A Functional Conceptualization of Understanding Science in the News

By

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Abstract

The idea that the public should have the capacity for understanding science in the news has been embraced by scientists, educators, and policymakers alike. An oft-cited goal of contemporary science education, in fact, is to enhance students' understanding of science in the news. But what exactly does it *mean* to understand science in the news? Surprisingly few have asked this question, or considered the significance of its answer. This dissertation steps away from issues of science teaching and learning to examine the nature of understanding science in the news itself. My work consolidates past scholarship from the multiple fields concerned with the relationship between science and society to produce a theoretical model of understanding science in the news as a complex, multidimensional process that involves an understanding of science as well as journalism.

This thesis begins by exploring the relationship between the understanding implicit in understanding science in the news and understanding science. Many assume these two ways of knowing are one in the same. To rebut this assumption, I examine the types of knowledge necessary for understanding science and understanding science in the news. I then use the literature devoted to scientific literacy to show how past research has imagined the knowledge necessary to understand science in the news. Next, I argue that one of the principle difficulties with these conceptualizations is that they define *science in the news* in essentially the same terms as *science*. They also, I suggest, oversimplify how and why public interacts with science in the news. This dissertation concludes with a proposal for one way we might think about understanding science in the news on its own terms rather than those of understanding science.

This dissertation attempts to connect two fields of research that rarely intersect, despite their multiple common interests: science education and mass communication. It considers the

notion of “understanding science in the news” in light of the principles of each, rather than maintaining their distinction.

Preface

I was a very poor chemistry student. That I spent a great deal of my undergraduate career fulfilling a minor in chemistry, then, was an exceedingly unfortunate circumstance, particularly for my GPA. Although much of my knowledge of chemistry has been lost to time, one lesson remains particularly distinct. I doubt it is one my instructor intended. During his introductory talk on the first day of Biochemistry 350, he stressed his hope that the material covered in his course would improve our overall understanding of the science in the news. This was a hope, he noted, specifically for those of us that would not be pursuing careers in science. In response, I clearly remember thinking, "Scientist or not, there is no way I would ever voluntarily read anything about biochemistry." Much to my relief, my instructor dropped the notion after those few remarks and it did not to appear again during the remainder of the course.

What I did not know at the time is that I would go on to become a science writer, regularly reporting on scientific research from multiple disciplines, from entomology to primate behavior to forensics, and deeply invested in the notion of understanding science in the news. Initially, I recalled the biochemistry episode described above to marvel at the irony of my disdain, but slowly, I began to realize I had witnessed a larger phenomenon. That the public, a majority of whom are nonscientists, should have the capacity to understand science in the news has been enthusiastically embraced across multiple disciplines as a valuable, often essential, educational goal and social achievement. What exactly understanding science in the news entails, however, depends a great deal on whom you ask—scientists, policymakers, educators, journalists, or others with an interest in the how the public makes sense of news reports about science.

In surveying the visions of understanding science in the news put forth by these groups, I was struck by the relatively limited way they portrayed the understanding implicit in understanding science in the news. Broadly, the dominant view of understanding science in the news said that in order to understand science in the news, one must have some understanding of science. I didn't disagree. But as a journalist, I wondered about the substantial amount of knowledge necessary to make sense of the news component of "science in the news." Where did it fit in? Was it explained by media literacy? Or was it something else?

Sometime during my consideration of the nature of understanding science in the news, I realized that I no longer wanted to be a journalist. I was less concerned with producing the science news than determining what happened when the public met the science news. To me, the important question had become: What does it actually mean to understand science in the news? It was to explore this question that I turned to the field of science education. This dissertation is the product of that exploration.

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The highest and most difficult kind of inquiry and a subtle, delicate, vivid and responsive art of communication must take possession of the physical machinery of transmission and circulation and breath life into it. When the machine age has thus perfected its machinery, it will be a means of life, not its despotic master. Democracy will come into its own, for democracy is a name for free and enriching communion. It has its seer in Walt Whitman. It will have its consummation when free social inquiry is indissolubly wedded to the art of full and moving communication.

John Dewey, 1927

Chapter 1: Introducing the Concept of "Understanding Science in the News"

Ask any assembly of policymakers, scientists, and educators to identify the key goals of science education, and building students' capacity to understand science in the news will likely make the list. Indeed, some version of "understanding science in the news" appears as an educational aim everywhere from the mandates put forth by educational policymakers (e.g., American Association for the Advancement of Science, 1989, 1993; National Research Council, 1996, 2011; Millar and Osborne, 1998; American Academy of Arts and Sciences, 2010) to the less formal, though equally compelling, talk among scientists. In the United States, the demand for a populace capable of understanding science in the news has been voiced for nearly a century.

In 1935, Benjamin C. Gruenberg published *Science and the Public Mind*, an examination of the relationship between science and the public. He argued that the diffusion of understanding science throughout the population was an important social objective because it 1) advanced an individual's interests and wellbeing, 2) tended to promote civic and social interests, and 3) advanced common and cultural interests. Although Gruenberg was neither the first nor last to recognize the individual, social, cultural, civic, and other applications of understanding science in everyday life, he was one of the earliest to explicitly emphasize the role of mass media in the relationship between science and society. In particular, he acknowledged the significance of a public capable of understanding the science reported by mass media. He noted the important role of the "printed word" in the distribution of scientific knowledge, and recognized that new knowledge concerning science was often delivered by mass media (p. 134). Gruenberg argued, for example, that newspapers "diffuse a great deal of information about new applications, new practices, new ideas arising from scientific research; and much of this information has a bearing on everyday affairs" (p. 61). He was highly critical, however, of how newspapers presented that information. He objected to journalists' "need to simplify" and "desire to be perfectly objective," believing that these practices resulted in "making much of the material as it is offered to the public extremely trivial" (p. 95).

In the 1920s, journalist Walter Lippmann (1922) had expressed similar concerns about the nature of the news and its impact on public knowledge. Lippmann argued that it was more important for newspapers to get advertisers than to portray "the truth." "News and truth are not the same thing," Lippmann wrote. "The function of news is to signalize an event; the function of the truth is to bring light to the hidden facts to set them in relation to each other, and make them a picture on which men can act. Only at those points where social conditions take recognizable and measurable shape, do the body of truth and the body of news coincide" (p. 358). When philosopher of education John Dewey reviewed Lippmann's essay for *The New Republic* he defended "the body of news" against these criticisms, arguing for a more moderate view. Dewey suggested that Lippmann "surrenders the case for the press too readily" and assumes "too easily that the press is what it should be." Instead, Dewey recommends treating news as a "continuing study," as "the union of social science, access to facts, and to the art of literary presentation is not an easy thing to achieve" (p. 288).

During the course of his relatively pro-news argument, Dewey lists "science" among the types of knowledge the news might build. He observes that the news serves a valuable social function as it provides a means of passing information through a "definite procedure of analysis and record." Dewey wrote, "gradually…a body of conceptions like science will be built up and these will become available for purposes of education. Future citizens, during their schooling, can be taught effective…science. [This] will provide the zest of conquest over the superstitions of the mind and give reason the force of passion" (p. 288).

Over the course of the twentieth century, education researchers and policymakers eager to, in Dewey's terms, "build up" citizens' knowledge about science have turned to mass media time and again. As a result, the visions of "understanding science in the news" encountered in the resulting research and policy literature tend to focus on the role of mass media in the dissemination of information about science. The National Society for the Study of Education (NSSE), for example, has noted the relationship between science in the news and science teaching and learning in a number of their "yearbooks." The NSSE, an educational organization founded in 1901 by a group of educators including Dewey, has published an annual two-volume yearbook that examines a host of educational issues almost continuously since its inception. Each yearbook tackles a different educational issue. The science news appears in the forty-sixth NSSE Yearbook, *Science Education in American Schools* (1947), in two short, descriptive statements: "radio broadcasts may have certain values for science instruction" and "[mass media may] relate science more closely to [students'] everyday experiences" (p. 105). A few years later, spurred by the onset of the Cold War, the launch of the Russian satellite *Sputnik* in 1957, and the explosive changes in science and technology policy and practice that followed, concern about students' "everyday experiences" would be replaced by concern about students' capacities to act as thoughtful critics of science, among other things (Rudolph, 2002). The fifty-third NSSE Yearbook, *Mass Media and Education* (1954) reflects this shift toward building more critical citizens, focusing explicitly on the role of mass media in forming public attitudes and opinion. Specifically, it highlighted the growing impact of movies and newspapers on American society and schooling (Schwarz, 2005). In the introduction to the 1954 yearbook, Edgar Dale, chairman of the yearbook committee, stated that, “no teacher in our schools can teach with full effectiveness unless he has a keen understanding of the role of the mass media in the life of his students” (p. 8).

The NSSE has only occasionally revisited the role of mass media in education since 1954, most recently its 2005 yearbook, *Media Literacy: Transforming Curriculum and Teaching*. As its title suggests, this volume focuses on media literacy, which is often defined as the ability to consume the products of mass media in a critical and competent way. Notably, the science curriculum, as well as science teaching and learning in general, is not addressed in this volume, although its does cover science-related topics like the environment and health. This absence may reflect the current practice among many in the science education community to define the understanding implicit in understanding science in the news solely in terms of knowledge about science—media literacy or other types of knowledge unrelated to science are rarely discussed. Two of the most influential educational policy documents published in the last 30 years, in fact, have conceptualized understanding science in the news in terms of science.

The *National Science Education Standards* (NSES) (National Research Council (NRC), 1996), for example, includes understanding science in the news as part of its definition of scientific literacy. The NSES states that, “scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions” (p. 22). A variation of understanding science in the news also appears in *Project 2061*, the American Association for the Advancement of Science’s (AAAS) long-term, multi-phased educational reform initiative in pursuit of scientific literacy. Phase I of this effort is a policy document, titled *Science for All Americans* (1989), posits that, “education should prepare people to read or listen to [assertions in mass media] critically, deciding what evidence to pay attention to and what to dismiss, and distinguishing careful arguments from shoddy ones" (p. 193). Similar emphasis on understanding science in the news is found in *Benchmarks for Scientific Literacy* (1993), the second phase of *Project 2061*, which states that "by the time [students] graduate, [they]…should be able to understand discussions of scientific issues in the news" (p. 14). More recently, the NRC (2011) has included a variation of understanding science in the news in its report *Framework for K12 Science Education,* suggesting that "being a critical consumer of science and the products of engineering, whether as a lay citizen or a practicing scientist or engineer, also requires the ability to read or view reports about science in the press or on the Internet" (p. 3-20). More specifically, *Framework* recommends that by grade 12 students should be able to "engage in a critical reading…of media reports of science and discuss the validity and reliability of the data, hypotheses, and conclusions" (p. 3-20).

Understanding science in the news has also been defined in terms of knowledge about science in educational policy documents at the state level. For example, Wisconsin's state science standards include the evaluation of scientific evidence used in "various media" among its performance standards for grade eight (Wisconsin Department of Public Instruction (DPI), 2009). According to the DPI, students in Wisconsin should be able to "evaluate the scientific evidence used in various media (for example, television, radio, Internet, popular press, and scientific journals) to address a social issue, using criteria of accuracy, logic, bias, relevance of data, and credibility of sources" (para. 2). Similarly, Texas's state science standards declare that students are expected to "communicate and apply scientific information extracted from…news reports" by the end of high school (Texas Education Agency, 2010, p. 24).

In addition to a certainty that understanding science in the news is related to understanding science in some fundamental way, policymakers' visions of "understanding science in the news" share another defining trait as well—brevity. As these examples show, policymakers' visions rarely extend beyond two or three sentences. This is due, in part, to the abbreviated nature of these types of policy documents. The NSES (1996), for example, merely lists "media" among the types of secondary sources "student inquiry in the classroom" prepares students to critically analyze (p. 33). But it is also representative of how "understanding science in the news" has been considered by policymakers in general. They presume that understanding science in the news enlists the same types of knowledge, skill, understanding, and judgment as understanding science in any other context, leaving the exact practice and purpose of understanding science in the news mostly taken-for-granted—giving one the sense it is more a rhetorical aim of science education than a true objective.

