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The Emerging Role of Science Media Literacy

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Abstract

Many characterizations of scientific literacy are notoriously slippery. Here, I articulate one new dimension of the civic purpose of science education: science media literacy. In an era where scientific misinformation has become ubiquitous, a well-informed citizen-consumer needs to understand not only what makes science reliable, but also what makes science communication reliable. I discuss important shifts from conventional norms: from evidence to sources, from intellectual independence to epistemic trust, and from solo science to critical consensus.

Keywords: scientific literacy; science media literacy; epistemic trust; consensus; nature of science; science-in-the-wild

1. Introduction: Science Literacy and Science Media Literacy

"Scientific literacy," like "common sense," is a weasel term (Rudolph, 2023). It can mean just about whatever you want it to mean, while conveying that it is nonetheless essential to science education. It can signify the basic ability to *do* science, as a scientist, or it can be understanding basic concepts to engage with socioscientific issues, as a citizen-consumer. It can refer to being conversant with the language of scientific discourse itself, or to appreciating the human and cultural contexts that broadly characterize the nature of science. You choose.

Characterizations of scientific literacy are thus ultimately ideological arguments about the core question: "what should be taught?" While such debates are surely legitimate, they should not be disguised as an ostensibly analytical exercise. Such "definitions" are little more than efforts to naturalize a normative view into a purportedly objective description (on the naturalizing error, see Allchin & Werth, 2017).

Here, under whatever label, I want to focus on the aims of science education appropriate to the 21st century. John Rudolph (2023) has nicely summarized the aspirational goals of science education historically. They have remained relatively consistent for over a century (re-expressed, for example, in the U.S. National Research Council's (2012, pp. 1, 9) *Framework*):

1. develop an appreciation of the cultural role of scientific achievements, including a sense of wonder;
2. learn scientific reasoning for everyday contexts;
3. prepare to participate in civic discourse on issues informed by science;
4. become an informed, critical consumer; and
5. prepare for a scientific career.

That is, there have always been multiple rationales for science education (or different dimensions of scientific literacy, perhaps): to become competent as a citizen, a consumer,

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a capable thinker, a professional scientist (for some), and a humanist (everyone). Yet, as Rudolph points out, public curricula have inevitably drifted to just the last aim—training future scientists—often at the cost of the other goals. A rebalancing of priorities is desperately needed. So, without trying to discount the other dimensions, I narrow the focus here to address: "what is needed to achieve the civic purposes (#3 and #4)?"

As a society, we often sponsor scientific research to provide the specialized knowledge that helps inform or guide many societal goals—public and occupational health, pollution control, natural disaster management, weather forecasting, food and drug safety, a sustainable energy supply, criminal forensics, and so on. In a democracy, we thus have an additional civic responsibility to educate each individual to participate in our collective decision-making: to discuss these socioscientific issues, including about funding the research at the very outset (Goodlad, 2004). We need to focus holistically on the scientific ecosystem, not just on the work of individual scientists. This context—a system for delivering relevant and reliable science to everyone, individually and collectively—forms the core of justifying public science education.

What does this entail in the 21st century? Science is perpetually growing and changing. Consumers and citizens must have tools to learn about and interpret new findings. PISA 2025 has recently articulated this goal as the ability to "research, evaluate and use scientific information for decision making and action" (OECD, 2026). Notably, this does not place the burden of doing science on every individual. Rather, in a world of distributed knowledge, we enlist specialized experts to do that work for us and to answer key questions on our behalf. Still, we need to tap into those solutions and certify their reliability. That involves communication between the scientific experts and citizen-consumers (which include all scientists, too, outside their own field). Namely, in contemporary culture, scientific information is inescapably *mediated* (Goldman, 1999; Norris, 1995, 1997). As PISA's new standard indicates, to learn about ongoing scientific developments in the modern world, you need to engage the public media (Höttecke & Allchin, 2020).

