Communications in Information Literacy

Volume 11 | Issue 2 Article 7

2017

The Intersection of Information and Science Literacy

Kristin M. Klucevsek
Duquesne University, klucevsekk@duq.edu

Recommended Citation
Klucevsek, K. M. (2017). The Intersection of Information and Science Literacy. *Communications in Information Literacy, 11* (2), 354-365. https://doi.org/10.15760/comminfolit.2017.11.2.7

The Intersection of Information and Science Literacy

Kristin Klucevsek, Duquesne University

Abstract

To achieve higher science literacy, both students and the public require discipline-specific information literacy in the sciences. Scientific information literacy is a core component of the scientific process. In addition to teaching how to find and evaluate resources, scientific information literacy should include teaching the process of scholarship as a conversation and publication in the sciences. Faculty and librarians can be challenged in their efforts to teach students because of limited access to published research. Stronger scientific information literacy and more access to scholarly research could improve science literacy as a whole.

Keywords: information literacy; science literacy; scientific literacy; open access; publishing; peer review; scientific communication

Perspectives edited by Carolyn Gamtso & Stewart Brower

Klucevsek, K. (2017). The intersection of information and science literacy. *Communications in Information Literacy, 11*(2), 354-365.

The Intersection of Information and Science Literacy

Introduction

In an atmosphere of constant debate and discovery, the definition of science literacy evolves with the times. While at first a simple definition of knowledge, science literacy is now better recognized as much more complex and difficult to achieve. Knowledge alone is inadequate for students, but it is also inadequate for the general public, especially in a time of community disagreement on issues such as climate change and vaccination. The requirements for full science literacy have spanned the process of conducting scientific research, including how to question, test, and analyze. True science literacy requires scientific information literacy, as well as a deeper understanding of how scholarship is created and the access to read it. In this paper, I will explore the impact of finding and evaluating published research on the potential of true science literacy in students and ultimately, the public.

Science literacy

Science is a multistep, reflective process. To scientists, one of the most professionally communal steps is the publication or communication of results. The behind-the-scenes steps to achieve those results include hypothesis, design, implementation, troubleshooting, conversation, and analysis–hardly ever in a linear order. Most recent definitions of science or scientific literacy depend on these steps of the scientific method, and therefore, science as a process. The definitions often consider this process combined with an authentic experience. For example, Yore, Pimm, and Tuan (2007) described science literacy as requiring scientific-specific literacy skills, including a cognitive understanding of scientific inquiry, design, and communication (Yore et al.). Norris and Phillips (2003) described science literacy that emphasized reading and writing as fundamental. They argued that "… science literacy comprises both the concepts, skills, understandings, and values generalizable to all reading, and knowledge of the substantive content of science" (Norris & Phillips, 2003, p. 235). Together, these definitions of science literacy emphasize a wide range of knowledge and abilities true to the profession.

While science literacy in an authentic form is obviously important to science students, science literacy in the public has been more complicated to define. Here, the simple definition of knowledge still doesn't work. Scientific facts evolve with discovery, making

https://pdxscholar.library.pdx.edu/comminfolit/vol11/iss2/7
DOI: 10.15760/comminfolit.2017.11.2.7

problem-oriented science literacy more meaningful than knowledge-based literacy (Paisley, 1998). Yet, the authentic experience of scientific research remains unrealistic at a large scale. Science literacy also faces competition against many other types of literacies that the public should know and understand (Paisley, 1998). This is especially true in our expanding digital world, which demands a larger metaliteracy to use new technology to enhance traditional literacy (Mackey & Jacobson, 2011). In one way or another, science literacy in terms of process might be equally important to all groups, as it forgives some of the content-based knowledge one might need to know.