The notion of understanding science in the news has been similarly overlooked in the science education research literature. Although past work has examined how teachers use news media in the classroom (e.g., Wellington, 1991, 1993; Hutton, 1996; Jarman and McClune, 2002; Hoskins, 2010) and students' perceptions and understandings of issues related to the science that appear in mass media (e.g., Norris and Phillips, 1994; Korpan, Bisanz, Bisanz, and Henderson, 1997; Millar, 1997; Korpan, Bisanz, Bisanz, and Snyder, 1999; Phillips and Norris, 1999; Ratcliffe, 1999; Norris, Phillips, and Korpan, 2003), the notion of "understanding science in the news" itself has never been examined in a critical way. Given its success as an educational goal and social objective, this lack of scrutiny is startling. Yet what is perhaps most perplexing is the considerable amount of "hand waving" that occurs at its specifics. That is, there is plenty of talk *about* understanding science in the news found in the research literature, but little sense of what that understanding might actually entail. While there are a few comprehensive visions of understanding science in the news (see, for example, McClune and Jarman, 2010), science education researchers have, for the most part, done very little to develop the expectations and purpose of understanding science in the news beyond a mere slogan. As a result, the idea of building a public that understands science in the news has become a broad, even generic, aim that signals a commitment to serving both the public and scientific enterprise, but, as it is currently conceptualized, lacks the capacity to do so.

This dissertation is an attempt to liberate the notion of "understanding science in the news" from its current obscured state. That is, to transform "understanding science in the news" from a dysfunctional, throwaway objective among the science education community into a more practical one. An important part of this transformation, and the primary focus of this work, is the establishment of "understanding science in the news" as its own entity—what it means, what it entails, and why it matters. What exactly is the role of scientific knowledge in understanding science in the news? What else might citizens need to know to understand science in the news? And why does the distinction between scientific understanding and understanding science in the news matter? I will argue that if, as policymakers and researchers suggest, the goal of understanding science in the news is to build critical consumers of the products of *mass media*, then knowledge about science alone is arguably not enough. *Some* knowledge about mass media—its norms and values, practices and products—is equally necessary for a full and functional understanding of science in the news.

I begin my argument in Chapter Two by examining the relationship between the understanding implicit in understanding science in the news and scientific understanding. In Chapter Three, I address how scientific literacy has been used in past research as a means of linking understanding science in the news and scientific literacy. Chapter Four distinguishes *science* from *science in the news*. In Chapter Five, I examine how the public interacts with science in the news. I conclude in Chapter Six, proposing one way we might think about understanding science in the news in a more functional way and discussing the implications of this work for science education in the United States.

About the phrase "Understanding Science in the News"

The capacity to critically evaluate and interpret the theories, concepts, findings, people, events, and phenomena of science as they appear in the news is a goal I call "understanding science in the news."[1] This phrase, however, is not a universal idiom. Others describe this phenomenon as "critical engagement with science in the media" (McClune and Jarman, 2010, p. 727) or the ability to "understand, and respond critically to, media reports with a science component" (Millar and Osborne, 1998, p. 12). The precise meaning of the terms employed within these phrases is often left undefined. What does it mean, for example, to "understand" and "respond critically to" the science in the news? And what exactly is a "science component"? One can imagine a range of technically correct responses that disagree with both one another as well as the authors' original vision. Of course, unless carefully qualified, the phrase "understanding science in the news" is similarly flawed. As I have previously stated, determining the exact meaning of "understanding science in the news" is one of the principle aims of this dissertation. As such, its definition, as well as the definition of "understanding," "science," and "news," is a

[1] Why exactly the phrase "understanding science in the news"? As an undergraduate, I took a biochemistry class. On the first day of class, the instructor gave a brief preamble where he listed "understanding science in the news" among the goals of the course. No further explanation was given, but the phrase caught my attention and inspired the refrain used throughout this dissertation.

recurring theme and I will not define them here. I will note, however, that I define the understanding implicit in “understanding science” and “understanding science in the news” in terms of cognitive knowledge. Omitted are affective (trust, efficacy, etc.) and skills-based (how to plan, organize, etc.) knowledge.

My use of the phrase “science in the news” undoubtedly warrants more immediate clarification. Here I am referring to a singular entity—one that is related to “science,” but that ultimately requires its own way of knowing. I will talk at length about the distinction between “science in the news” and “science” in Chapter Four, but I will differentiate them here in brief, for clarity’s sake. Broadly, the phrase “science in the news” refers to the “science” transmitted in the news that has been shaped by journalists, editors, scientists, and even the public. As a result, the “science in the news” is an entity that has been shaped, in part, by the values of journalism. On the other hand, “science” as I use it here is body of knowledge generated by science professionals who conduct investigations, their attitudes and beliefs, the processes those professionals use, and the communities they operate within. As I will argue, there are issues of news production and practice—like editorial constraints or timeliness—that shape “science in the news” and differentiate it from “science” that should not be overlooked. My aim in doing this is not to argue what does and does not count as “science,” but instead, to suggest that the ability to recognize and respond to issues of news practice and production is a key component of understanding science in the news, and one reason why we cannot define understanding science in the news solely in terms of science.

Opposition to a concept being defined “in terms of science” typically stems from an objection to defining that concept in terms of what the scientific community believes the public should know about science. This objection is most often deployed by scholars who oppose defining scientific literacy in terms of what the scientific community believes should be known and appreciated about scientific enterprise (e.g., Wynne, 1991; Layton, Jenkins, MacGill, and Davey, 1993; Jenkins, 1997). My objection to science in the news being defined "in terms of science" here has a slightly different meaning. My argument is less about objecting to what the scientific community says the public should know about science in the news than opposing the idea that science in the news might be understood in essentially the same terms as science.

This idea—that "science in the news" might stand apart from "science"—has its origins in the work of Walter Lippmann, who argues that the "nature of news" separates its content from the "truth" (1922, p. 340). He suggests that the press is "too frail to carry the burden" of delivering a reliable picture of the "whole of public life," including science and scientific issues. Lippmann observes that, "when we expect [the news] to supply such a body of truth we employ a misleading standard of judgment. We misunderstand the limited nature of news" (p. 362). Lippmann's argument focuses on philosophical ramifications of entrusting the news with the translation of society. Given the nature of the news, Lippmann suggests, "it is not even thinkable" that we should consider the news an "organ of direct democracy" (p. 363). Since Lippmann, scholars from a variety of fields—sociology and communication, to name a few—have written about the role of mass media in the distribution of "truth" and democracy (e.g., Schudson, 2003; Benkler, 2006; Barney, 2008). As for mass media's role in the distribution of science, Gruenberg (1935) echoes Lippmann's concerns, suggesting that "if science, as a mode of dealing with problems, is to be effectively assimilated by the public, it would seem to be necessary to supplement the journalistic function of newspapers with forms of comment that will bring out the cultural and philosophical implications of the 'news,' as distinguished from the economic or technical applications [the applications of science most frequently reported by news media]" (p. 95-96).

More recently, the field of mass communication has addressed the distinction between "science" and "science in the news" in terms of *popularization*, the somewhat controversial process of translating technical and scientific information into a "simpler" idiom as a means of broadcasting scientific information to the public (Lewenstein, 1992, p. 45). According to this view, the differentiation between "science" and "science in the news" is considered a "distortion" between "popular" and "genuine" science (Hilgartner, 1990). That is, the extent to which "science in the news" is a faithful reproduction of "science." Yet while this body of research acknowledges the distinction between "science in the news" and "science," the features of "science in the news" are still primarily conceived in terms of science. For example, past research has examined the overall impact of science news messages on public perception of and knowledge about science, and how journalists might distort or reframe scientific issues in ways that deviate from the scientific ideal (see Dunwoody, 1999; Nesbit, Scheufele, Shanahan, Moy, Brossard, and Lewenstein, 2002). This dissertation expands on the arguments put forth in these and other works on the relationship between "science" and "science in the news" to make a case for the importance of recognizing that "science in the news" is a version of "science," not its abbreviated equivalent.

I use the phrase "science in the news" to isolate the science that appears in the news from the science that appears anywhere else in mass media. (The term "mass media" refers to any medium of communication that reaches a large number of people.) In this work "science in the news" means the science reported in newspapers, television, radio, magazines, and Internet news sites, such as *Daily Kos* or *Slate*. Two notable sources of science information excluded from this list are social media, like Facebook and Twitter, and entertainment media, like television's *CSI* and *Bones*. While these types of media are unquestionably a major source of scientific information, the information presented by these media are not subject to the same sort of scrutiny as the information presented by news media (Brewer and Ley, 2010). Twitter, for example, has been used to help organize and disseminate information during major events like the 2008 California wildfires, the January 2009 crash of US Airways flight 1549 into the Hudson River, and the social uprisings in Egypt and other countries in 2011 (Sutton, Palen, and Shklovski, 2008; Fox, Zickuhr, and Smith, 2009; Ghannam, 2011). While the democratized form of information produced by Twitter and other social networks clearly has value and is *some* form of news, the guiding principles of these media differ from more "traditional" news media (Emmett, 2009; Ahmad, 2010; Armstrong and Gao, 2010a). Moreover, there are tacit differences between how we interact with entertainment and social media that influence the various ways we understand, interpret, and respond to the information they present (Gee and Hayes, 2011). This is particularly true of social media, where there are issues related to the widespread use of hyperlinks (Eveland and Dunwoody, 2001; Eveland and Dunwoody, 2002; Eveland, Cortese, Park, and Dunwoody, 2004) and its role in the creation and distribution of information (Armstrong and Gao, 2010b). For these reasons, they are excluded from this dissertation.

A second motivation for my use of the phrase "science in the news" is to distinguish the science reported across *all* news (politics, business, travel, etc.) from the science that is reported in a designated science section (or segment). This section is often called the "science news." For example, one might refer to the science section of *Newsweek* as the "science news." Therefore, for the purposes of this dissertation, the "science news" is the medium that delivers information about science; "science in the news" is the science that appears anywhere in the news regardless of thematic distinction.

The phrase "science in the news" can be used in different ways by different disciplines. Some in the field of informal science education, for example, consider the "science in the news" as either a setting for science learning or means of transmitting scientific information, not an entity capable of being more or less understood (e.g. Rennie, 2007; Stocklmayer, Rennie, and Gilbert, 2010). For example, the National Research Council (NRC) (2009) report *Learning Science in Informal Environments: People, Places, and Pursuits* portrays science in the news as a context or tool for learning. The conceptualization of "understanding science in the news" encountered in the NRC report largely focuses on the impact of the medium—print, electronic, television, etc.—on science learning, rather than the message. My interest in "science in the news" concerns the types of knowledge needed to make sense of the science that appears in the news ("the message"), not the medium that delivers it.

What is a Functional Understanding of Science in the News?

The title of this dissertation is: *The Argument for a Functional Understanding of Science in the News*. Here, the term "functional" serves two purposes. First, I mean to rescue the notion of understanding science in the news from its current unusable form—that is, to make it functional. Second, I mean to invoke Ryder's (2001, 2002) definition of "functional scientific literacy," a conceptualization that has its origins in the multiple arguments for scientific literacy. In 1987, Thomas and Durant assembled an overview of the arguments for why people should understand science. Millar (1996) later translated (and critiqued) these arguments to apply to scientific literacy, categorizing them into five groups: economic, utilitarian, democratic, social, and cultural.

- The *economic* argument: we need a supply of qualified scientists to maintain and develop the industrial processes on which national prosperity depends.
- The *utilitarian* argument: everyone needs to understand some science to manage the technological objects and processes they encounter in everyday life.
- The *democratic* argument: in a democracy, it is desirable that as many people as possible can participate in decision-making; many important issues involve science and technology; everyone should understand science in order to be able to participate in discussion, debate, and decision-making about these.
- The *social/cultural* argument: science is a major cultural achievement; everyone should be enabled to appreciate it.

Ryder's argument for a functional scientific literacy is a further refinement of this list. Ryder defines functional scientific literacy as the "science knowledge needed by individuals to enable them to function effectively in specific settings" (2001, p. 3). This dissertation employs Ryder's notion of "functional" in its broadest sense, discussing the types of knowledge—scientific or otherwise—that enable individuals to "function effectively" when they encounter science in the "specific setting" of news.