In recent decades, however, developments in communication technology have introduced profound new challenges. Gone are the days when all our news was neatly curated by a few trustworthy journalistic gatekeepers: the heritage news organizations. Information is now widely available from diverse sources across the internet and electronic media. The information landscape is now more democratic, perhaps. But also more treacherous. Rogue actors and science imposters are everywhere, as well (Allchin, 2012a). Misinformation, including about science, floods the media (e.g., ALLEA, 2021; National Academies of Sciences, Engineering, and Medicine, 2025). New questions arise: "Who speaks for science? (Allchin, 2022) How does a citizen-consumer learn to sort fact from faux?" The radically transformed information environment forms a new horizon for science education in the 21st century: *science media literacy* (Höttecke & Allchin, 2020; Osborne & Allchin, 2025; Osborne et al., 2022). Whatever vision of science literacy may have been justified in the past must now include media literacy.

In the sections that follow, the focal question is "what competencies contribute to this new vision of science media literacy?" (Allchin, 2024). While one may imagine at first that such items merely extend the list of curricular benchmarks, in many cases they involve substantive reorientations from current norms. Priorities must shift to accommodate the new media landscape. In particular, the wider focus of the civic purpose of science education means that the priority is not trying to teach individuals how to do scientific research on their own, but rather to teach the whole succeeding generation how to sustain a complex scientific ecosystem.

2. From Evidence to Sources

Science teachers are well-steeped in the goal of teaching scientific reasoning (#2 above), often construed as a variant of critical thinking. In recent years, argumentation has been characterized as "a core activity of science," and hence "central" to science education (Driver et al., 2000, pp. 287, 290, 296, 297, 301, 309; Erduran & Jimenez-Aleixandre, 2008, p. 4). Educators have developed lessons based on the canonical Toulmin schema, the C-E-R framework (claims–evidence–reasoning), or the CRAAP checklist (currency, relevance, authority, accuracy, purpose), among others. These resonate with a basic understanding of scientific practices: experimentation, the relevance of observations, interpreting empirical results, and the layers of inductive or hypothetico-deductive (or other) forms of reasoning that lead to generalizations, models and probative explanations. All well and good. Every student should understand how science works, and thus why (or when) its claims may be considered trustworthy.

However, scientific misinformation poses some severe challenges. How does a citizen address possibly misleading claims about fracking, climate change, or the epidemiological origins of a viral pandemic? You cannot test most of these claims yourself (or dozens of other relevant issues). Too much time, too many resources, too much background knowledge. So, you are left to rely on the evidence and arguments you are given. Yet that evidence may be cherry-picked, or technically sloppy, or just plain fabricated. If so, the claims would unravel. How do you know? If you are not already an expert, you don't. Likewise, an argument may sound quite plausible, yet still be critically flawed—for example, through subtle tricks of statistics or by failing to address alternative explanations. Again, a non-expert cannot know all of these gambits fully. In these cases, skills in reasoning from evidence, which are so important to experts assessing each other's claims and to *producing* and validating knowledge, fail to serve the consumer-citizen *consuming* knowledge.

Consider, too, science teachers themselves, who generally accept claims about anthropogenic climate change. They may urge their students to "weigh the evidence." But how many teachers have read through the IPCC reports page by page and assessed each bit of evidence presented there? Not even the authors of the report have done that! They all trust each other—for good reasons, to be detailed in sections to follow. What you need to know, instead, is the credibility and the reliability of the *source of information*.

For a consumer of science (and that includes all scientists, as well, outside their own fields), we must consider foremost the source, not the evidence. Namely, is the claimant able to vouch for the scientific consensus reliably? That may include tracking the claim's provenance. Where did the report come from? What is the pathway from trustworthy experts who consulted the original evidence and were competent to assess it? Have the transfers across generations of communication been faithful? Sources, not evidence.

This is a seismic shift for what counts as useful epistemic skills in everyday living. We still want to secure reliable knowledge. However, the aim is not to *create* or generate *new* knowledge, but to *access* knowledge that has *already* been established. That repositions us from the mechanisms of scientific knowledge production in an expert community to the channels of communication. Misinformation highlights the role of the latter—and its epistemic importance.