Information literacy supports science literacy

In 2015, the Pew Research Center surveyed scientists and the general public for their opinions on scientific issues (Pew Research Center, 2015). Not surprisingly, some of the most polarized issues, such as genetically modified foods and climate change, had some of the largest gaps in agreement. Regardless of opinion, scientists and the public do not seem to agree on these pressing issues. Why? For some, the simple answer may be a difference in science literacy. But that answer isn't simple at all. If the answer is science literacy, it doesn't mean literacy in terms of basic knowledge. Only a high level of science knowledge correlates with action on scientific issues, suggesting that minimal science education on an issue is not a solution (Crowell & Schunn, 2015).

Science literacy, in terms of process and inquiry, is a more likely cause for the difference in opinion. While we can't expect everyone to have the same level of knowledge or skill in all disciplines, fundamental literacy could be a cross-disciplinary skill and part of a solution. In fact, if we delve deeper into how the public reads or finds information about science, we would likely see that the public obtains scientific knowledge in ways different than scientists. It may be that scientists form similar opinions because they read similar literature in the field; they also have more access to such literature, and more experience evaluating it. If that's true, information literacy could also be part of the reason for differences between scientists and the general public.

We know that students learn scientific authenticity from seeking and reading scientific research and information closer to the original source. The act of reading scientific primary research helps support scientific inquiry, and therefore literacy (Phillips & Norris, 2009). While primary literature published in academic journals is notoriously difficult to read, adapted primary literature, with similar structure but easier language, helps promote science literacy in high school students (Baram-Tsabari & Yarden, 2005; Yarden, 2009). After all, scientific publications describe and often mirror the organizational steps of the scientific process. In addition, a large body of research supports the integration of information literacy and librarians into science courses to improve the science literacy of students and help them find and use literature in their fields (Kingsley et al., 2011; Klucevsek & Brungard, 2016; Kozeracki, Carey, Colicelli, & Levis-Fitzgerald, 2006; Krontiris-Litowitz, 2013; Reisner, 2016; Thompson & Blankinship, 2015).

In reality, one of the most fundamental and continuous parts of the scientific process *is* information literacy. It is essential to continue to review the literature and search for new conversations while asking questions, designing experiments, analyzing data, and performing research. Discovery is continuous. Yet these steps are the ones students most often forget as they focus on obtaining and analyzing data. We routinely discuss the process of science in my scientific writing classes. When I ask students to diagram the steps a scientist would take during a research project, they rarely include finding relevant literature and communicating results through conferences and publications. Indeed, the parts of this process that are most often forgotten are arguably the most essential for contributing to research as a conversation.

As such an authentic and integral part of the scientific process, scientific information literacy is essential for the science literacy of any group. Science process skills, including the ability to find resources, determine reliability, and understand content, are also basic professional skills (Turiman, Omar, Daud, & Osman, 2012). Without the ability to find research in the sciences, students and the public cannot be expected to understand the impact of the scientific process.

In addition, our science students are professionals in training and integral contributors to academic research. Without specifically addressing scientific information literacy as a key component of science literacy, we are ignoring an essential part of their education. To fully train in the profession, the most authentic research experiences immerse students in the ways scientists communicate and publish their results, as well as how they peer review and evaluate publications (Hunter, Laursen, & Seymour, 2007). By teaching that science and information are linked processes, we can improve writing, research, and inquiry skills (Coil, Wenderoth, Cunningham, & Dirks, 2010).

https://pdxscholar.library.pdx.edu/comminfolit/vol11/iss2/7
DOI: 10.15760/comminfolit.2017.11.2.7

Literacy includes scholarship as a conversation

To become information literate, a student must be proficient at all levels of information literacy as defined by the ACRL, including finding and evaluating research (Association of College and Research Libraries, 2016). Yet in my experience, there is a cognitive separation between the authentic process of scientific inquiry and the publication process behind the articles students find in databases. Without knowing how articles are published, it is difficult to evaluate the types of scientific literature and use them ethically.