Conclusion: The Goals of This Dissertation

A considerable motivation for this dissertation is my training and experience as both a science educator and journalist. In journalism school, I was introduced to the notion of "understanding science in the news" as a debate between scientists and journalists. This debate generally focuses on what scientists believe the public should know about science, how far the "science in the news" deviates from that norm, and what that departure means for scientific literacy or public engagement with science (see, for example, Brossard and Shanahan, 2006).

Working in the field of science education has allowed me to consider this debate from an alternative perspective that questions aspects of “understanding” as well. From this viewpoint, one thing is clear: few have imagined the dimensions and characteristics of understanding science in the news in an interdisciplinary way. That is, education researchers talk very little about issues of communication and communication scholars talk very little about issues of science learning. I feel current debates about the relationship between mass media, science, and society could benefit from the considerations raised by an interdisciplinary point of view. The first goal of this dissertation, then, is to bring these two perspectives together to redefine “understanding science in the news” according to research on aspects of understanding science *and* mass media.

Of course, scholarly interest in the relationship between the public and media reports of science is not limited to science education and mass communication—it lies at the intersection of multiple disciplinary domains, including science studies, the public understanding of science, scientific literacy, science communication, and public engagement with science. Although outwardly similar, these domains offer an additional array of opinion regarding the overall purpose and practice of understanding science in the news—from building science content knowledge to promoting the efficacy citizens need to negotiate the science they encounter in everyday life, with a variety of views in between. As a result, asking the seemingly straightforward question “What does it mean to understand science in the news?” produces a range of answers from a number of competing perspectives. One consequence of which has been that discussions about understanding science in the news that occur both between and within these fields are often marked by substantial conceptual confusion. The second goal of goal of this dissertation, then, is to establish a vision of understanding science in the news that presents the expectations and purpose of that understanding in practical, consistent terms that apply across disciplines.

My work will, I hope, be of interest to scholars, educators, journalists, scientists, policymakers, and others interested in improving how the public engages with science and scientific issues both in mass media and beyond. These groups are all somewhat in agreement that, in pursuit of an enhanced relationship between science and society, a public with the capacity to understand science in the news is an important and worthwhile objective. Though their specific rationales may vary, several themes emerge from this common interest, including a commitment to public knowledge of science and an appreciation of the complexities of communicating science to the public. This dissertation has a similar obligation—it does not merely assemble competing perspectives on understanding science in the news for purposes of comparison and contrast, nor does it aim for some universal characterization. Instead, my objective is to assist in the constructive development and retooling of efforts to promote understanding science in the news. It is my hope that this work will provide valuable insights into the intricacies of understanding science in the news and as a result, contribute to how we understand and interpret understanding science in the news as an educational aim and social objective. No longer will “understanding science in the news” be considered a throwaway goal of the science curriculum, but instead, portrayed as an important end in its own right.

References

Ahmad, A.N. (2010). Is Twitter a useful tool for journalists? *Journal of Media Practice, 11*(2), 145-155.

American Academy of Arts and Sciences. (2010). *Science and the Media*. Cambridge, MA: American Academy of Arts and Sciences

American Association for the Advancement of Science (AAAS) (1989). *Project 2061—Science for all Americans*. Washington, DC: AAAS.

American Association for the Advancement of Science (1993). *Benchmarks for science literacy*. New York, NY: Oxford University Press.

Armstrong, C.L. and Gao, F. (2010a). Now tweet this: How news organizations use twitter. *Electronic News, 4*(4), 218-235.

Armstrong, C. L. and Gao, F. (2010b). Gender, twitter and news content. *Journalism Studies, 12*(4), 490-505.

Brewer, P.R. and Ley, B.L. (2010). Media Use and Public Perceptions of DNA evidence. *Science Communication. 32*(1), 93-117.

Brossard, D. and Shanahan, J. (2006). Do They Know What They Read?: Building a scientific literacy measurement based on science media coverage. *Science Communication, 28*(1), 47-63.

Dewey, J. (1922, May 3). Public Opinion. *The New Republic*, *30*, 286-288.

Dooley, K.J. and Corman, S.R. (2002). The dynamics of electronic media coverage. In B.S. Greenberg (Ed.), *Communication and terrorism: Public and media responses to 9/11*, 163-74. Cresskill, NJ: Hampton Press.

Dunwoody, S. (1999). Scientists, journalists and the meaning of uncertainty. In S. M. Friedman, S.M., Dunwoody, S. and Rogers, C.L (Eds.) *Communicating uncertainty: Media coverage of new and controversial science,* 59-80. Mahwah, NJ: Lawrence Erlbaum.

Emmett, A. (2009, December/January) Networking News: Traditional news outlets turn to social networking Web sites in an effort to build their online audiences. *American Journalism Review*. Retrieved from http://www.ajr.org/Article.asp?id=4646.

Eveland, W. P., Jr. and Dunwoody, S. (2001). User control and structural isomorphism or disorientation and cognitive load? Learning from the Web versus print. *Communication Research, 28*, 48–78.

Eveland, W. P., Jr. and Dunwoody, S. (2002). An investigation of elaboration and selective scanning as mediators of learning from the Web versus print. *Journal of Broadcasting & Electronic Media, 46*, 34–53.

Eveland, W.P., Jr., Cortese, J., Park, H., and Dunwoody, S. (2004). How Web Site Organization Influences Free Recall, Factual Knowledge, and Knowledge Structure Density. *Human Communication Research, 30*(2), 208-233.

Fox, S., Zickuhr, K., & Smith, A. (2009, October 21). Twitter and status updating, Fall 2009. *Pew Internet and American Life Project*. Retrieved from http://www.pewinternet.org/Reports/2009/17-Twitter-and-Status-Updating-Fall-2009.aspxv.

Gee, J.P. and Hayes, E.R. (2011). *Learning and Language in the Digital Age.* London: Routledge.

Ghannam, J. (2011) *Social Media in the Arab World: Leading up to the Uprisings of 2011*. Washington, DC: Center for International Media Assistance.

Gregory, J. and Miller, S. (1998). *Science in Public: communication, culture and credibility*. New York, NY: Plenum.

Gruenberg, B.C. (1935). *Science and the Public Mind.* New York, NY: McGraw-Hill.

Hilgartner, S. (1990). The Dominant View of Popularization: Conceptual problems, political uses. *Social Studies of Science*, *20*(3), 519-539.

Hoskins, S.G. (2010). Teaching Science for Understanding: Focusing on Who, What, and Why. In Meinwald, J. and Hildebrand, J.G. (Eds.), *Science and the Educated American: A Core Component of Liberal Education*, 151-179. Cambridge, MA: American Academy of Arts and Sciences.

Hutton, N. (1996). Interactions between the formal UK school science curriculum and the public understanding of science. *Public Understanding of Science, 5*, 41-53.

Jarman, R. and McClune, B. (2002). A survey of the use of newspapers in science instruction by secondary teachers in Northern Ireland. *International Journal of Science Education, 24*(10), 997-1020.

Jenkins, E.W. (1997) Towards a functional public understanding of science. In Levinson, R. and Thomas, J. (Eds.) *Science Today, Problem or Crisis?* 137 – 150. London: Routledge.

Korpan, C. A., Bisanz, G. L., Bisanz, J., and Henderson, J. M. (1997). Assessing literacy in science: Evaluation of scientific news briefs. *Science Education, 81*, 515–532.

Korpan, C.A., Bisanz, G.L., Bisanz, J., and Snyder, J.J. (1999). Reading News Briefs about Science: How Education Is Related to the Questions People Ask. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching. Retreived from http://eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED446924&ERICExtSearch_SearchType_0=no&accno=ED446924.

Layton, D., Jenkins, E., Macgill, S., and Davey, A. (1993). *Inarticulate science? Perspectives on the public understanding of science and some implications for science education.* Leeds, England: University of Leeds.

Lenhart, A. and Fox, S. (2009, February 12). 11% of online adults use Twitter or update their status online: Twitter users are mobile, less tethered by technology. Pew Internet & American Life Project. Retrieved from http://www.pewinternet.org/Reports/2009/Twitter-and-status-updating.aspx.

Lewenstein, B.W. (1992). The meaning of 'public understanding of science' in the United States after World War II. *Public Understanding of Science, 1*, 45-68.

Lippmann, W. (1922). *Public Opinion.* New York, NY: Harcourt, Brace.

McClune, B. and Jarman, R. (2010). Critical reading of science based-news reports: Establishing a knowledge, skills, and attitudes framework. *International Journal of Science Education, 32*(6), 727–752.

Millar, R. (1996). Towards a science curriculum for public understanding. *School Science Review*, *77*(280), 7-18.

Millar, R. (1997). Science education for democracy: What can the school curriculum achieve. In R. Levinson and J. Thomas (Eds.) *Science today: Problems or crisis?* London: Routledge.

Millar, R., & Osborne, J. E. (Eds.). (1998). *Beyond 2000: Science education for the future.* London: Kings College London.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

National Research Council. (2009). *Learning Science in Informal Environments: People, Places, and Pursuits*. Washington, DC: The National Academies Press.

National Research Council. (2011). *Framework for K12 Science Education*. Washington, DC: The National Academies Press.

National Society for the Study of Education. (1947). *Science Education in American schools: Forty-sixth yearbook of the NSSE.* Chicago, IL: University of Chicago Press.

National Society for the Study of Education. (1954). *Mass Media and Education: Fifty-third yearbook of the NSSE.* Chicago, IL: University of Chicago Press.

National Society for the Study of Education. (2005). *Media Literacy: Transforming curriculum and teaching.* Chicago, IL: University of Chicago Press.

Nesbit, M.C., Scheufele, D.A., Shanahan, J., Moy, P., Brossard, D., and Lewenstein, B.V. (2002). Knowledge, Reservations, or Promise?: A media effects model for public perceptions of science and technology. *Communication Research*, *29*, 584-608.

Norris, S. P., & Phillips, L. M. (1994). Interpreting pragmatic meaning when reading popular reports of science. *Journal of Research in Science Teaching, 31*, 947–967.

Norris, S. P., Phillips, L. M., & Korpan, C. A. (2003). University students' interpretation of media reports of science and its relationship to background knowledge, interest and reading difficulty. *Public Understanding of Science, 12,* 123–145.

Phillips, L. M., & Norris, S. P. (1999). Interpreting popular reports of science: What happens when the reader's world meets the world on paper? *International Journal of Science Education*, *21*(3), 317–327.

Ratcliff, M. (1999). Evaluation of abilities in interpreting media reports of scientific research, *International Journal of Science Education, 21* (10), 1085-1099.

Rennie, L.J. (2007). Learning Science Outside of School. In Abell, S.K. and Lederman, N.G. (Eds.). *Handbook of Research on Science Education*, 125 – 167. Mahwah, NJ: Erlbaum.

Rudolph, J.L. (2002). *Scientists in the Classroom: The cold war reconstruction of American science education*. New York, NY: Palgrave Macmillian.

Ryder, J. (2001). Identifying science understanding for functional scientific literacy. *Studies in Science Education*, *36*, 1-44.

Ryder, J. (2002). School science education for citizenship: strategies for teaching about the epistemology of science. *Journal of Curriculum Studies*, *34*(6), 637-658.

Schwarz, G. (2005). What is Media Literacy, Who Cares, and Why? In Schwarz, G. and Brown, P.U. (Eds.), PGS. *Media Literacy: Transforming curriculum and teaching.* Chicago, IL: University of Chicago Press.

Sutton, J., Palen, L., and Shklovski, I. (2008). Backchannels on the Front Lines: emergent uses of social media in the 2007 southern California wildfires. In Fiedrich, F. and Van de Walle, B. (Eds.) *Proceedings of the 5th International Information Systems for Crisis Response and Management Conference (ISCRAM 2008).*

Stocklmayer, S.M., Rennie, L.J, and Gilbert, J.K. (2010). The roles of the formal and informal sectors in the provision of effective science education. *Studies in Science Education, 46*(1), 1-44.