So, in the context of using science to inform societal and personal decision-making, science literacy is achieved—here and now—through science media literacy.

A first step in learning may be developing basic fact-checking skills. Here, we can learn from the experience of professionals (e.g., Caulfield & Wineburg, 2024; Neuvonen et al., 2018). How do fact-checkers do their job? Well (to begin), they don't try to replicate experiments. And they don't examine the arguments or the evidence or study the fancy graphs. They first ask, *who* claims this? What is the context? What is the motive? Is the

source *trustworthy*, or should we be on the alert for bias or outright deception? Can the claim be traced to its original context and verified? Research has already shown the effectiveness of even brief classroom lessons (e.g., Wineburg & McGrew, 2019; Pimentel, 2025).

However, the basics of fact-checking should be seen as a gateway to deeper lessons about the misinformants themselves. What are the contexts that motivate individuals, industries or ideological groups to spread falsehoods or otherwise misleading scientific claims? Who wants to discount science, and why? Here, for example, students may be introduced to the concept of conflict of interest: when a spokesperson's interest in providing information is not aligned with the receiver's interest in true and complete accounts (e.g., Allchin, 2025a; Barrett, 1974). Namely, a "scientifically literate" individual has learned how to distinguish scientific fact from faux *in the media*, now polluted with misinformation.

3. From Intellectual Independence to Epistemic Trust

Discussions about scientific literacy almost inevitably drift into profound philosophical questions about the nature of knowledge. Here, by focusing on how we consume science, we must address the discomforting realization that most of "our" knowledge really comes from others. It is, literally, mediated. So, what then does it mean to "know" something about science?

That is, a majority of what we "know," we know second-hand, not from our own direct experience or personal "scientific reasoning." Even standard science textbooks. Who among us—notably, teachers—has replicated the whole history of science, to "know" that the classroom textbook is actually correct? No one. We trust the author(s). We trust the publisher. We trust the original work of the many scientists in the field. (Indeed, why not?) What does this commonplace relationship portend for cases of scientific claims beyond school—on social media, the internet, or other public media?

As characterized by philosopher John Hardwig (1991), we are *epistemically dependent* on others. That is, as cogently argued by educator Stephen Norris (1995, 1997), we must relinquish the age-old Enlightenment vision—and widespread educational ideal—of intellectual dependence. We must acknowledge that we navigate the world through *epistemic trust*. Not blind faith in science (we hope). But informed trust (Osborne & Allchin, 2025).

Epistemic trust is not unfamiliar in society. Doctors, lawyers, auto mechanics, airline pilots, food safety inspectors, bridge welders. We rarely think twice about it. It is a consequence, of course, of distributed knowledge in our culture and a society built on specialized expertise (Goldman, 1999). We have developed mechanisms for sharing and validating that expertise. We may thus reflect on the "social architecture" that justifies that commonplace trust (Allchin, 2012b).

A goal for education, then, must be to articulate the nature of epistemic trust in science. In conventional lore, science is based on skepticism (e.g., Novella, 2018; Shermer, 2016). But, as noted by sociologist Steven Shapin (1994), since the very emergence of modern science in the 17th century, trust has been foundational. Scientists do not doubt every experiment and then replicate them. Results are reported, and the methods detailed, so that others may interpret the results vicariously. An implicit system of accountability means that others rarely doubt the testimony. Conclusions may unravel later, but that is the exception, and dealt with accordingly. As a result, scientists can build on each other's findings, rather than become mired in constantly checking what others have done. Today, scientists develop reputations based on their contributions and track record: their *credibility*. These implicit ratings—like online reviews, perhaps—help guide how scientists evaluate each other's claims.