Less than half of STEM students are moderately knowledgeable of the peer review process, open access, and the impact of scientific publishing (Riehle & Hensley, 2017). Yet most students report it is important that they understand the process of scholarly communication (Riehle & Hensley, 2017). This suggests that many science students may not understand that journal publications represent years of research, discussion, and conference presentations. They may be unaware that publishing involves choosing the appropriate journal, submitting articles for anonymous peer review, revising an article after feedback, and sometimes rejection. It is difficult to understand science and information as a process without understanding the intricacies of creating academic scholarship.

Most students only learn about this scholarly publication process if it is taught in a course or by a research mentor. Performing research alone would not guarantee this knowledge, especially if the students haven't presented at a conference or published their data. This learning could be intentionally supported by information literacy through the help of librarians and faculty (Riehle & Hensley, 2017). This instruction would support scientific information literacy by simultaneously teaching how research and scholarship intersect, enhancing science literacy.

Impact on the public

We can make curriculum adjustments to improve our students' science literacy by teaching more scientific information literacy. However, this is a more challenging solution for the public. The results of the Pew research survey indicate that a deficit in information literacy may contribute to a lack of science literacy (Pew Research Center, 2015).

Part of the issue in science literacy may be how we communicate research. After all, presenting at conferences and publishing in journals not generally known to the public means that scientific conversations and debates are hidden from the public until someone translates it. The public needs to see the process, the analysis, and the early stages of discovery and publication, just as much as they need to know an end result (Miller, 2001). Differences in public opinion could represent a fundamental difference in the information resources of the general public and scientists. If that's true, the simple act of giving the public research articles may not be the solution. This type of information rarely changes opinions in a scientific debate, as positions often are driven by human nature rather than data and support (Julien, 2016).

It's not clear how to teach information literacy to the public in a way that would increase science literacy and the use of appropriate resources. First, the non-scientist would need to be proficient in finding a variety of authentic and authoritative scientific resources. Takahashi and Tandoc (2016) found that people who are more interested in science tend to use the Internet as a source of information over news sources, but this leads to a higher distrust for scientists. The same people also tend to know more "facts" about science, even if they are critical of sources and scientists. This further supports that facts and resources alone do not train readers to think like scientists. Given what we know about science literacy in students, this isn't surprising. The public may also need to understand science as a process and how research is communicated and accessed.

Even with more general education to teach the public how to find resources similar to those accessible by scientists, the public would also need to evaluate these resources. However, opinion influences this evaluation too; scientific information literacy for the public is complicated by deep-rooted bias. In one study, well-educated undergraduates of diverse majors relied on the "scientificness" of a document, such as citations and methods, to determine if the resource should be valued (Bromme, Scharrer, Stadtler, Hömberg, & Torspecken, 2015). However, these measures of "scientificness" were not as strong on the subject of climate change, indicating that political reasoning polarizes opinions (Bromme et al., 2015). When a person feels strongly on an issue, the data, even from a more authentic source, may not be that influential. The resources and reasoning these groups use to make scientific decisions in their personal or political life may differ, as well as their level of scientific knowledge or literacy (Rudolph & Horibe, 2016).

There may be arguments against scientific information literacy for the public due to any inherent bias or lack of background to understand articles, but this argument only fails to solve problems in science literacy. Those interested in improving science literacy might benefit from what scientific communication scholars already consider about research communication—how the public receives and digests science through the media and how

https://pdxscholar.library.pdx.edu/comminfolit/vol11/iss2/7
DOI: 10.15760/comminfolit.2017.11.2.7

their individualities might affect how they engage with it (or not) (Feinstein, 2015). Further research is needed to understand how to overcome bias as we work to improve science literacy through teaching science and information as processes.

