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EDITORIAL

I Read It On The Internet, It Has To Be True!

Norman G. Lederman[1] · **Judith S. Lederman**[1]

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We all periodically hear things that our friends, relatives, and colleagues say that give us pause and a lifting of an eyebrow. These anecdotal instances just go with the territory of being human. However, sources such as the Pew Reports and the Science and Engineering Indicators more systematically assess what people believe, and in this case what Americans believe. On the average, over a decade of assessments indicate that approximately:

50% believe in spiritualism
45% believe in faith healing
40% in astrology
35% in UFOs
15% in fortune telling
45% in ghosts
30% in witches

These numbers have been consistently on the rise. Not stable, not decreasing, but on the rise! About 20 years ago, Norman overheard two businessman sitting in front of him on a plane. They were talking about charging the battery on a laptop computer and the consequences of disconnecting the electrical cord from the wall without disconnecting it from the computer and the alternative of disconnecting the cord from the computer, but not the wall. The final consensus was that disconnecting the cord from the wall, but leaving the other end of the cord connected to the computer would result in electricity "trickling" out of the computer. This would be an interesting question to ask the public today. We are not sure if anything will have

✉ Norman G. Lederman
jste@iit.edu

✉ Judith S. Lederman

[1] Illinois Institute of Technology, Chicago, IL, USA

improved. And we now have influential people in the upper administration of the U.S. government questioning whether climate change is a reality.

It has been several decades since the general public has had unrivaled access to information of all types, scientific and otherwise. You would think the beliefs just described would have changed to the more positive. But they haven't and this is a critical concern.

The phrase "scientific literacy" has been around for over half a century and its connection to an understanding of nature of science and scientific inquiry was, perhaps, most formalized by the work of Roberts (2007), Showalter (1974) and by a National Science Teachers Association position statement on science-technology-society (NSTA, 1982). In general, scientific literacy was always at least partially associated with an individual's ability to make informed decisions about scientifically based personal and societal issues. The work of Miller (1983, 1998) and the recent publication by the National Academies of Science (2016) has maintained concern and interest in the achievement of scientific literacy globally, let alone throughout the science education community. It would seem that the expansion of the internet and access to knowledge would have brought us closer to the goal of scientific literacy than what appears to be the case. What is the problem?

One could argue that knowledge has expanded at such an enormous rate that it is difficult for the average person to keep track. However, some of the issues and beliefs previously discussed are not knew issues that have emerged from the expansion of knowledge. If you are a current or former teacher who has assigned independent research papers and projects to students, you no doubt have noticed that students have used the internet to a great degree, resulting in completed papers that have evolved to include far more literature and data sources. This is a good thing, right? Alternatively, we have heard many of our teacher colleagues describe the situation more as a "data dump" than the improvement or more sophisticated approach to answering a scientifically-based problem or issue.

Although our students have benefitted from the increase access to knowledge, they have not learned to critically analyze the credibility and veracity of what they are reading. As Shellenbarger (2016) of the Wall Street Journal reports, most students don't know when news should be believed or dismissed as fake. The data she discusses in her article is derived from a multi-year study of students' ability to discern the credibility of information received from electronic media sources. Thus, the problem with respect to the internet still exists and it is real. How a resource that would appear capable of assisting in the achievement of scientific literacy does not appear to be helping much at all.

As science teacher educators, we cannot help but feel a bit culpable. What have we (collectively) done to help the preservice and inservice teachers with whom we work facilitate their students' ability to critically analyze what they read and gather on the internet? Presumably, the stress on argumentation in science education over the recent years and its continued emphasis in the *Next Generation Science Standards* (NGSS Lead States, 2013) will help address the problem. But, it is unclear if argumentation skills generalize to contexts and issues outside of the specific learning situation involved.

So, as science teacher educators, what can we do to help alleviate the continuing problem of our students and general public falling prey to unverified and unwarranted claims? Certainly some more emphasis on nature of science (NOS) and its use in helping students make decisions on scientifically-based issues is needed. We stress the latter portion of this recommendation because, although there is an increasing emphasis on NOS in science teacher education and inservice professional development, the use of NOS knowledge in helping make informed decisions is not stressed as often as it could be. This recommendation by us should be of no surprise to any of you who know us, and probably does not appear to be insightful at all.

Action research projects are a component of many preservice programs and professional development initiatives. The usual rationale is that doing action research projects will cause teachers to more systematically view their own and their colleagues' practices. However, how much emphasis is really placed on research design and the translation of what one knows about research design to their science students? In general, how much emphasis on research design is addressed in elementary and secondary school classrooms? How much emphasis is there beyond the infamously wrong "scientific method?"

In relation to action research, and research in general, is enough attention given to data representation and analysis? We are strong supporters of inquiry-oriented teaching approaches and learning experiences. However, it seems to us, that the most ignored component of scientific inquiry, as it is presented in classrooms, is data analysis. It appears obvious to us that the tandem of research design and data analysis are critical in helping our students be more critical and discerning of the information they read and hear. After all, aren't these the areas in which most of our Ph.D. students experience the most difficulty? In our opinion, preservice and inservice science teacher education programs need to stress these important areas of knowledge as well as the specific pedagogical approaches that increase the likelihood of student learning. PCK for research design and data analysis, if you will. We know this is an ambitious recommendation. We also know that often students, and the public, are not given enough information about the actual data and how it was analyzed. And, they certainly do not always have the where with all to make sense of all the data that could be presented. However, more stress on data representation and analysis is at least a step in the right direction for many of the claims students hear and read.

Scientifically literacy has been a perennial goal of science education. But it appears, from the difficult problems our students have wading through the credible and not so credible claims associated with matters scientific, that much work remains to be done. Scientific literacy is a complex educational outcome that involves much more than knowledge of subject matter. How scientific knowledge is developed (i.e. inquiry/practices) and the resulting characteristics and status of the resulting knowledge (i.e. NOS) are clearly just as important. What we have tried to do here is be just a little more specific than the often stated advocacies for knowledge of and the doing of inquiry. We feel more serious consideration for research design and data representation/analysis should be present in the various forms of teacher education, and ultimately in our K-12 science classes, if we

eventually want our students, and general public, to become more savvy with respect to the claims they see, read, and hear.

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