Consumers of science today face similar challenges in addressing scientific claims in the media. *Who* can be trusted? *Who* speaks for science? Consider, again, the case of climate

change. Should we believe Michael Crichton, a best-selling sci-fi author, or Steve Milloy, founder of junkscience.com (both naysayers)? Their connections to science might seem important, but they are not scientists themselves. Namely, we need authentic experts, not celebrities or talking heads. Should we trust two Nobel Prize-winning scientists, then, who have also dismissed the climate risks? They are undoubtedly experts. *But not in climate science*. So, their "expertise" is not the *relevant* expertise. What about the U.S. Department of Energy's Climate Working Group which issued a 2025 report asserting that fears of climate change had been grossly overstated for years? All five authors were widely respected scientists. However, they were also known as vocal dissenters. Their report diverged from the consensus of the relevant expert community on dozens of basic facts (Union of Concerned Scientists, 2026). By contrast, citizens can trust the IPCC report. We trust that the relevant experts were appointed. We trust that they have vetted each other's work. We trust that they have resolved disagreements and articulated any remaining uncertainties (Oreskes, 2019). Many science teachers may easily recognize these hallmarks of credible scientific claims. And this understanding seems critical to a fully contextualized, functional civic scientific literacy. But it cannot be assumed. These principles of scientific credibility must be taught.

Trust also involves the mediators. The IPCC report may be the authoritative benchmark, but few citizens are likely to encounter it directly. Rather, it is read by journalists and summarized in news articles or podcasts. The role of being a science spokesperson is also often adopted by independent scientific institutions, such as the National Academy of Science, various professional societies, museums or science centers. So, understanding the roles of responsible science journalism and scientific institutions can be equally important to scientific literacy (Zucker & Miller, 2024).

In summary, a scientifically literate person acknowledges the limits of their own knowledge about science. They understand the nature of epistemic dependence and the basis for trust in scientists and responsible science journalism.

4. From Solo Science to Critical Consensus

The educational ideal of intellectual independence is typically coupled with framing individuals as the chief epistemic agents of science. This is expressed in the custom of characterizing "the scientific method" as a step-by-step process—one person's epistemic journey. Accordingly, science seems to advance through the rare insights and superior reasoning of special individuals, celebrated as the heroes (and now, equally, heroines) of science. We honor discoveries through their *discoverers*: with Nobel Prizes and eponymous laws or units of measure (*Boyle's* law, *Ohm's* law, *Mendel's* laws, amperes, daltons, teslas, curies, and so on). We might call this a view of *solo science*.

Yet, as noted by an editor of the journal *Science*, "scientific research is a social process" (Thorp, 2023, p. 873). In part, the social perspective acknowledges that lab and field work is a joint endeavor, requiring the collaboration of many contributors. So, too, for critical interdisciplinary studies that integrate expertise from different fields. But even more than this, the social dimension is critical to the *reliability* of science. Individuals are susceptible to bias. Groups, less so. Individuals, with their particular mindsets, may allow some errors to go unnoticed. Peers, however, will be ready to call out their mistakes! Each researcher may subscribe to their own theoretical orientation, fostering blind spots. Discussion among different perspectives, however, can lead to more robust conclusions. Namely, through critical discourse, scientists vet each other's claims. Sociologist Robert Merton called it "organized skepticism." Many scientists, at the community level, thereby develop a *consensus*, which is inevitably more probative and reliable than what an isolated individual may conclude on their own. Thus, for citizens and consumers, as "outsiders," consensus becomes

an important benchmark—indicating when they can confidently consider the science more or less fit for informing decision-making. The consensus of the scientific community has more credibility than the testimony of an individual expert.

Not all science is settled, however. For many contemporary socioscientific issues, the science is still in progress. Outsiders may encounter reports of disagreement. Understanding the social practices of science helps in such cases. By contending that science should always yield a single, unambiguous answer, some critics portray any discord as evidence of a deviation from proper reasoning. It must signal, they say, incompetence or prejudicial bias—reasons not to trust the science. By contrast, anyone familiar with doing research will recognize active debate as indicative of healthy science-in-the-making. Scientists need to work through discordant results, ambiguous evidence, and different conceptual interpretations. Resolving disagreement is part of the process. The consumer should thus not reject the science, but rather turn their attention to the scope of disagreement and the possible biases or interests behind the divergent views (again, using whatever credible sources are available).