Texas Education Agency. (2010). Texas Essential Knowledge and Skills. Retreived from http://ritter.tea.state.tx.us/rules/tac/chapter112/index.html.

Thomas, G. and Durant, T. (1987). Why Should We Promote the Public Understanding of Science? *Science Literacy Papers, 1*, 1–14.

Wellington, J. (1991). Newspaper science, school science: friends or enemies? *International Journal of Science Education, 13*(4), 363–372.

Wellington, J. (1993). Using newspapers in science education. *School Science Review, 74*(268), 47-52.

Wisconsin Department of Public Instruction. (2009). *Wisconsin Common Core State Standards*. Retreived from http://dpi.wi.gov/standards/scih8.html.

Chapter 2: Understanding Science and Understanding Science in the News

One common reason scholars and policymakers argue for building citizens' understanding of science in the news is that it relates to understanding science in some fundamental way. That is, an individual's understanding of science in the news is frequently assumed to directly correlate with the extent of that individual's knowledge about science. Seemingly, this makes good sense. The news illustrates the impact of science on society, provides insight about its capabilities and limitations in human progress, and enlists some mastery of scientific terms, concepts, and theories. As a result, the notion of understanding science in the news implies not only some mastery of science content, but the ability to critically evaluate scientific issues as well. Here is where the case for linking understanding science and understanding science in the news often rests, its relation seemingly self-evident.

There are, however, two difficulties with this argument. First, the exact nature of the relationship between understanding science in the news and understanding science is ambiguous—missing is a clear sense of how understanding science in general applies to understanding science in the news, and vice versa. Second, the "understanding" involved in understanding science should not be correlated with the "understanding" implicit in understanding science in the news in an unproblematic way. As I will suggest, understanding science in the news is supported *in part* by understanding science, but has an epistemology all its own. Before proceeding with this argument, however, the problem of demarcation between understanding science and understanding science in the news must first be addressed. In this chapter, I argue that by examining the types of knowledge necessary for understanding science and understanding science in the news, the conceptual boundary between these two domains becomes clear.

Understanding Science

The ability to understand *something* of science and the capacity of that understanding for "good" have been widely embraced across multiple disciplines as a remedy for a number of social, economic, cultural, and other ills (Thomas and Durant, 1987; Millar, 1996). By understanding science, the argument typically runs, people can decipher new information and solve novel problems with a science component for the benefit of both individuals themselves and society as a whole—that is, they possess the ability to reflect upon, articulate, and apply scientific knowledge for personal and public gain. According to the National Research Council (2011), to develop understanding in an area of inquiry, students must (a) have a deep foundation of factual knowledge (b) understand facts and ideas in the context of a conceptual framework (c) organize knowledge in ways that facilitate retrieval and application. At the core of this vision for understanding are *knowledge* and the *application*. One way we might think about understanding science, then, is as an amalgam of conceptual knowledge about science and the ability to apply that knowledge (Figure 1). Knowledge of any kind is largely useless without application, and application without knowledge cannot reasonably be considered a worthwhile educational aim. Instead, it is some combination of these two that gives rise to what is commonly referred to as "understanding science."

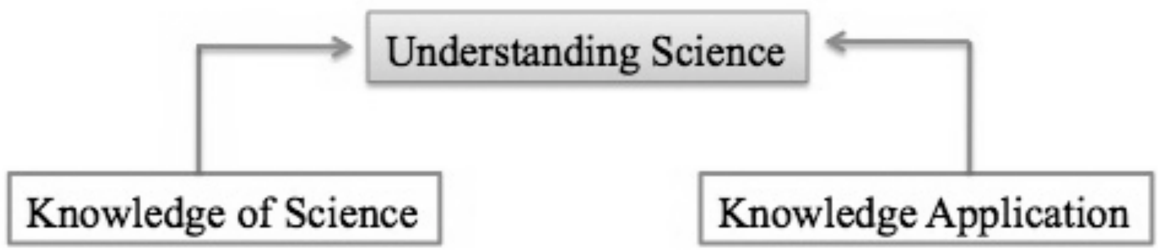

Figure 1. Visualizing understanding science. Understanding science is an amalgam of conceptual knowledge about science and the knowing how and when to apply that knowledge.

Of course, this is an oversimplification of a complex phenomenon—understanding, scientific or otherwise, is a complicated, emergent mental process. Any issue or idea may be understood in a number of ways and on a number of levels (Millar and Wynne, 1988; Layton, Jenkins, MacGill, and Davey, 1993; Irwin and Wynne, 1996; Carpenter and Lerher, 1999). The goal here, then, is not to supply a rigid definition of "understanding science" in terms of knowledge and application, but to instead provide a way of visualizing how knowledge of science and the application of that knowledge come together to support the broader goal of understanding science.

Defining understanding science in terms of knowledge of science and its application, however, suggests that these terms are well-defined entities. In truth, they are indefinite and frequently the subject of critical examination themselves. There is, for example, a significant amount of scholarly attention devoted to knowledge about science. Identifying what counts as knowledge about science proves a particularly challenging task. On the one hand, there is the canonical view of scientific knowledge, which looks to the products and processes of science itself to determine what does and does not count as knowledge about science (e.g. Miller, 1983, 1987, 1992, 1998). This includes knowledge of scientific methods, such as experimental design, the importance of theory and hypothesis testing (Bauer, Allum, and Miller, 2007). On the other hand, there is also a view of scientific knowledge that takes considerations other than those of science into account. This view includes knowledge about situations with a scientific component, or situations citizens are likely to encounter science in out-of-school contexts. This vision of scientific knowledge is rooted in science-related situations or contexts, where science has a role, but other factors, like trust and efficacy, also contribute (Wynne, 1991; Durant, Evans, and Thomas, 1992; Shapin, 1992; Collins and Pinch, 1993; Layton *et al.*, 1993; Durant, 1993; Millar, 1997; Shapin, 1998).

Another contested area related to knowledge of science is determining what exactly citizens need to know about science. Attempts to quantify the types of scientific knowledge citizens need to confront larger questions about science and science-related issues have been occurring for more than a century, from the educational themes suggested in the National Education Association's *Report of the Committee of Ten* (1894) to the more recent efforts of the National Research Council (2009, 2011) devoted to learning science in informal environments. Indeed, debates about many aspects of scientific knowledge remain unsettled. This makes the job of communicating its definition a delicate exercise for there is not one definition of "knowledge of science," but several. Nor is there only one *type* of knowledge—in the conceptualizations of scientific knowledge I have just described, "knowledge" is depicted in both cognitive and affective terms. To address the multiple ways scientific knowledge might be defined, then, in the next section I will define scientific knowledge in its largest sense, from knowing "facts" about science to understanding scientific enterprise itself. Because this dissertation is primarily concerned with cognitive knowledge about science, I will only be discussing scientific knowledge that fits that description, before moving on to define "knowledge application," the second component of scientific understanding.

Knowledge of Science

In its broadest sense, knowledge of science may be described as both knowledge about the natural world and knowledge about science as an institution. Education researcher Jim Ryder (2002) differentiates these two aspects by calling them: *knowledge in science* and *knowledge about science*. Knowledge in science is defined as knowledge of the facts, laws, concepts, and theories that make up the body of accepted scientific knowledge about the natural world. For example, knowing that antibiotics kill bacteria (not viruses) or that the earth revolves around the sun (but the moon revolves around the earth). Of course, determining what is recognized as "accepted scientific knowledge" is no mean feat—scientific experts frequently disagree about what data tells us (Ziman, 1991). Knowing that scientific experts may disagree over the same piece of data is an example of the second type of scientific knowledge—knowledge about science. Knowledge about science is an understanding of how science, as a practice and an institution, really works to generate knowledge (Durant, 1993). In addition to making sense out of disagreements among scientific experts, other examples of knowledge about science include knowledge about collecting and evaluating data, interpreting data, and modeling in science (Millar and Wynne, 1988). This is, however, only a brief introduction to knowledge about science. While defining knowledge *in* science is a relatively straightforward task (it is mostly amassing information about scientific "facts"), knowledge *about* science requires further explication.

According to Ryder (2002), knowledge about science consists of knowledge about the development and use of scientific knowledge. He notes that there is a range of terminology used to identify what counts as this type of meta-knowledge about science, citing knowledge of "methods or processes of science, nature of science, and socio-scientific issues" as examples (p. 639). Broadly, then, we might define knowledge about science as knowledge of (1) the process of scientific inquiry and (2) science as a social enterprise (Figure 2). The first of these—knowledge about the process of scientific inquiry—refers to the procedure and methods used to generate scientific knowledge. Ryder cites the following examples of this type of knowledge: assessing the quality of data, examining the relationship between phenomena and theory, and investigation how conflicts of ideas are resolved in science. This includes knowledge of the step-by-step actions that generate scientific knowledge—the scientific actions, algorithms, steps, and procedures needed to solve problems (Shavelson, Ruiz-Primo, Li, and Ayala, 2003). Miller (1983, 1987) describes this type of knowledge as the ability to define what it means to study something scientifically. This type of knowledge, he argues, allows people to identify the differences between the sciences and the non-sciences (like astrology). Wynne (1991) additionally posits that procedural knowledge of science is necessary so as to appreciate its limits as well as its powers.

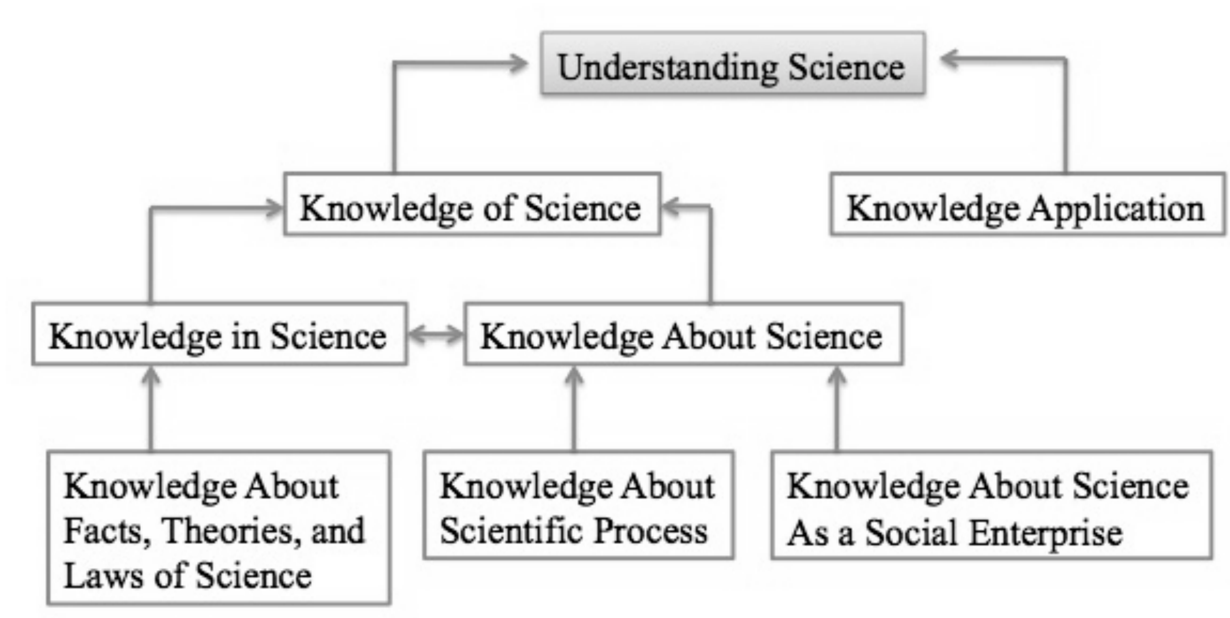

Figure 2. Visualizing Knowledge of Science. Scientific knowledge is composed of conceptual knowledge in science and knowledge about science. Knowledge in science refers to knowledge about the facts, theories, and laws of science. Knowledge about science is composed of knowledge about the processes of science and science as a social enterprise.

