Report
IN BRIEF

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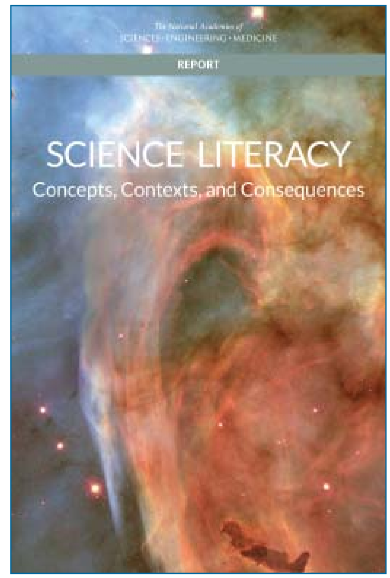

Science Literacy

Concepts, Contexts, and Consequences

What is science literacy, and what is the status of science literacy in the United States? Is there a connection between science literacy and public support for science? A committee of the National Academies of Sciences, Engineering, and Medicine conducted a study in order to answer these questions, releasing its findings and conclusions in the report *Science Literacy: Concepts, Contexts, and Consequences* (2016).

Among the committee's key conclusions:

- On current measures of science knowledge, U.S. adults perform comparably to adults in other economically developed countries.
- Studies using measures of science knowledge observe a small, positive relationship between science literacy and attitudes towards and support for science in general. However, the relationship is small, and available research does not support the claim that increasing science literacy will lead to appreciably greater support for science in general.
- An individual's attitude toward science in general does not always predict his or her attitude toward a specific science topic (for example, genetic engineering or vaccines). Some specific science issues evoke reactions based on worldviews rather than on knowledge of the science alone.
- While science literacy has historically focused on individual competence, communities can also develop and use science literacy, leveraging the varying knowledge and skills possessed by different individuals to achieve their collective goals.

DEFINING SCIENCE LITERACY

Science literacy is often interpreted as knowing the basic facts established by science, but the concept entails much more than this. The committee identified many aspects of science literacy, including:

- an understanding of scientific practices (for example, formulation and testing of hypotheses, probability/risk, and causation vs. correlation)
- content knowledge (knowledge of basic facts, concepts, and vocabulary); and

- an understanding of science as a social process (for example, the criteria for the assignment of expertise, the role of peer review, and the nature of funding and conflicts of interest)

These aspects of science literacy are some of the most common ideas emerging in research, and represent what some scholars expect would be valuable for individuals when using science in their lives, interacting with science information, and making decisions related to science.

However, the committee questioned the common understanding that science literacy should only be understood as a property of individuals. Societies or communities can possess science literacy in ways that may transcend the aggregation of individual knowledge or accomplishments.

SCIENCE LITERACY AT THE SOCIETY LEVEL

Currently, what is measured on science literacy at the society level comes from large public opinion surveys among adults and survey tests of adolescents in many countries. Indicators of adults' knowledge of science are limited to a narrow range of measures on public surveys, and it is difficult to draw strong conclusions on cross-national performance. The large public opinion surveys in different countries also include measures of attitudes toward science, and on these measures, there are many similarities among countries.

Conclusions:

- On most current measures of science knowledge, the population of adults in the United States performs comparably to adults in other economically developed countries.
- Current evidence, though limited, shows that populations around the world have positive attitudes toward science and support public funding for scientific research. These attitudes have been generally stable over time. In addition, the same evidence reveals an overall high level of trust in scientists and scientific institutions.
- Within societies, evidence shows that severe disparities in both foundational literacy—the ability to process oral, written and graphic information in ways that enable one to construct meaning—and health literacy exist and are associated with structural features such as distribution of income and access to high-quality schooling. Though direct evidence for such structural disparities in science literacy is scarce, the committee concluded that they too exist, in part because the possession of foundational literacy is so integral to the development of science literacy.

SCIENCE LITERACY AT THE COMMUNITY LEVEL

Evidence from case studies suggests that science literacy can be expressed in a collective manner—in other words, resources are distributed in such a way that the varying abilities of community members work in concert to contribute to their overall wellbeing. Science literacy within a community does not require that each individual attain a particular threshold of knowledge, skills, and abilities; rather it is a matter of that community having sufficient shared capability necessary to address a science-related issue.

In addition, communities can and do contribute to new scientific knowledge, often in collaboration with scientists. Case-based evidence shows that community involvement has helped to bring new questions to light, provided data that would otherwise be unavailable, and produced new instruments and technologies, among other benefits.