Potential solutions

Opinion and bias present challenges and a need for more intricate studies and solutions. In education, information literacy educators can address this problem through changes in pedagogy, encouraging students to reflect on how their own motivated reasoning may affect how they acquire and analyze information (Lenker, 2016). This may be true of the public as well. If they reflect on their reasoning for their information-seeking behaviors, perhaps they would be encouraged to seek multiple resources. In addition, discussing research with others could foster analysis and application. One study investigated how individuals interacted with different texts containing scientific research, such as a journal article or a news article of the research (Davis & Russ, 2015). They found that people frame their understanding differently, but conversations with other people can help them see alternative frames through guidance (Davis & Russ, 2015). It may be more successful to communicate scientific research if we understand how individuals frame the scientific research they receive through different resources, and why they seek specific information.

There's always the possibility that people may be able to transfer information literacy skills from other disciplines to the sciences, especially if this transfer of skill sets was taught intentionally. A survey of several large U.S. employers revealed that employees valued information literacy and the ability to evaluate research sources and read text closely, often relying on their college educations to help them in their current work (Head, Van Hoeck, Eschler, & Fullerton, 2013). In fact, even for those without a science degree, the ability to read a scientific article may be improved through the application of information and reading skills in the humanities (Head et al., 2013). The task may be promoting this skill transfer to override bias or situation. This is admittedly a problem in education as well; students are more likely to turn to search engines than library databases for research in their everyday lives (Head & Eisenberg). They may not hold the same credibility for resources when answering questions they have outside of the classroom.

After my own students learn about the scholarly process and spend a semester writing in the sciences, I ask them where they would go to find out more information about a disease. The most common answer is always WebMD and "Dr. Google," even though they have demonstrated their ability to use databases in the classroom. I assure students that they can, at the very least, find and read secondary content in any discipline. They are information literate in the sciences–that gives them that ability. Yet it appears the transfer of those skills to an outside context must be intentional and encouraged.

The added challenge of open access to literacy

The challenge of teaching scientific information literacy to any group is further complicated by open access to published literature. A person without information literacy skills cannot evaluate credibility. A person without access to databases and journals cannot find as many articles to evaluate or understand how one article fits into a larger research conversation. The combination of these two scenarios deepens the divide in science literacy. Indirectly, open access affects everyone through the media, which can only report what they have access to read. Some may wonder if more open access will solve issues in the public's science literacy if the public does not have the training to analyze scientific data. In a small study in the Netherlands, citizens confirmed a concern that they wouldn't be able to read scientific literature, but still had an interest in having open access to it to improve their knowledge (Zuccala, 2010). If the public gains more access to scientific literature, early education with science as a process would be essential to building lifelong literacy.

Most students have access to a set of subscription journals and research while enrolled in a university, but access could be a greater challenge if they leave academia (Blake, 2016). Access is an especially pertinent problem if we consider the constant challenge of transferring skills to a new setting. It could limit a trained population's ability to practice scientific information literacy, participate in the research conversation, and communicate to the public.

While there are certainly challenges to open access, there are signs that the consensus favors open data and accessibility in scholarly work to improve literacy (Pinfield, 2015). For example, at this time, any peer-reviewed manuscript funded by the National Institutes of Health (NIH) must be made open to the public within 12 months. While this is a step toward open access, there is still the potential for delay and the compliance rate is approximately 80%, even with extensive outreach from librarians (Lapinski, Osterbur, Parker, & McCray, 2014). We also have increasing choices of open access journals or access options, as well as preprint servers that promote the access of data before traditional publication methods. These new models may change data communication and traditional peer review. As access and publication methods evolve, we will need to change how we teach the scholarship process as part of scientific information literacy.

https://pdxscholar.library.pdx.edu/comminfolit/vol11/iss2/7
DOI: 10.15760/comminfolit.2017.11.2.7

Conclusion

To build a more scientifically literate population, we must reflect on how scholarship as a conversation fits into science literacy, both for our students and for the public. Some of the differences in science literacy that we see may be caused by an overall lack of scientific information literacy; therefore, we need to include scientific information literacy in both student and public education while emphasizing literacy's role in the scientific process. Literacy, on a simple level of knowledge in a digital age, will never substitute for immersion within a discipline's practices to improve literacy from multiple angles. Scientific information literacy is an essential part of understanding science as a process, and therefore science literacy.