Learning about the social practices of science, with their checks and balances, also provides an important model for how non-experts should approach science in the media. Some commentators urge citizens to "do your own research!" (DYOR). They fuel intuitions about intellectual independence, almost as a political ideology. But just as scientists are prone to various cognitive flaws, so too are non-scientists. Perhaps even more so? *Confirmation bias* is a major challenge. Our brains are predisposed to reinforce prior preconceptions. So, when a consumer encounters a source of information that provides support for their prior views, they will more likely deem it a good one. At the same time, if they encounter counterevidence, the source itself will be more easily discounted as less credible. So, "doing your own research"—pursued with an intent to collect objective information—may actually become an exercise in rationalization. Studies have now demonstrated that those who adopt the DYOR posture are ultimately less likely to reach conclusions consistent with the scientific consensus (Ballantyne & Dunning, 2022). In one study, DYOR-oriented consumers exhibited more COVID-19 misperceptions, and lower levels of trust in science generally (Chinn & Hasell, 2023). In another, mothers who chose to not vaccinate their children relied on their self-styled critiques of expert research, substituting their own personal experience in its place (Carrion, 2017). Flat Earthers frequently report they were unconvinced at first, but changed their minds after doing their own research: namely, binging on YouTube videos (Burdick, 2018; Weill, 2022). Individuals in these three cases, by relying solely on their own wits, were sadly misled into rejecting the scientific consensus (e.g., Dunning, 2019).

A recent trend in education has been to develop a student's sense of "epistemic agency" (e.g., Stroupe, 2014). Of course, all students should be engaged in their own learning and come to feel equipped to continue learning on their own. At the same time, teachers need to be wary of promoting epistemic hubris and the unfruitful DYOR syndrome. That is, the conventional educational goal of nurturing scientific reasoning skills may—if framed in terms of "solo science"—also foster overconfidence in one's own competence, even in a society dominated by experts and specialized knowledge (Motta et al., 2018). Ultimately, a scientifically literate student should develop basic skills to ensure autonomy in navigating scientific claims in public media. But they should also exhibit intellectual humility, and be able to acknowledge when others know more than they do (Pimentel & Osborne, 2026) and when (and why) it is appropriate to respect the scientific consensus.

5. Nature of Science and Nature of Science Communication

Most visions of science education now include teaching about the nature of science (NOS) (although characterizing nature of science itself can be quite contentious!). The

generally accepted notion is that a scientifically literate person should know something about how science works, its empirical basis, its limits and potential biases, and so on (e.g., Allchin, 2026b; McComas, 2020; Olson, 2018). Understanding the process of science is certainly integral to interpreting the reliability of claims in the media. For example, it is important to know that scientific conclusions are typically based on publicly available observations and/or repeatable experiments (empirical nature of science). Familiarity with the nature of controlled experiments and statistical tests allows one to see how uncertainties about sample size or confounding variables are reduced (error and inference). Equally, the consumer should recognize the possibility of gender, race or class bias (social and cultural context of science). Aware of all the possible sources of error, one can also appreciate the methods used to manage them, allowing consumers to ask about particular claims (Allchin, 2013, 2026a).

At the same time, most treatments of NOS are quite narrow. They are generally internalist—focusing only on what scientists do in a lab or field site in the course of an investigation. They are often idealized—disregarding the informalities and practicalities of real work. As noted in the section above, for the consumer of science, it is equally important to know about the social practices of science, whereby claims are vetted against diverse backgrounds and perspectives. Students need to learn about peer reviewed publications, correspondence, online discussion boards, criticisms, rebuttals, conferences, inter-lab collaborations, follow-up experiments, and so on. Science does not end when you write a "lab report," as most conventional School Science might lead you to believe.