Conclusions:

- There is evidence from numerous case studies that communities can develop and use science literacy to achieve their goals. Science literacy can be expressed in a collective manner, when the knowledge and skills possessed by particular individuals are leveraged alongside the knowledge and skills of others in a given community.
- Based on evidence from a limited but expanding number of cases, communities can meaningfully contribute to science knowledge through engagement in community action, often in collaboration with scientists.

SCIENCE LITERACY AT THE INDIVIDUAL LEVEL

Research on science literacy at the individual level has largely assessed individuals' knowledge using tests of content knowledge and measures of understanding of scientific principles administered through large public surveys.

The existing empirical evidence on the impact of science literacy is drawn largely from two separate research fields: science literacy and health literacy. Research examining the application of health literacy has looked for impact on health-related behaviors (such as compliance with medical advice), whereas studies on the impact of science literacy have mostly examined its relationship to individual attitudes toward science and support for scientific research.

Though there seems to be a small, positive relationship between general knowledge and attitudes toward science, this relationship becomes more complicated when assessing science knowledge and attitudes toward specific science issues. Knowledge affects sub-groups of the

COMMUNITIES ORGANIZING AROUND SCIENCE AND HEALTH ISSUES

Research reveals that community-level engagement with science and health is surprisingly common. A few examples:

- Alarmed at the rapid progress of AIDS and high mortality rates in the 1980s, AIDS activists developed scientific knowledge to demand modifications to drug-testing procedures and to the Food and Drug Administration's drug-approval policies. Working together, they successfully advocated for alternatives to the placebo-control protocol for clinical trials in order to expedite the delivery of drugs to consumers in health emergencies.
- A group of families in Woburn, Massachusetts, identified high rates of leukemia in their community and developed the scientific knowledge to link the increased cancer rates to industrial pollution in the local water supply.
- In many parts of the world, community coalitions have used relatively simple, homemade air quality monitoring devices to produce surprisingly reliable measurements and hold industrial and agricultural polluters to account.

The evidence is compelling that the success of such communities in promoting policy changes and other outcomes depends at least partly on their ability to develop knowledge of science and health and on their capacity for sophisticated interaction with scientists and health professionals, scientific institutions, and health systems.

population differently depending on a host of factors, including levels of religiosity, political predispositions and worldviews, and scientific deference. In fact, in cases of controversial issues, there is often an interaction between knowledge and worldviews such that greater knowledge is associated with increased polarization. In other words, having more knowledge about a particular topic can drive people to different viewpoints depending on their world views. People tend to select information that is consistent with their views or beliefs or, alternatively, avoid information that is inconsistent with their views or beliefs.

Conclusions:

- Studies using measures of science knowledge observe a small, positive relationship between science literacy and attitudes towards and support for science in general. However, available research does not support the claim that increasing science literacy will lead to appreciably greater support for science in general.
- An individual's general attitude toward science does not always predict that same individual's attitude toward a specific science topic (such as genetic engineering or vaccines).
- Some specific science issues evoke reactions based on worldviews—such as ideology, religion, deference to scientific authority—rather than on knowledge of the science alone.
- The commonly used survey-based measures of science literacy, along with other measures of scientific knowledge, are only weakly correlated with action and behavior across a variety of contexts.

These weak relationships among knowledge, attitudes, and behaviors suggest that efforts to simply promote knowledge and understanding to change behavior or attitudes may have limited results. Efforts should focus on increasing knowledge while also removing impediments to actions and lowering the literacy demands of particular situations.

NEEDS FOR FUTURE RESEARCH

In future research on science literacy, the scientific community and other interested stakeholders should continue to expand conceptions of science literacy to encompass an understanding of how social structures,such as education systems, might support or constrain an individual's science literacy, as well as an understanding that societies and communities can demonstrate science literacy in ways that go beyond aggregating the science literacy of the individuals within them.

In addition, the report identifies specific questions researchers should explore, such as:

- Under what conditions and for which types of knowledge does acquiring new scientific knowledge affect individual attitudes and behavior related to science?
- To what extent do the current measures of science literacy map onto people's capacities to accomplish specific tasks, such as to understand science or health messages, choose between competing sources of information, identify expertise, or modify behavior?
- How can we measure, understand, and support the features, structures, and circumstances of communities that make it possible for them to engage collectively with and use science?

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For More Information . . . This report in brief was prepared by the Board on Science Education (BOSE) based on the report *Science Literacy: Concepts, Contexts, and Consequences* (2016). The study was sponsored by the National Institutes of Health. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of any organization or agency that provided support for the project. Copies of the report are available from the National Academies Press, (800) 624-6242; http://www.nap.edu or via the BOSE page at http://nas.edu/ScienceLiteracy.

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