In addition to procedural knowledge about science, the second component of knowledge about science is an understanding of science as a social enterprise. This includes knowledge about the relationship between science and society—how science relates to society and vice versa—and knowledge about the social dimension of scientific practice. Knowledge of the relationship between science and society might include an awareness of the public's own role in scientific enterprise, such as how their vote shapes government levels of funding for science. Knowledge of the social dimension of scientific practice concerns an understanding of the institution of science and its politics—what Prewitt (1983) calls "scientific savvy," Wynne (1995) describes as the "body language" of science, and Durant (1993) labels "how science really works." Examples of this type of social knowledge about science include an understanding of how scientists operate within a community and the relationship between research and development. According to Durant, this particular type of scientific knowledge is the key to differentiating reliable and unreliable knowledge—an ability that is itself perhaps the very point of scientific understanding. He argues that it is the professional aspects of science—scientific training, peer review, etc.—that generate scientific knowledge. As a result, in order to "understand science" what the public needs is "a feel for the way the social system of science actually works to deliver what is usually reliable knowledge about the natural world" (p. 136).

As the above explanation of "the social system of science" demonstrates, the distinction between knowledge *in* science and knowledge *about* science is highly artificial. As Gregory and Miller (1998) point out, "in order to understand how science really works, one also needs to understand quite a lot of science" (p. 91). Knowing "a lot" of science, however, is not the same thing as *understanding* science (Durant, 1993). Durant argues that knowing scientific facts, concepts, and theories is a fine achievement, but having knowledge *in* science does not necessarily indicate one understands the implications of those facts for the natural world, nor their significance to the wider pursuit we call "science." Instead, it some combination of knowledge in science *and* knowledge about science that generates the broader goal of "scientific knowledge."

Knowledge Application

In addition to knowledge of science, a complete conceptualization of "scientific understanding" also includes knowledge application. For scientific understanding, one must, in addition to conceptual knowledge about science, also know when and how to apply that knowledge (Dewey, 1916; Layton, 1987; Lave, 1988; Shavelson, Ruiz-Primo, and Wiley, 2005). I am not referring to the application of knowledge as a means of "doing" science here (i.e. bench work, data collection and analysis, etc.), although that is certainly one way scientific knowledge may be applied (Gallagher, 2000). Instead, I am referring to the application of scientific knowledge across contexts, from the laboratory to the classroom to everyday life. In order to accomplish this goal, one needs more than a string of memorized facts—one needs the capacity to make sense of and connections among those facts as well. This is the difference between, say, knowing that plants "breathe" carbon dioxide and "release" oxygen (recall, memorization), and inferring that as a result of this "exchange" most of a plant's biomass comes from carbon dioxide (sense-making, making connections among knowledge). It is this ability to connect facts to other facts and draw on that new knowledge to make sense of the natural world that is arguably the more desirable form of scientific understanding (American Association for the Advancement of Science, 1989; National Research Council, 1996). Equipped with such understanding, individuals can then apply their knowledge to solve unfamiliar problems and come to terms with important issues raised by scientific advances. Without this understanding, however, knowledge exists merely as isolated facts and cannot be applied to learn new knowledge (Carpenter and Lerher, 1999). Or, as Dewey (1946) eloquently puts it, "understanding has to be in terms of how things work and how to do things. Understanding, by its very nature, is related to action: just as information, by its very nature, is isolated from action" (p. 49). For Dewey, this connection between knowledge and its application is essentially what understanding is about.

Recent studies in the field of sociology of science have revealed an individual decides to take action about science or a science-related issue for a variety of reasons—understanding science may or may not be one of them (Wynne, 1992; Layton, Jenkins, MacGill, and Davey, 1993). Therefore, the relationship between understanding science and action is most likely a matter of degree (Figure 3). The left end of this theoretical continuum signifies *understanding with action* (e.g. action motivated by knowledge of radiation) and the right represents *understanding without action* (e.g. action motivated by anything else, like fear of radiation), with a variety of levels in between.

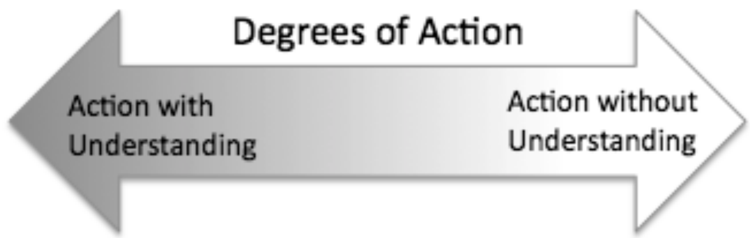

Figure 3. Degrees of action. The relationship between "action" and "understanding."

So what might knowledge application look like? The work of Shavelson, Ruiz-Primo, Li, and Ayala (2003) offers one way we might think about the relationship between scientific knowledge and its application from a Deweyian perspective. They have constructed a model where knowledge cannot be easily separated from its application. Shavelson *et al.* visualize the application of scientific knowledge—what they call "science achievement"—as a series of knowledge domains (Figure 4). These include: *declarative* knowledge ("knowing that"), *procedural* knowledge ("knowing how"), *schematic* knowledge ("knowing why") and *strategic* knowledge ("knowing when, where and how our knowledge applies") (p.7-8).

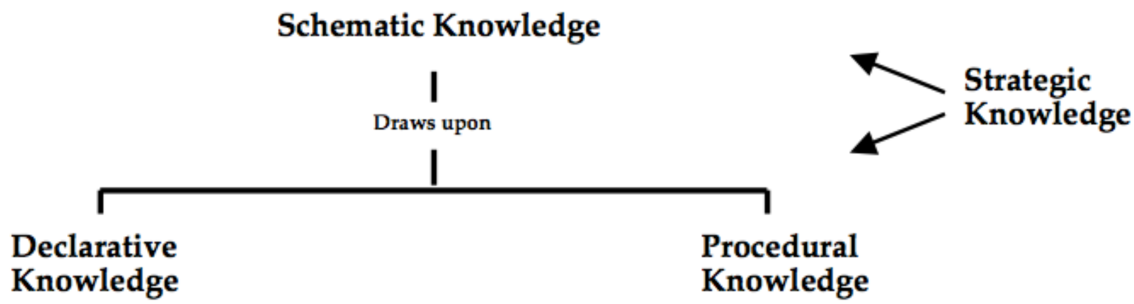

Figure 4. A Knowledge Framework. Shavelson *et al*.'s (2003) knowledge framework for science achievement (p. 8).

Shavelson *et al.* define declarative knowledge as factual knowledge about science. For instance, "knowing that" photosynthesis takes place in chloroplasts or that acceleration is any change in motion, not just speeding up. Declarative knowledge is typically expressed in the form of terms, statements, descriptions, or data. For example, a statement like, "photosynthesis involves the green pigment chlorophyll" is a description of photosynthesis. The next domain is procedural knowledge, which involves knowing how to do something, like "knowing how" to measure latitude or longitude. More broadly, procedural knowledge includes knowing how to describe natural phenomena using scientific facts and theories, verify evidence, and construct and organize ideas. Next, there is schematic knowledge. This entails knowing why a phenomenon occurs, like "knowing why" Santa Fe is in a different time zone than Baltimore . Shavelson *et al.* describe schematic knowledge as having "a scientifically justifiable 'model' or 'conception' that explains the physical world. Schematic knowledge includes principles, schemes, and mental models" (p. 8). Finally, there is *strategic* knowledge. Strategic knowledge is a culmination of sorts—it entails knowledge of when, where, and how knowledge applies. According to Shavelson *et al.*

> Strategic knowledge includes domain-specific conditional knowledge and strategies such as planning and problem-solving as well as monitoring progress toward a goal. People use strategic knowledge to recognize the situations where some procedures can be carried out, to examine the features of tasks in order to decide what schematic knowledge can be applied, to set task goals, or to control and monitor cognitive processing (p. 8).

To translate, strategic knowledge allows one to make sense of scientific information by building connections between new information and existing ideas. Shavelson, Ruiz-Primo, and Wiley (2005) describe strategic knowledge as one way scientific experts may be delineated from lay people. They cite the following example, originally put forth by Chi, Feltovich, and Glaser (1981): "experts know when to apply Newton's first law given a problem to solve dealing with force and motion whereas novices are attracted to the surface features of the problem" (p. 414).

Incorporating Shavelson *et al.*'s terms of knowing that/how/why/when into the model of understanding science described above effectively demonstrates the key role of application in the process of understanding (Figure 5). In this new conceptual model, Ryder's "knowledge in science" and "knowledge about science" becomes Shavelson *et al.*'s "knowing that" and "knowing how". These two notions now come together to create "schematic knowledge" ("knowing why"), instead of "knowledge of science." The most significant alteration to the prior model concerns the role of knowledge application. Whereas knowledge and application were previously described as separate entities, by incorporating the Shavelson *et al.* conceptualization of "strategic knowledge," or knowing when, where, and how knowledge applies in a given situation or context, application itself becomes a form of knowledge. The model now shows how application and knowledge work together to form the broader goal of understanding. For example, "knowing that" aquatic life functions best in a pH range of 6.0 to 9.0 accomplishes very little on its own. But if one applies that knowledge to "know when" a body of water is susceptible to fluctuations in pH, one can act to adjust the alkalinity of the water. It is this capacity—to make connections among knowledge and apply it accordingly—that he was referring to when he wrote that "understanding, by its very nature, is related to action" (1946, p. 49).

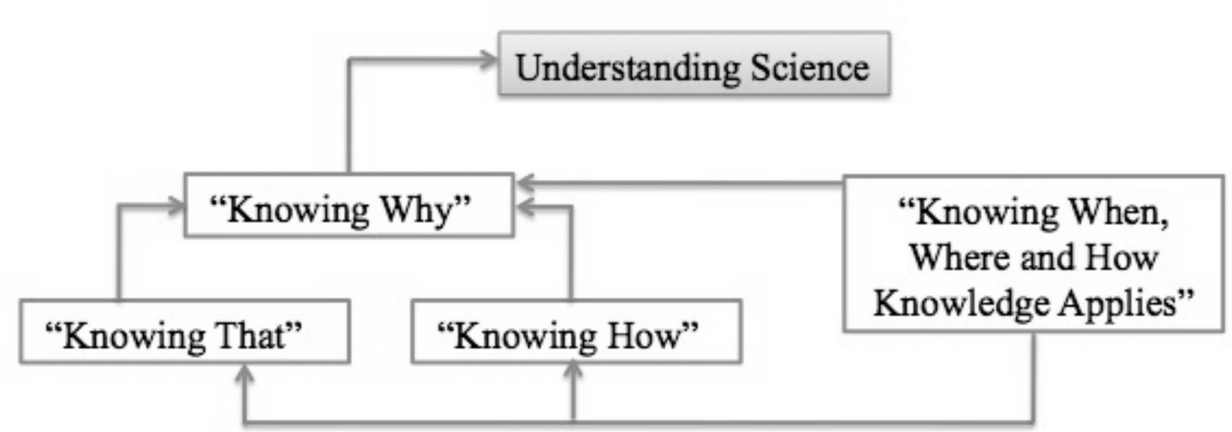

Figure 5. Model of Understanding Science. By translating the model of understanding science into the terms of Shavelson, Ruiz-Primo, Li, and Ayala (2003), the relationship between knowledge and application is clear.

The Relationship between Understanding Science and Understanding Science in the News

In looking over the features and goals of understanding science, the link between understanding science and "understanding science in the news" seems clear enough—news media offers an array of social, cultural, and other contexts for applying any and all forms of science knowledge. Indeed, a central component of understanding science in the news is making sense of new information and making connections between new and old ideas about science. This is where current working notions of "understanding science in the news" typically stop, defining the understanding implicit in understanding science in the news as the application of knowledge of science in the context of news. Simply put, they conceive "understanding science in the news" as understanding science by any other name. Many of these accounts emanate from a particular subset of the research literatures from multiple fields that address *scientific literacy*, a term that describes the ability to understand, interpret, and apply knowledge about science in a variety of contexts across modern life. In pursuit of scientific literacy, scholars have envisioned "understanding science in the news" for purposes of both pedagogy (e.g., Wellington, 1991; Jarman and McClune, 2007) and assessment (e.g., Miller, 1983; Wellington, 1993; Norris and Phillips, 1994; Ratcliffe, 1999; Brossard and Shanahan, 2006).