In addition, peer-reviewed journals are not the only places to find scholarly research. Scholarship as a conversation in the sciences will continue to evolve as access and open data do. As the future of research, our students will contribute to what publishing looks like years from now; their literacy will also shape how they make a broader impact on public literacy. We can't mistake what an important part of their education it is to learn the current systems, the new systems in progress, the challenges, and the potential. To understand scientific research as inquiry, our students must apply the ACRL *Framework* to the scientific method, simultaneously improving both their science and information literacy.

Acknowledgements

This work has been influenced by years of classroom discussions and observations. I thank my students for their interest in these topics. I also thank A. B. for helpful perspectives, comments, and suggestions.

References

Association of College and Research Libraries. (2016). *Framework for Information Literacy for Higher Education | Association of College & Research Libraries (ACRL)*. Retrieved from http://www.ala.org/acrl/standards/ilframework

Baram-Tsabari, A., & Yarden, A. (2005). Text genre as a factor in the formation of scientific literacy. *Journal of Research in Science Teaching, 42*(4), 403–428. http://dx.doi.org/10.1002/tea.20063

Blake, L. (2016). Lifelong learning and open access. *Issues in Science and Technology Librarianship: a Quarterly Publication of the Science and Technology Section, 1*(95), 1.

Bromme, R., Scharrer, L., Stadtler, M., Hömberg, J., & Torspecken, R. (2015). Is it believable when it's scientific? How scientific discourse style influences laypeople's resolution of conflicts. *Journal of Research in Science Teaching, 52*(1), 36–57. http://dx.doi.org/10.1002/tea.21172

Coil, D., Wenderoth, M. P., Cunningham, M., & Dirks, C. (2010). Teaching the process of science: Faculty perceptions and an effective methodology. *Cell Biology Education, 9*(4), 524–535. http://dx.doi.org/10.1187/cbe.10-01-0005

Crowell, A., & Schunn, C. (2015). Unpacking the relationship between science education and applied scientific literacy. *Research in Science Education, 46*(1), 129–140. http://dx.doi.org/10.1007/s11165-015-9462-1

Davis, P. R., & Russ, R. S. (2015). Dynamic framing in the communication of scientific research: Texts and interactions. *Journal of Research in Science Teaching, 52*(2), 221–252. http://dx.doi.org/10.1002/tea.21189

Feinstein, N. W. (2015). Education, communication, and science in the public sphere. *Journal of Research in Science Teaching, 52*(2), 145–163. http://dx.doi.org/10.1002/tea.21192

Head, A. J., & Eisenberg, M. B. (2010). *How college students evaluate and use information in the digital age.* The Information School, University of Washington Research.

Head, A. J., Van Hoeck, M., Eschler, J., & Fullerton, S. (2013). What information competencies matter in today's workplace? *Library and Information Research, 37*(114), 74–104.

Hunter, A.-B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education, 91*(1), 36–74. http://dx.doi.org/10.1002/sce.20173

Julien, H. (2016). Beyond the hyperbole: Information literacy reconsidered. *Communications in Information Literacy, 10*(2). 124-131.

Kingsley, K., Galbraith, G. M., Herring, M., Stowers, E., Stewart, T., & Kingsley, K. V. (2011). Why not just Google it? An assessment of information literacy skills in a biomedical science curriculum. *BMC medical education, 11*(1), 1.

https://pdxscholar.library.pdx.edu/comminfolit/vol11/iss2/7
DOI: 10.15760/comminfolit.2017.11.2.7

Klucevsek, K. M., & Brungard, A. B. (2016). Information literacy in science writing: how students find, identify, and use scientific literature. *International Journal of Science Education*, *38*(17) 1–23.

