge. The Pew survey found that participants particularly struggled with more complex aspects of scientific practice, such as identifying a hypothesis. The National Science Foundation also regularly conducts a survey of Americans' knowledge and attitudes about science. In their true-false science literacy test, participants [scored](#) at a very similar 62 percent in 2018.

The survey results produced some interesting correlations as well, especially around news consumption. Those who said they relied on social media for their news scored about 6 percent lower on the quiz. In addition, those who said they believed they spent more time on the Internet and/or social media than they did 10 years ago also scored lower – about 7 percent.

These results suggest ongoing problems with the way scientific information is portrayed and consumed online and via social media. During the COVID-19 pandemic, a great deal of misinformation about the spread and severity of the disease, the efficacy of various interventions, and risk of the vaccines spread widely on social media. One [meta-analysis](#) found that up to 28 percent of social media posts on COVID-19 could be classified as misinformation. Misinformation about vaccinations in general, climate change, health fads, and technology are all prevalent on social media.

Of course, social media is not solely responsible. Popular media consistently misrepresents or poorly represents scientific findings, by touting individual experiments with sensationalist interpretations that are misleading or outright false. For example, a study that found people tend to be less generous in investing money when they don't interact with other people, [became](#) “City life makes humans less kind to strangers” in the press. The pressures of the online media environment—in terms of speed and audience—also create bad incentives for journalists. Health advice in popular media, to take one example, is notoriously unreliable.

The practice of science deserves a share of the blame as well. Too many studies, especially in areas like diet, rely on poor-quality data with many confounding variables. For example, health benefits [attributed to coffee](#) in some studies might be more attributable to characteristics correlated with people who drink coffee, such as the fact that they tend to be more educated and exercise more. The social sciences, meanwhile, have faced a “replication crisis” in recent years, with poorly designed studies producing results that are widely disseminated only to turn out to be unreplicable years later. As in journalism, this is partially a result of [perverse incentives](#) that can lead scientists to chase funding or provocative results instead of strictly pursuing the truth. Finally, industry influences and increased private funding of science have unduly [distorted](#) scientific evidence—perhaps most prevalently in the medical and pharmaceutical industries.

These flaws in scientific practice and reporting, along with the proliferation of misinformation on social media, create a climate of widespread distrust and illiteracy around science. The uncertainty and misinformation surrounding the pandemic only exacerbated these problems.

The survey asked respondents to rate sources of scientific information in terms of reliability. Just 36 percent found “sources like the World Health Organization and Food and Drug Administration very reliable,” with another 37 percent rating them “somewhat reliable.” Meanwhile, mainstream television was found either “somewhat” or “very unreliable” by around a third of respondents, with just half finding it “somewhat” or “very reliable.” Print media fared better, though 23 percent still found it “somewhat” or “very unreliable.”

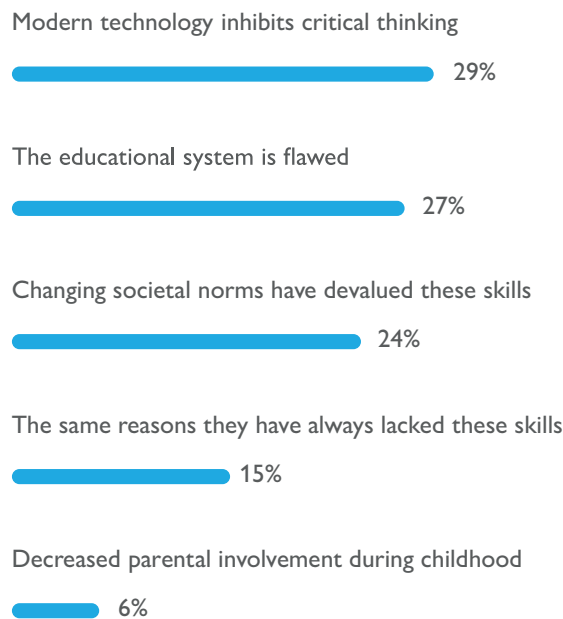
These results align with recent evidence of a serious decline in trust in science, especially medical science, since the onset of COVID-19. The Pew Research Center [recently found](#) that just “29% of U.S. adults say they have a great deal of confidence in medical scientists to act in the best interests of the public, down from 40% who said this in November 2020.”

[Blame for the rise in conspiracy theories is distributed widely, but the leading reason cited was a lack of critical thinking. Most respondents recognize better education as the best solution to these problems.](#)

The survey did uncover some good news. The public generally recognizes the crucial importance of critical thinking and education in pushing people away from conspiracy theories. When we asked what factors in contemporary life are most to blame for the prevalence of conspiracy theories, a plurality of respondents cited a lack of critical thinking (23 percent). The other leading factors held responsible included untrustworthy mainstream media (20 percent), political polarization (18 percent), and technological change (10 percent).

Respondents felt the lack of critical thinking was attributable to a number of different sources: the leading causes cited were modern technology (29 percent), a flawed educational system (27 percent), and changing societal norms that have devalued these skills (24 percent). This is a slight change from last year when we asked the same question and more people blamed changing societal norms (33 percent) than technology (21 percent).

What is the primary reason that people, today, lack critical thinking skills?



When asked how to dampen the power of conspiracy theories, a clear plurality of 33 percent identified better education programming as the best pathway. More regulation of social media (whether by the government or through self-regulation by the platforms themselves) (19 percent), and more transparency in government and public institutions (15 percent) came in second and third. An overwhelming majority – 84 percent – said they support required media literacy education in schools. Moreover, 82 percent thought critical thinking skills were lacking in the general public, and 90 percent supported required critical thinking instruction at the K-12 level.