Scientific literacy is a part of the ongoing debate about what the public should know about science (Hurd, 1958; Shen, 1975; Miller, 1983; Thomas and Durant, 1987; Durant, Evans, and Thomas, 1989; Lewenstein, 1992; Millar, 1997; Roberts, 2007; Turner, 2008; Feinstein, 2010). Many scholars argue that an individual should have *some* level of scientific literacy to effectively contribute to and participate in an increasingly scientific and technological society. Yet scientific literacy is widely recognized as a multiply ambiguous concept—the research literature is replete with references to the indeterminate nature of scientific literacy, where it is often dismissed as a catchy slogan or a vague concept too broadly defined to be useful.[2] The notion of "understanding science in the news" frequently appears in the substantial literature devoted to defining, assessing, and clarifying this problematic concept (e.g., Shen, 1975; Miller, 1983; Prewitt, 1983; Hazen and Trefil, 1991; Norris and Phillips, 1994; Korpan, Bisanz, Bisanz, and Henderson, 1997; Zimmerman, Bisanz, and Bisanz, 1998; Brossard and Shanahan, 2006;

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[2] A full description of the multifaceted concept of scientific literacy is beyond the scope of this dissertation. For a complete conceptual overview, see Roberts (2007).

Jarman and McClune, 2010). Shen, for example, defines scientific literacy as “an acquaintance with science, technology, and medicine, popularized to various degrees…through information in the mass media” (p. 45). Brossard and Shanahan suggest that, “if citizens know scientific and technological terms they see frequently in the media, one could argue that they are scientifically literate within the bounds of normal civic discourse. If, on the other hand, people do not show familiarity even with terms that are frequently covered in the media, their literacy can be termed low” (p. 51). And Hazen and Trefil posit that “if you can understand the news of the day as it relates to science, if you can take articles with headlines about genetic engineering and the ozone hole and put them in meaningful context—in short, if you can treat news about science in the same way that you treat everything else that comes over your horizon, then…you are scientifically literate” (p. xii). One of the most common (and compelling) arguments for civic scientific literacy, in fact, prominently features the notion of understanding science in the news.

Current scholarship posits that, in a democratic society, the public accountability of science depends, in part, on a public in possession of those skills that “best” represent modern civic participation—discussion, debate, and decision-making (Millar, 1997; Millar and Osborne, 1998; Jenkins, 1999). Mass media are often viewed as substitute or “symbolic sites” for debates about science, among other things (Gumpert and Drucker, 1994). As a result, there is a growing amount of scholarly interest in the public’s capacity to interpret and respond to the science and scientific issues reported there (e.g., Miller, 1998; Nisbet, Scheufele, Shanahan, Moy, Brossard, and Lewenstein, 2002; Bennett, 2003; Davies, 2004; Brossard and Shanahan, 2006). According to Davies, the issues reported in mass media demonstrate both the need and the opportunity to develop a vital form of “scientific understanding,” eloquently arguing that through our attempts to resolve science in the news we “define ourselves and, hopefully, understand what we mean by what it is to be a citizen and, by extension, human" (p. 1751). Kolstø (2001) similarly argues, "when focusing on democratic participation … it is important to gain insights into how [citizens] deal with socio-scientific issues presented and discussed in the media" (p. 879).

By committing to this particular vision of scientific literacy—one that focuses on science in the news—these works have advanced the cause for enhancing public levels of understanding science in the news. In their inattention to ultimate goals, however, they have simultaneously corrupted its meaning. Science literacy scholars have typically cast the knowledge at the center of these efforts as some version of science knowledge. There is a common assumption among policymakers, scientists, and educators that knowing something of science grants individuals the capacity to recognize misinformation and "bad" science reported in mass media (see Bodmer, 1985). That is, that understanding science in and of itself enables understanding science in the news. Few have questioned this assumption, and, as a result, the exact nature of the knowledge needed to understanding science in the news remains mostly unknown. In the next chapter, I explore the competing, even conflicting, ways that knowledge has been imagined in the scientific literacy research literature.

References

American Association for the Advancement of Science (AAAS) (1989). *Project 2061—Science for all Americans*. Washington, DC: AAAS.

Bauer, M.W., Allum, N., and Miller, S. (2007). What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science*, *16*, 79-95.

Bennett, J. (2003). *Teaching and learning science: A guide to recent research and its applications*. London, UK: Continuum.

Bodmer, W. (1985). *The Public Understanding of Science.* London, UK: Royal Society.

Brossard, D. and Shanahan, J. (2006). Do They Know What They Read?: Building a scientific literacy measurement based on science media coverage. *Science Communication, 28*(1), 47-63.

Carpenter, T. P. and Lehrer, R. (1999). Teaching and learning mathematics with understanding. In E. Fennema & T. R. Romberg (Eds.), *Mathematics classrooms that promote understanding* (pp. 19-32). Mahwah, NJ: Lawrence Erlbaum Associates.

Chi, M.T.H., Feltovich, P.J., and Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science*, *5*, 121-152.

Collins, H. M. and Pinch, T. (1993). *The Golem: what everyone needs to know about science*. Cambridge, UK: Cambridge University Press.

Committee of Ten. (1894). Report of the Committee of Ten on secondary school studies. Washington, DC: National Education Association of the United States.

Davies, I. (2004) Science and citizenship education. *International Journal of Science Education*, *26*(14), 1751-1763.

Dewey, J. (1916). Method in science teaching. *General Science Quarterly, 1*(1), 3-9.

Dewey, J. (1946). *Problems of men*. New York, NY: Philosophical Library.

Durant, J. (1993). What is scientific literacy? In Durant, J. and Gregory, J. (Eds.), *Science and Culture in Europe* (129-138). London, UK: Science Museum.

Durant, J., Evans, G.A., and Thomas, G.P. (1989). The public understanding of science. *Nature*, *340*, 11-14.

Durant, J., Evans, G.A., and Thomas, G.P. (1992). Public understanding of science in Britain: the role of medicine in the popular representation of science. *Public Understanding of Science*, *1*, 161-182.

Feinstein, N. (2010). Salvaging Science Literacy. *Science Education, 95*(1), 168-185.

Gallagher, J.J. (2000). Teaching for understanding and application of science knowledge. *School Science and Mathematics.*

Gregory, J. and Miller, S. (1998). *Science in Public: communication, culture and credibility*. New York, NY: Plenum.

Gumpert, G. and Drucker, S.J. (1994). Public Space and Urban Life: Challenges in the Communication Landscape. *Journal of Communication, 44*(4), 169-177.

Hazen, R.M. and Trefil, J. (1991) *Science matters. Achieving scientific literacy*. New York, NY: Anchor Books Doubleday.

Hurd, P. D. (1958). Science literacy: Its meaning for American schools. *Educational Leadership*, *16*(13–16), 52.

Irwin, A. and Wynne, B. (1996). *Misunderstanding science? The public reconstruction of science and technology*. Cambridge, UK: Cambridge University Press.

Jarman, R. and McClune, B. (2007). *Developing scientific literacy*. Maidenhead, UK: Open University Press.

Jenkins, E.W. (1999) School science, citizenship and the public understanding of science. *International Journal of Science Education, 21*(7), 703-710.

Kolstø, S.D. (2001). Scientific literacy for citizenship: Tools for dealing with the science dimension of controversial socioscientific issues. *Science Education, 85*(3), 291-310.

Korpan, C.A., Bisanz, G.L., Bisanz, J., and Henderson, J.M. (1997). Assessing literacy in science: Evaluation of scientific news briefs. *Science Education, 81,* 515-532.

Layton, E.T. (1987). Through the Looking Glass, or news from lake mirror image. *Technology and Culture. 28*(3), 594-607.

Layton, D., Jenkins, E., Macgill, S., and Davey, A. (1993). *Inarticulate science? Perspectives on the public understanding of science and some implications for science education.* Leeds, UK: University of Leeds.

Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. Cambridge, UK: Cambridge University Press.

Lewenstein, B. (1992). The meaning of public understanding of science in the US after World War II. *Public Understanding of Science, 1*, 45-68.

McClune, B. and Jarman, R. (2010). Critical reading of science-based news reports: Establishing a knowledge, skills, and attitudes framework. *International Journal of Science Education, 32*(6), 727-752.

Millar, R. (1996). Towards a science curriculum for public understanding. *School Science Review*, *77*(280), 7-18.

Millar, R. (1997). Science education for democracy: What can the school curriculum achieve. In R. Levinson and J. Thomas (Eds.) *Science today: Problems or crisis?* London: Routledge.

Millar, R. and Osborne, J. E. (1998). *Beyond 2000: Science education for the future.* London: Kings College London.

Millar, R. and Wynne, B. (1988). Public understanding of science: from contents to processes. *International Journal of Science Education*, *10*(4), 388-398.

Miller, J. D. (1983). Scientific literacy: A conceptual and empirical review. *Daedalus, 112*, 29-48.

Miller, J. D. (1987). Scientific literacy in the United States. In D. Evered and M. O'Connor (Eds.), *Communicating science to the public* (19-40). Chichester, UK:Wiley.

Miller, J.D. (1992). Toward a Scientific Understanding of the Public Understanding of Science and Technology. Public Understanding of Science, *1*(1), 23-26.

Miller, J. D. (1998). The measurement of civic scientific literacy. *Public Understanding of Science, 7*, 203-23.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

National Research Council. (2009). *Learning Science in Informal Environments: People, Places, and Pursuits*. Washington, DC: The National Academies Press.

National Research Council. (2011). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: National Academies Press.

Nisbet, M.C., Scheufele, D.A., Shanahan, J., Moy, P., Brossard, D., and Lewenstein, B.V. (2002). Knowledge, reservations, or promise?: A media effects model for public perceptions of science and technology. *Communication Research*, *29*(5), 584-608.

Norris, S.P. and Phillips, L.M. (1994). Interpreting pragmatic meaning when reading popular reports of science. *Journal of Research in Science Teaching, 31*(9), 947-967.

Prewitt, K. (1983). Scientific literacy and democratic theory. *Daedalus*, *112*, 49–64.

Ratcliffe, M. (1999). Evaluation of abilities in interpreting media reports of scientific research. *International Journal of Science Education, 21*(10), 1085-1099.

Roberts, D. A. (2007). Scientific literacy/science literacy. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research in science education* (729 – 779). Mahwah, NJ: Erlbaum.

Ryder, J. (2001). Identifying science understanding for functional scientific literacy. *Studies in Science Education*, *36*, 1-44.

Ryder, J. (2002). School science education for citizenship: strategies for teaching about the epistemology of science. *Journal of Curriculum Studies*, *34*(6), 637-658.

Shapin, S. (1992). Why the public ought to understand science-in-the-making. *Public Understanding of Science, 1*(1): 27- 30.

Shapin, S. (1998). Placing the view from nowhere: Historical and sociological problems in the location of science. *Transactions of the Institue of British Geographers, 23*, 5-12.

Shavelson, R., Ruiz-Primo, M.A., Li, M., and Ayala, C.C. (2003). Evaluating new approaches to assessing learning. *CSE Report 604*. Los Angeles: University of California, Los Angeles, Center for the Study of Evaluation (CSE).

Shavelson, R., Ruiz-Primo, M.A., and Wiley, E.W. (2005). Windows into the mind. *Higher Education*, *49*, 413-430.

Shen, B. S. P. (1975). Science literacy and the public understanding of science. In S. B. Day (Ed.), *Communication of scientific information* (44 – 52). New York, NY: S. Karger and A. G. Basel.

Thomas, G. and Durant, T. (1987). Why Should We Promote the Public Understanding of Science? *Science Literacy Papers, 1*, 1–14.

Turner, S. (2008) School science and its controversies; or, whatever happened to scientific literacy? *Public Understanding of Science*, *17*, 55-72.

Wellington, J. (1991). Newspaper science, school science: friends or enemies? *International Journal of Science Education*, *13*(4), 363-372.

Wellington, J. (1993). Using newspapers in science education. *School Science Review, 74*(268), 47-52.

Wynne, B. (1991). Knowledges in Context. *Science, Technology & Human Values*, *16*(1), 111-121.