Lessons about NOS help explain why (or when) scientific claims are trustworthy. But there are further hurdles of trust for the consumer-citizen. The open internet, social media, advertising, and influencers flood us with disinformation, claims that pretend to be science but are not. When is a particular claim in the media actually backed by science? When is it ersatz? This is *science-in-the-wild* (Allchin & Osborne, 2026), outside the boundaries of critical discourse among experts, where it is not always clear what is authentic science, what an imposter. Here, the epistemic challenges differ sharply from those within a scientific community. The epistemic problem is no longer evaluating the justification of the claim itself; rather, it is assessing whether the scientific consensus has been conveyed faithfully. Students thus need to understand the *nature of science communication* (NOSC), an important complement to the nature of science (Höttecke & Allchin, 2020).

The citizen-consumer may avail themselves of quick fact-checking protocols, of course (section above). But to understand the problem fully, they must delve beyond interrogating any particular claim or source of information. They need a bird's-eye view of the context—their media environment and the pathways of scientific claims (and purported claims) within it (Figure 1). Scientific claims make up only a fraction of the messaging they receive. And only some of those are genuine. Traditionally, consumers relied on the news media as *gatekeepers*—to select the relevant news on their behalf, vet questionable sources, summarize it concisely, and make it intelligible (Shoemaker et al., 2009). Broadcast media have waned, however. Science journalists remain, but in far fewer numbers. Meanwhile, the internet has opened access to more information and allowed more voices to flourish. But at a cost: compounding the problem of sorting meaningful messaging from junk. Now we must filter and curate information ourselves. That shift has sharpened the need to teach media literacy and NOSC (Höttecke & Allchin, 2020).

The problem of assessing credibility is profound. Deceptive messaging is everywhere. Because science is respected and trusted in our culture, those seeking power *pretend* to be scientific and thus try to steal its authoritative mantle. Using "cheap symbols and ersatz images," they conjure an illusion of science (Toumey, 1996). One can find bogus data, bogus journals, bogus technical reports, bogus expertise, bogus credentials, bogus organizations,

bogus consensus statements, and even bogus museums and bogus textbooks (Rampton & Stauber, 2001). As former U.S. Assistant Secretary of Labor David Michaels (2008) notes, they endeavor to replace sound science with what "sounds like science" (p. xi). Consumers thus need to be aware of (and wary of) the various deceptive tactics leveraged by disinformation engineers. Such strategies include professional style and the aura of prestige; faked expertise and competence; appeal to social emotions and shared identity; repetition; uncertainties and unjustified skepticism; fear and stressful urgency; among others—all while trying to conceal any telltale hint that might betray their persuasive intent (Allchin, 2012a, 2024).

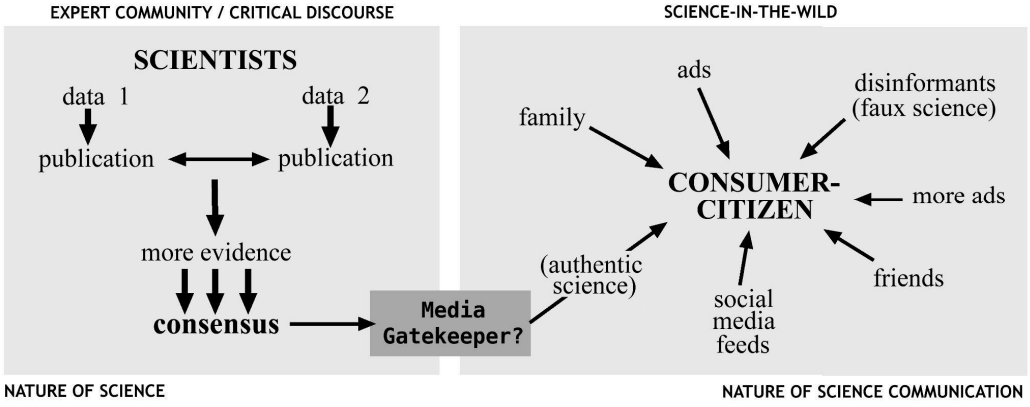


Figure 1. A "bird's-eye" view of science media literacy, showing the relationship between the expert scientific community and the consumer-citizen's domain of "science-in-the-wild".