Kozeracki, C. A., Carey, M. F., Colicelli, J., & Levis-Fitzgerald, M. (2006). An intensive primary-literature-based teaching program directly benefits undergraduate science majors and facilitates their transition to doctoral programs. *Cell Biology Education, 5*(4), 340–347. http://dx.doi.org/10.1187/cbe.06-02-0144

Krontiris-Litowitz, J. (2013). Using primary literature to teach science literacy to introductory biology students. *Journal of Microbiology & Biology Education, 14*(1). 66-77.

Lapinski, P. S., Osterbur, D., Parker, J., & McCray, A. T. (2014). Supporting public access to research results. *College and Research Libraries, 75*(1), 20–33.

Lenker, M. (2016). Motivated reasoning, political information, and information literacy education. *portal: Libraries and the Academy, 16*(3), 511–528.

Mackey, T. P., & Jacobson, T. E. (2011). Reframing information literacy as a metaliteracy. *College & Research Libraries, 72*(1), 62–78.

Miller, S. (2001). Public understanding of science at the crossroads. *Public Understanding of Science, 10*(1), 115–120. http://dx.doi.org/10.1088/0963-6625/10/1/308

Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education, 87*(2), 224–240.

Paisley, W. J. (1998). Scientific literacy and the competition for public attention and understanding. *Science Communication, 20*(1), 70–80. http://dx.doi.org/10.1177/1075547098020001009

Pew Research Center. (2015). Public and scientists' views on science and society. Retrieved from http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/

Phillips, L., & Norris, S. (2009). Bridging the gap between the language of science and the language of school science through the use of adapted primary literature. *Research in Science Education, 39*(3), 313–319. http://dx.doi.org/10.1007/s11165-008-9111-z

Pinfield, S. (2015). Making open access work: The "state-of-the-art" in providing open access to scholarly literature. *Online Information Review, 39*(5), 604–636. http://dx.doi.org/10.1108/OIR-05-2015-0167

Reisner, B. A. (2016) Building data and information literacy in the undergraduate chemistry curriculum. Vol. 1232. ACS Symposium Series (31–56).

Riehle, C. F., & Hensley, M. K. (2017). What do undergraduate students know about scholarly communication?: A mixed methods study. *portal: Libraries and the Academy, 17*(1), 145–178.

Rudolph, J. L., & Horibe, S. (2016). What do we mean by science education for civic engagement? *Journal of Research in Science Teaching, 53*(6), 805–820. http://dx.doi.org/10.1002/tea.21303

Takahashi, B., & Tandoc, E. C. (2016). Media sources, credibility, and perceptions of science: Learning about how people learn about science. *Public Understanding of Science, 25*(6), 674–690. http://dx.doi.org/10.1177/0963662515574986

Thompson, L., & Blankinship, L. A. (2015). Teaching information literacy skills to sophomore-level biology majors. *Journal of microbiology & biology education, 16*(1), 29–33. http://dx.doi.org/10.1128/jmbe.v16i1.818

Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21st century skills through scientific literacy and science process skills. *Procedia—Social and Behavioral Sciences, 59*, 110–116. http://dx.doi.org/10.1016/j.sbspro.2012.09.253

Yarden, A. (2009). Reading scientific texts: Adapting primary literature for promoting scientific literacy. *Research in Science Education, 39*(3), 307–311. http://dx.doi.org/10.1007/s11165-009-9124-2

Yore, L. D., Pimm, D., & Tuan, H. L. (2007). The literacy component of mathematical and scientific literacy. *International Journal of Science and Mathematics Education, 5*(4), 559–589. http://dx.doi.org/10.1007/s10763-007-9089-4

Zuccala, A. (2010). Open access and civic scientific information literacy. *Information Research, 15*(1). 1-27.

https://pdxscholar.library.pdx.edu/comminfolit/vol11/iss2/7
DOI: 10.15760/comminfolit.2017.11.2.7