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Despite clear support for education in the general public, the survey results suggested schools are still not doing enough. Only 42 percent of respondents reported learning how to analyze science news stories in high school, and only 38 percent reported learning how to analyze media messaging in general. Another [recent Reboot report](#) examined data from a national survey of teachers and found that, at the eighth-grade level, fewer than 40 percent of teachers were placing “quite a bit” or “a lot” of emphasis on deductive reasoning, a key skill associated with critical thinking.

Part of the problem is that there is very little consensus on how to teach skills like critical thinking and media literacy in schools. Research suggests that critical thinking is [best taught by integrating it into the rest of the curriculum](#). Teachers should be explicit about [teaching critical thinking principles and methods](#), such as logic, research techniques, and the mechanics of argumentation. But these tools cannot be taught in isolation; students need opportunities to apply these skills to compelling and relevant issues in a variety of different subjects. A critical thinking curriculum that is integrated into subject matter instruction can produce students able to practice critical thinking independently both inside and outside of the classroom.

Media literacy also remains under-taught in schools, though there have been recent strides to add it to the curriculum. Fourteen states have [passed legislation](#) to address the deficit, though the nature and quality of media literacy instruction remains [highly variable](#). There are also new resources, including those from Stanford’s History Education Group (SHEG), that show [promising results](#). More research and state action is needed to expand effective media literacy instruction.

[Support for critical thinking skills remains nearly universal, and polarization appears to be solidifying.](#)

Each year, Reboot takes stock of the public’s attitude towards critical thinking and specific critical thinking practices. This year, as expected, general support for critical thinking remains high. Ninety-three percent of respondents affirm that critical thinking skills are important in today’s world, and, 90 percent say “courses that develop critical thinking skills should be required in K-12 schools.” Additionally, 89 percent said courses that develop critical thinking skills should be required in college.

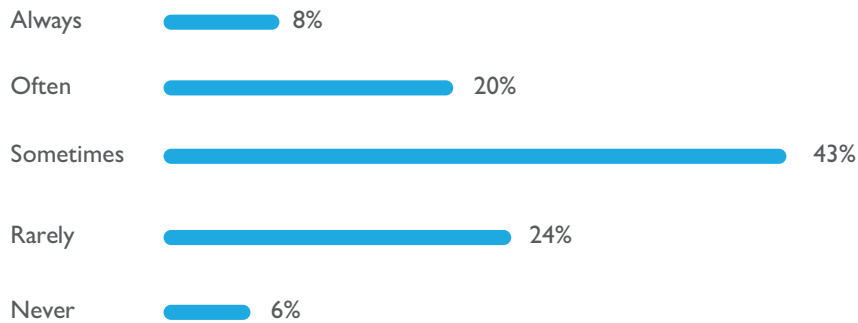
The education system, in general, is not highly regarded when it comes to teaching critical thinking, with only a quarter of respondents saying they received an “extremely” or “very” strong background in critical thinking from their schools – the same percentage as last year. About the same number (27 percent) described the background provided as “not strong at all,” with another 22 percent calling it only “slightly strong.” More than half the participants indicated that they did not study critical thinking in school. These percentages all track very closely to what respondents reported in last year’s survey.



One shift seen in this year’s survey, however, is the extent to which polarization appears to be solidifying in American society. Each of Reboot’s annual surveys has asked people if they “seek out people who tend to have different opinions than me to engage in discussion or debate.” In 2018, 37 percent of respondents said that they do that, but that number fell to 28 percent this year – a 26-percent drop.

One shift seen in this year’s survey, however, is the extent to which polarization appears to be solidifying in American society.

I seek out people who tend to have different opinions than me to engage in discussion or debate.



Additionally, 33 percent of people said they sometimes, rarely or never “listen to the ideas of others even if I disagree with them,” while 30 percent also said they rarely or never “seek out people who tend to have different opinions than me to engage in discussion or debate.”

Conclusion

How does a society win a war on truth? How can leaders chart a path forward when so many citizens appear allergic to knowable facts and truths?

The Reboot Foundation believes this process must begin with an education that prepares students for the modern media environment and equips them with the skills to understand and evaluate complex concepts in science and technology. While it is heartening to see some steps taken in this direction in recent years, more new programming, legislation, and curriculum changes at the local level are needed to address the problem. New ideas in online and continuing education should also be explored to bring critical thinking to adults who have already completed their school educations.

The institutions and communities of science and journalism also have an important role to play. Too frequently scientific and technical issues are oversimplified or even distorted as they are presented to the general public. Popular media fails to convey nuance, uncertainty, or the state of ongoing debates in science. This prevents the public from genuine engagement with scientific issues and contributes to mistrust of the policy recommendations that scientific authorities issue. To many citizens, science appears as a distant and mysterious apparatus, rather than an accessible and vital tool in the democratic process. In science, more transparency is needed to reassure the public that research is advancing public rather than private interests.

Finally, at a structural level, more needs to be done to change the incentives in media, especially online. Social media business models dissuade users from patient engagement and direct them toward addictive, sensationalistic content that is frequently biased or outright false. Meanwhile, there are few viable financial models for genuine public interest journalism capable of informing the public with nuance and without bias. New legislation and funding from the government, as well as philanthropic investment, can help to change incentives and carve out more spaces for genuine public debate and education. In brief, if decision-making in contemporary societies is to be guided by both democratic and scientific principles, much more needs to be done to bring people and science together.

Science Fictions:
Low Science Knowledge and Poor Critical
Thinking Are Linked To Conspiracy Beliefs

The Reboot Foundation is devoted to elevating critical thinking. In a time of vast technological change, the foundation aims to promote richer, more reflective forms of thought in schools, homes, and businesses. Reboot funds efforts to integrate critical thinking into the daily lives of people, and it conducts surveys, opinion polls and original research.

For more information please visit: reboot-foundation.org