Wynne, B. (1995) Public understanding of science. In Jasanoff, S., Markle, G., Pinch, T. and Petersen, J. (Eds.) *Handbook of Science and Technology Studies* (361–388). London, UK: Sage.

Zimmerman, C., Bisanz, G.L., and Bisanz, J. (1998). Everyday Scientific Literacy: Do Students Use Information about the Social Context and Methods of Research To Evaluate News Briefs about Science? *Alberta Journal of Educational Research*, *44*(2), 188-207.

Chapter 3: Examining the Relationship between Understanding Science in the News and Scientific Literacy

In order to establish a more accurate description of the nature and practice of scientific literacy, a growing number of researchers have turned to the science in the news as a means of achieving clarity (e.g. Millar and Wynne, 1988; Korpan, Bisanz, and Bisanz, 1997; Phillips and Norris, 1999; Ryder, 2001). Looking over the various definitions of and rationales for scientific literacy that have adopted this approach, one encounters a number of versions of the knowledge necessary to understand science in the news. This knowledge has generally been portrayed in one of two ways—as either an *indicator* of scientific literacy (if you can understand science in the news, then you are scientifically literate) or a *component* of scientific literacy (if you are scientifically literate, then you can understand science in the news). As a result, determining the exact relationship between scientific literacy and understanding science in the news has become a particularly knotty problem—does understanding science in the news *reveal* that one is scientifically literate, or is it part of what *makes* one scientifically literate? The dilemma this dichotomy poses is real enough. The treatment of "understanding science in the news" as an essential aspect of scientific literacy has assured its place both in the science curriculum and on the academic agenda of multiple disciplines. Its true nature, however, remains unsubstantiated, making its use among educators and researchers as a means of addressing scientific literacy, and other goals related to the public understanding of science, more problematic than has previously been known. In this chapter, I examine three of the most prominent approaches to the relationship between understanding science in the news and scientific literacy, particularly how they imagine the knowledge needed to understand science in the news. I call these the Interpretive Approach, the Vocabulary Approach, and the Media Literacy Approach.

The Interpretive Approach

The interpretive approach to the relationship between scientific literacy and understanding science in the news has its origins in the research tradition that examines scientific literacy from the perspective of literacy studies (e.g., Norris and Phillips, 1994; Phillips and Norris, 1999; Norris, Phillips, and Korpan, 2003) These researchers define scientific literacy in terms of reading and writing—what Norris and Phillips (2003) describe as scientific literacy in its "fundamental sense" (p. 224). Those who employ the interpretive approach place a similar emphasis on reading and writing in their conceptualizations of "understanding science in the news" (e.g., Korpan, Bisanz, Bisanz, and Henderson, 1997; Zimmerman, Bisanz, and Bisanz, 1998; Zimmerman, Bisanz, Bisanz, Klein, and Klein, 2001; Osborne, 2002; Jarman and McClune, 2007; McClune and Jarman, 2010). Osborne, for example, observes that understanding science in the news is the "highest and most demanding" form of literacy in that it requires "the reader … to analyze and critique what they read and interpret meaning" (p. 214). Zimmerman *et al.* (2001) additionally posit that, "the ability to read and critically evaluate reports of science in the popular media is an important skill for citizens in an information-oriented society" (p. 38). To explore how citizens "understand" science in the news, research in this category examines how literacy practices contribute to an individual's ability to read and evaluate conclusions based on scientific research that appear in written forms of mass media, like newspapers and news magazines. (A majority of this research was conducted in the 1990s and early 2000s, just as the Internet was becoming a viable news source. Based on timing alone, Internet news has mostly been excluded from this body of work.)

I call this the "interpretive" approach, as opposed to the "literacy" approach, because while reading, and sometimes writing, is a central component of each study in this category, literacy itself is not necessarily the primary focus here. Korpan *et al.* (1997), for example, use the science news to determine how students think critically about scientific research, rather than their reading comprehension. Zimmerman *et al.* (1998) refer to this method as the "request or question-generation method" (p. 190). Korpan and colleagues presented students with four fictitious news briefs and asked students to determine whether or not the news report was "true." They hypothesized that if students understood the nature of scientific research, they would ask for more information about links between evidence and theory, methodology, and the social context of the research to evaluate the claims made in the news briefs. Ultimately, students generated questions about methods (*how* the research reported in the news was conducted), theory (*why* the results might have occurred), *what* results were found, and *who* conducted the research. Of these, students most frequently requested more information about methods (*how*) and theory (*why*). Students did not, however, inquire about social context. Although reading is clearly a key part of this work, the research foci of the Korpan *et al.* study are students' ability to ask questions and the features students consider important for evaluating scientific research. Literacy itself is never mentioned.

The work of Norris and Phillips, on the other hand, examines the link between understanding science in the news and literacy in a more explicit way. They argue that reading and writing are "inextricably linked to the very nature and fabric of science" and that, as a result, scientific literacy must necessarily be defined in terms of reading and writing (Norris and Phillips, 2003, p. 226). Norris and Phillips have often used science news articles to examine students' abilities to infer meaning from text. They observe that "the essential nature of reading—inferring meaning from text—is the same no matter what is being read, even though there may be variations in reading purposes and strategies across text types and reading contexts" (2003, p. 228). In a 1994 study, they used news reports about science to explore students' interpretations of three aspects of scientific statements: their certainty, their scientific status, and their role in the chain of scientific reasoning. They found that students tend to overestimate the degree of certainty expressed in science news articles, demonstrating a "bias toward truth ascription" (p. 959). That is, students attributed a higher degree of certainty toward statements in the news than was ascribed by the conclusions reported in the original scientific research. Regarding the scientific status of statements in the news, Norris and Phillips found that most students could recognize statements of observation and methodology, but less than one-half recognized statements indicating causal claims. And finally, in an attempt to measure students' ability to follow the chain of scientific reasoning, students were asked to infer the relationship between news statements about science. Norris and Phillips discovered that just over half of could recognize statements of conclusion that were drawn on the "basis of reasons," less than half could recognize statements of "evidence for other statements that are made" in the news report, and less than one-tenth could recognize statements of "justification for what ought to be done" (p. 691). Norris and Phillips argue, "because the ability to see connections is fundamental to scientific understanding, [this] result is alarming." This "alarming" result, they argue, suggests that students "simply are not being taught to make such interpretations and…are unlikely to be able to play the role that is expected of scientifically literate citizens and unlikely to keep abreast of developments in science" (p. 692).

These two studies demonstrate the interpretive approach to the relationship between scientific literacy and understanding science in the news overall—to understand science in the news one must be able to interpret the meaning of text. That is, if you can interpret text, you can understand science in the news. Because interpretation of text is viewed as constitutive to scientific literacy here, understanding science in the news is considered a component of scientific literacy as well. Thus, if you are scientifically literate, you can understand science in the news. McClune and Jarman (2010), in fact, describe the capability and aptitude to engage critically with science in the news as a "manifestation" of scientific literacy (p. 729).

In the body of research that adheres to the interpretive approach, the knowledge necessary to understand science in the news has generally been imagined as a set of evaluative practices. There has been a particular focus on the types of knowledge related to the evaluation of the conclusions presented in the news. This includes recognizing the features of research (Zimmerman *et al.* 2001; Korpan *et al.*, 1997), social context of research (Norris, 1995; Zimmerman *et al.*; Korpan *et al*), and certainty of results (Norris and Phillips, 1994; Ratcliffe, 1999; Norris *et al.,* 2003). Korpan and colleagues developed a framework to classify knowledge about the features of scientific research individuals might consider when evaluating conclusions reported by mass media that is commonly used by researchers in this group (Table 1). This framework presents the features of scientific research in terms of "what," "who," "where," and "why." Like the model of the knowledge domains constructed by Shavelson, Ruiz-Primo, Li, and Ayala (2003) described in Chapter Two, the knowledge about science in the news presented in the Korpan *et al.* framework might be described as "knowing what," "knowing why," "knowing how," and knowing that."

Topic	Description
Social context	Information about the prestige and bias related to who did the research or funded it and where it was conducted or published.
Method	Information about how the research was conducted, including such topics as research design and procedures.
Theory/Agent	Information about why the reported effects might have occurred, including questions about the properties of the putative causal agent and/or possible underlying mechanisms.
Data/Statistics	Information about precisely what was observed in the reported study or about statistical tests.
Related Research	Information about whether the findings have been replicated or fit other results.
Relevance	Information about the importance or applicability of the findings.

Table 1. Features of Scientific Research. Categories from the Korpan *et al.* (1994) taxonomy, as originally summarized by Zimmerman *et al.* (2001).

One of the primary difficulties with the interpretive approach is that these scholars point to the science in the news because they consider it an important context for literacy in general, not because understanding science in the news is an important entity unto itself. Of course, reading the news is often a part of talk about all forms of literacy. Hirsch (1987), for example, observes that *cultural* literacy is the "background information … that enables [citizens] to take up a newspaper and read it with an adequate level of comprehension, getting the point, grasping the implications, relating what they read to the unstated context which alone gives meaning to what they read" (p. 2). The difficulty with the interpretive approach to the relationship between understanding science in the news and scientific literacy in particular, however, is that this practice ignores the multiple other media where the public might encounter science in the news (television, radio, etc.). This is especially problematic because, for better or worse, the public receives most of its news, science or otherwise, from television. According to a report from The Pew Research Center for the People & the Press (2010), 58 percent of survey respondents "got their news yesterday" from television. Comparatively, 34 percent got their news from online sources, 34 percent from radio, and 31 percent from newspapers.[3] So, although it may be true that this body of research presents a viable description of the knowledge necessary evaluating text about science, it does not adequately reflect all one might know about the broader construct of "science in the news," which can be delivered by multiple media platforms.

The Vocabulary Approach

In the fields of science education and mass communication, there is a long research tradition of linking understanding science in the news to the vocabulary dimension of civic scientific literacy. Broadly, civic scientific literacy is defined as the types of skills and knowledge citizens require to effectively participate in the democratic processes of an increasingly scientific and technological society (Shen, 1975). The origins of the link between understanding science in the news and civic scientific literacy can be traced to educational researcher Charles Koelsche, who set out to define civic scientific literacy in the early 1960s. After examining nearly three thousand science news articles published over a six-month period from1962 to 1963, Koelsche (1965) identified 175 basic scientific principles and 693 vocabulary

[3] This report focuses on news medium, not news organizations. As a result, multi-platform news sources, like the *New York Times*, are counted as both an online source and a newspaper.

terms that he felt constituted scientific literacy. He argued that scientific literacy was the ability to "form relevant and independent conclusions from information acquired through the mass media" (p. 723).

Since Koelsche, many attempts have been made to distill a baseline measure of scientific literacy from the scientific facts or terms that appear in the news. As a result, some view understanding science in the news as somewhat synonymous with knowledge about scientific facts or terms encountered there (see Hazen and Trefil, 1991; Brossard and Shanahan, 2006). The work of Jon Miller has perhaps played the largest role in establishing this trend (1983, 1986, 1998). Miller, who currently directs the University of Michigan's International Center for the Advancement of *Scientific Literacy,* has been a driving force in the research literature devoted to scientific literacy for nearly 30 years. In 1983, his seminal article "Scientific Literacy: a conceptual and empirical review" was published in a special edition of *Daedalus*, the journal of the American Academy of Arts and Sciences. In that article, Miller presented scientific literacy as a construct with three components. I, however, am more interested in a later work. In 1998, Miller published an article in the journal *Public Understanding of Science*, where he proposed a multidimensional conception of civic scientific literacy. In that article, he explicitly defines the first dimension of civic scientific literacy as, "a level of understanding scientific terms and constructs sufficient to read a daily newspaper or magazine and to understand the essence of competing arguments on a given dispute or controversy" (p. 204).