The nature of communication equally involves the receiver. Namely, we choose which messaging and sources we deem worthy of attention. Who do we listen to? Our habits are shaped by deep cognitive intuitions. Namely, social learning is a feature of our species (e.g., de Waal & Bonnie, 2009; Rendell et al., 2011). Rather than solve problems on our own, we economize on time and risk by tracking what others do and copying their behaviors. However, we do not copy indiscriminately. Through evolution, we have evolved several inborn cognitive mechanisms for judging whose actions seem most worth adopting for ourselves. First, perhaps, is prestige bias: relying on those who seem to have succeeded—or at least bear all the trappings of success (celebrities and charismatic leaders, or the signals of expensive designer clothes or accessories). We also tend to follow the majority—call it relying on the wisdom of the crowd (even when the "norm" may be generated by advertisers or paid influencers). We copy our peers—those who share our identity, values or political affiliations: safety in fitting in with one's group, or just getting along. Yes, we also prefer individuals who exhibit competence, but sometimes that expertise can be faked. We are persuaded by confident voices ("they seem to know what they're doing, right?"). These cognitive dispositions are known by psychologists as the biases of social learning (Kendal et al., 2018). And they have been shown to influence trust in science (van Mulukom, 2026). So, each individual's predilections, values and identity act like subconscious filters. They are part of the nature of science communication, too.

Media consumers need to be equally aware of the social structure of their communication networks. Information tends to flow within social networks (Feinstein & Baram-Tsabari, 2024). With the advent of social media, this effect has been amplified. But are these networks epistemically reliable? Can one trust them—specifically for science? Sometimes, they become echo chambers and foster a false sense of consensus: misleading epistemic bubbles. Technology adds a further dimension. Search engines may tailor their results to the user, creating filter bubbles. AI programs, too, serve the user, not credible science, often generating what are politely called "hallucinations." So, students need to develop a mental

map of their many sources of information, their ultimate origin, and the credibility of each as a voice for the consensus of the scientific experts.

Many commentators fret about AI and internet bots. They are a relevant concern. But by understanding the nature of science communication, one can regard them as just another source of information, whose credibility must also be assessed. Indeed, AI can be leveraged to the consumer's advantage, by fact-checking and analyzing sources of information (e.g., Caulfield, 2025). The volume of media messaging will proliferate, merely underscoring the role of "critical ignoring" and the role of competencies for filtering reliable messages.

To be scientifically literate, then, an individual must be literate (able to read and perhaps even understand scientific jargon) and know about science and how it generates and validates knowledge. But in today's world, they must also be media literate—able to sort through the misinformation in the media and find the nuggets of genuine science (Allchin, 2023). And that entails having explored the nature of science communication (NOSC) itself.

6. Social Justice and Information Justice

Recently, social justice has emerged as a prominent theme in science education (e.g., Kraig-Turner et al., 2026; Kruse et al., 2025; Sjöström, 2024; Yacoubian & Hansson, 2020). Namely, in what ways might science contribute to or amplify social inequities, and what responsibility do educators have to address any such disparities—to bear witness to them, perhaps, or to work concretely toward remedying them? The implication is that a scientifically literate individual cannot (or should not?) be blind to the ethical or sociopolitical dimensions of science.

At first, it may seem that media literacy has little to do with social justice. Not so. For it is the marginalized and disenfranchised groups in society who are disproportionately affected by scientific misinformation (e.g., Barlow, 2024; Bhattacharya et al., 2024; Krings, 2020; Nemer, 2025). Science media literacy education is thus a means to help all citizens and consumers gain comparable access to scientific information: social justice through *information justice*.

Disinformation is ultimately about power.[1] When science threatens private interests (profit, power, privilege), those affected often work to discount the science—not through any evidence-based argument, but through rhetoric alone—hence disinformation. For example, the fossil fuel industry has sought to negate the science of global warming and climate change, *while calling their naysaying good science* in the media (Union of Concerned Scientists, 2007). The National Football League sponsored "research" and then appealed to its bogus findings in trying to obscure how brain trauma was caused by concussions on the playing field. Their studies were never properly peer-reviewed (Belson, 2026; Fainaru-Wada & Fainaru, 2013). Chemical companies hired consultants to deny (contrary to known evidence) that their flame retardants were toxic (Kenner, 2015). In all these cases, special interests disseminated scientific disinformation, trying to preserve their cultural power and economic profit (McGarity & Wagner, 2008; Michaels, 2008, 2020; Union of Concerned Scientists, 2018).

Science media literacy can help expose the strategic nature of such efforts and provide citizens a foundation for criticism in public political discourse (namely, "action" in PISA's framework). Here, reliable scientific information can help (re)balance power. For example, historically, analysis of scientific claims in the media would have helped validate Rachel Carson when the chemical industry attacked her 1963 work *Silent Spring*, describing the environmental dangers of pesticides (Allchin, 2025b). Or it would have helped defend the science of Alice Hamilton in her quest to safeguard worker health and safety in the 1910s especially around lead poisoning, in the face of powerful industries (Klein, 2012). Combat-

ing disinformation through science media literacy is thus a way to empower marginalized groups in a democracy or capitalist economy.

7. Future Directions: The New Horizon of Science Media Literacy

Against a background where many visions of scientific literacy are irresponsibly vague, I hope to have described the need for science media literacy as one essential component of modern science education.

In the preceding sections, I have profiled this new dimension of science education, as a way to respond to the recent transformations in the media environment and address the new challenges that students now face as citizens and consumers hoping to be informed by reliable science. Science media literacy is not intended to replace other visions of scientific literacy, which (as Rudolph has shown) are multi-faceted. Rather, it helps in articulating one critical dimension of the widely endorsed civic purpose of science education (summarized in Table 1). These competencies obviously need to be further refined and articulated.

Table 1. Major components of science media literacy.

epistemic dependence/epistemic trust
credibility
expertise
social practices of science
critical consensus
nature of science communication
gatekeeping
deceptive media practices
confirmation bias
social learning biases
social networks

At the same time, adopting media literacy will require some adjustments to conventional approaches. Most importantly, perhaps, we need a fuller, more robust and more accurate understanding of the nature of science as it is relevant to the nature of science communication (NOSC). For example, we need to teach about the social practices of science, the inescapable role of expertise, and the significance of critical discourse and consensus. This shift entails accepting the limits of the traditional ideal of intellectual independence and the corresponding popular myth of solo science. We must temper the inflated images of epistemic agency based on a non-expert evaluating the evidence, and instead promote intellectual humility and informed epistemic trust. A good epistemic agent acknowledges that others may know more than they do, and they will be equipped with the tools to find reliable sources of information, evaluate their credibility, and trust the consensus when one is available (while being wary not to second-guess their joint verdict based on one's own personal emotions, ideology, or sense of identity).

The primary purpose of this paper was to articulate new educational goals on existing themes and to sketch the corresponding competencies (in contrast to existing norms) in broad terms. It is hardly a ready-made curriculum. That is a new challenge for the future. However, samples of classroom inquiries and activities that address these problems can be found collected, for example, in *American Biology Teacher* (Allchin et al., 2024) and in *The Science Teacher*'s ongoing column, "Fact-or-Faux?" (SHiPS Resource Center, 2026). They exemplify how to use inquiry methods in science media literacy, not just in the more familiar domain of science (Mellberg et al., 2025).

Science can inform personal and public decision making—but only if consumers and citizens can access reliable information. They inevitably rely on public media well beyond

their school years, and thus need to know how to negotiate that now treacherous landscape. Accordingly, science education needs to adapt to the future and prepare students with lessons in science media literacy—whether one labels it "scientific literacy" or not.

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Abbreviations

The following abbreviations are used in this manuscript:

AI	Artificial intelligence
NOS	Nature of science
NOSC	Nature of science communication

Note

[1] The following two paragraphs draw from Allchin and Osborne (2026).

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