Miller's statement has been interpreted in two ways in the research literature. On the one hand, the mass media component of Miller's conceptualization—that the science terms that appear in mass media are the science terms worth knowing—has been ignored without comment. For example, in some works this dimension of civic scientific literacy appears as "a level of understanding of key scientific terms and constructs" or some variation thereof (Laugksch, 2000, p. 78). To define what counts as "key," these works draw upon the knowledge "experts" think the public should know about science, like the benchmarks for scientific literacy proposed by AAAS (1993), rather than the frequency of their appearance in the press. On the other hand, there are scholars who have responded by establishing measures of civic scientific literacy that follow Miller's conceptualization to the letter, opting to use the science terms and constructs that appear in the news as a foundation for their research. For example, instead of relying on expert opinion, Brossard and Shanahan (2006) use "the collective social decision making of the media" to reveal what scientific constructs are "important" (p. 48). They suggest that past measures of public knowledge of scientific vocabulary have been based on "ideal" knowledge defined by the judgment of scientific experts. When experts decide what scientific vocabulary is "appropriate," there is a possibility "that biases and prejudices of the scientific community can influence the overall definition of scientific literacy" (p. 50). According to Brossard and Shanahan, a more novel way to approach the issue is through the analysis of the media's use of scientific and technological terms. They identified 31 terms used most often in the media, arguing that if citizens know these 31 terms, "one could argue that they are scientifically literate within the bounds of normal civic discourse" (p. 51).

In their argument for using the scientific terms that appear most often in mass media as a means assessing civic scientific literacy, Brossard and Shanahan aptly convey the vocabulary approach to understanding science in the news overall. By defining scientific literacy as "knowing" scientific terms, they are essentially suggesting that the science in the news might be understood as a collection of terms and constructs as well. The vocabulary approach portrays this vision of understanding science in the news as an *indicator* of scientific literacy. Therefore, according to the vocabulary approach, if you can understand science in the news, then you are scientifically literate.

Characterizing understanding science in the news as knowing scientific terms is controversial for a few reasons. First, an individual may know the definitions of "electron" and "element," but that does not mean she could use those words together in a sentence correctly, say how their meanings relate to each other, or apply the information conveyed through those words in a meaningful way (Lemke, 1990). Second, the focus on terms and content is particularly unusual here, given that the general argument for the public understanding of science in general has shifted away from an emphasis on science content knowledge (Allum, Sturgis, Tabourazi, and Brunton-Smith, 2008). And finally, in support of their argument for viewing scientific literacy in terms of reading and writing, Norris and Phillips (2003) point out that the vocabulary dimension "risks equating successful reading with knowing the meaning of the individual terms" and that it "appears to assume that only scientific constructs need to be known to understand scientific text" (p. 227). In general, Norris and Phillips make a strong case against the vocabulary approach, stating:

> If scientific literacy is conceived only as knowledge of the substantive content of science, there is a risk that striving to learn the elements of that content will define our goals without any appreciation for the interconnection among the elements of content, their sources, and their implications (p. 236).

They add that viewing literacy as "knowledgeability in science" instead of "reading and writing" has "created a truncated and anemic view of scientific knowledge as facts, laws, and theories in isolation from their interconnections" (p. 233). Although it is true that their argument is in support of literacy practices, the sentiment expressed by this statement applies to the argument for understanding science in the news as well. The treatment of the science in the news as a means of constructing what is essentially an elaborate vocabulary test generates a similarly abridged view of understanding science in the news.

Another challenging aspect of the vocabulary approach is that scholars in this category often leverage the ubiquity of mass media. Embedded in the vocabulary approach is the idea that given mass media's sweeping presence and impact, the public must necessarily encounter science in the news at a frequent interval. Although concerns about the ubiquity of mass media are not without merit—see Jane Brown's work on the influence of mass media on sexuality and American adolescents' health (2002a, 2002b)—the ubiquity of mass media itself does not necessarily amount to unlimited science coverage. Newspapers in the 1980s, for example, typically reserved 70 percent of their print space for advertisements. The 30 percent left over was then divided among columns, comics, editorials, and regular features, about 5 percent of which was devoted to breaking news (Friedman, 1986). Finding space—literally finding the inches—for the extended explanations often required for a science news story was often impossible and editors, faced with reporting the latest scientific advancement or news about the economy, would often choose to leave the science story out of the news altogether in favor of what they felt their readers would want to know. More recently, the shift toward online news has further obscured science from ubiquitous public view. Although online news is no longer limited by space, the very nature of how the public consumes information online prohibits omnipresent science news (Anderson, Brossard, and Scheufele, 2010). Online media allow users to seek and assemble their news, as opposed to passively consuming whatever content newspaper or television news delivers. One consequence of user-compiled news is the chance that a user will ignore science altogether.

The Media Literacy Approach

The third and final approach to the relationship between scientific literacy and understanding science in the news focuses on the knowledge required to understand the media component of science in the news. Ryder (2001) describes this knowledge as "knowledge about the communication of science, rather than science knowledge itself" (p. 34). In the mass communications literature (and other literatures as well), this knowledge is described as media literacy (Aufderheide, 1997; Tyner, 1992; Livingstone, 2004). The overall purpose of media literacy varies. While some view media literacy as a means of achieving critical autonomy (Masterman, 1985; Hobbs, 1998), others consider media literacy as an important defense against negative media influences on student perceptions of race and gender (Eriksen-Terzian, 1992). Still others posit that media literacy is an important part of improving education overall (Piette and Giroux, 1997). As it is used here, media literacy stands for knowledge about science communication (broadly defined), rather than an awareness of the various practices and processes of mass media in general.

Those that have adopted the media literacy approach to the relationship between understanding science in the news and scientific literacy typically portray media literacy as an "add on" to scientific understanding. That is, to transform scientific understanding into an understanding of science in the news, they simply "add it on." Ryder (2002), for example, includes an understanding of "science communication in the public domain" among the "main areas of science understanding" required for functional scientific literacy (p. 8). He suggests that to "engage critically with the scientific information being communicated" an individual must:

- Recognize that mass media often excludes details of study design;
- Recognize that mass media presents scientific measurements without conveying the reliability or validity of these measurements;

- Recognize that mass media, in describing disagreements between groups of scientists, may provide limited consideration of the strength of each group's case (p. 32-33).

Certainly, a strategy like this fits with common sense. Most would agree that the boundary between science in the news (e.g., the *New York Times*) and science in other contexts (e.g., the laboratory) is clear enough. When one is listening to, say, National Public Radio's *Science Friday* then, one would presumably know to deploy knowledge about science communication. However, when one looks for the precise location of that boundary, the very point where "science" becomes "science in the news" and knowledge about science communication must be activated, one faces some difficulty (Hilgartner, 1990). That boundary shifts, and shifts *again*, based on variations in news medium (radio, newspaper, etc.), news source (the *Science Times*, *USA Today*, etc.), and others. This makes knowing exactly when to "add on" media literacy to scientific knowledge somewhat difficult for even media experts. Lippmann (1922), the journalist who argued that the "nature of news" separates its content from the "truth," might say that, given this complexity, we cannot reasonably expect our citizens to practice this particular form of media literacy (p. 340). He rejects the idea of the "omnicompetent citizen" who is capable of sorting out this amount of information to construct "a reliable picture of the world" (p. 364-365). Wynne (1991) makes a somewhat similar case, noting the "enormous amount of sheer *effort* needed for [the public] to monitor sources of scientific information, judge between them, keep up with shifting scientific understandings, and distinguish consensus from isolated scientific opinion" (p. 117).

More recently, reservations about the relationship between media literacy and understanding science in the news have taken on additional meaning, as the public is expected to traverse an increasingly complex media landscape. Although most of the public still receives a majority of its *general* news directly from traditional news sources (particularly television news), when they are looking for information about specific science or technology topics, a recent Pew Internet and American Life Project survey found that Americans turn to Internet search engines first to find scientific information (Horrigan, 2006). The distinction between consulting an Internet search engine and a news site, though seemingly a small concern, offers important insight into how people make decisions about who to trust and what to believe about science and scientific issues. Within the field of risk communication, a sub-field of mass communication, there has been a substantial amount of inquiry into how citizens' judge the trustworthiness of claims reported in the mass media (Jungermann, Pfister, and Fischer, 1996; Peters, Covello, and McCallum, 1997; Einsiedel and Thorne, 1999; Irwin, 2008). Most recently, concerns about trustworthiness have focused on how individuals interact with new media, a term used to define user-generated news sites, like Wikipedia, and social networking sites, like Twitter and Facebook (Jenkins, 2006; Brumfiel, 2009).

To decipher how the media literacy approach views the relationship between understanding science in the news and scientific literacy, I again turn to the works of Ryder. Ryder (2002) lists "knowledge about science communication" among his "epistemic learning aims to achieve science education for citizenship in compulsory school science" (p. 643). That is, knowledge about science communication is one means of bringing about "science education for citizenship," an aim Ryder notes has been identified elsewhere in terms of "enhancing the public understanding of science," "scientific literacy," functional scientific literacy," science for specific social purposes," and "citizen science" (p. 638). By suggesting that knowledge about science communication supports scientific literacy, Ryder is in essence stating that he considers understanding science in the news and scientific literacy as one in the same—that one component of scientific literacy is the ability to understand science in the news.

Conclusion

The prevailing, oft-cited view of understanding science in the news put forth by this relatively small corpus of research is that it is not something we do very well. No matter the approach, quantitative estimates of scientific literacy based on understanding science in the news routinely show that individuals do not evaluate the features of news reports about science in a way that indicates scientific literacy. The relationship between these results and understanding science in the news, however, is somewhat more difficult to sort out than this work might suggest. The visions of understanding science in the news and its related knowledge described above are imagined according to what the respective fields of the researchers believe should be known about science in the news as it relates to scientific literacy, rather than the types of knowledge and understanding necessary to address science in the news as an entity in its own right (Table 2). For the first two categories—the Interpretive Approach and the Vocabulary Approach—that means imagining the science in the news as a stand-in for science. Although they view the relationship between scientific literacy and understanding science in the news in different ways, both consider the knowledge for understanding science in the news as fundamentally related to scientific knowledge. This argument carries a certain amount of self-evident logic—understanding science in the news requires both knowledge *in* science and knowledge *about* science, the science in the news just happens to be a product of mass media, rather than a product of science. Alternatively, the Media Literacy Approach considers understanding science in the news a marginal adjunct to understanding science. That is, knowledge about science in the news is discrete from scientific knowledge. The logic here is equally apparent—knowledge about science communication clearly falls outside of what historian of science education John Rudolph (2000) has termed "the class of things that might be called 'scientific'" (p. 405). Ryder, in fact, suggests that knowledge about science communication (described in the bullet points above) and its associated "issues" might be better left to a "media studies course," noting that these issues "certainly…have not tended to be included in compulsory school science courses" (2001, p. 34). I wish to suggest, however, that as long as understanding science in the news is conceived in terms of science, its true measure and nature remains indefinite. Certainly understanding science in the news relies *in part* scientific knowledge, but it also relies on knowledge about journalism. If, as these visions suggest, the goal here is to understand, interpret, and respond to the science reported by news media, rather than science itself, then the concept of understanding science in the news has an epistemology of its own that has yet to be accurately depicted—one that relies on knowledge of science and journalism. A more accurate description of formative knowledge necessary for understanding science in the news, then, may be *knowledge about science in the news*, not knowledge about science.

	Interpretive Approach	Vocabulary Approach	Media Literacy Approach
How does Understanding Science in the News relate to Scientific Literacy?	Component of scientific literacy	Indicator of scientific literacy	Component of scientific literacy
What Types of Knowledge Are Necessary for Understanding Science in the News?	Interpretation of text Evaluate features of research, social context of research, and certainty of results	Recognize and define science terms	Awareness of practice and process of science communication

Table 2. Conceptualizing the Relationship between Understanding Science in the News and Scientific Literacy and Its Related Knowledge. Three ways past research has imagined the relationship between understanding science in the news and scientific literacy and its related knowledge.

To be fair, defining "understanding science in the news" is not the principle aim of any of the research described above. Instead, their aim is to define, assess, or rationalize scientific literacy. The resulting visions of understanding science in the news are somewhat the product of chance. What this chapter makes clear is there is no universal characterization of understanding science in the news, inadvertent or not, either within or between fields. There is widespread agreement, however, that understanding science in the news is an important component of the relationship between science and society. Yet if we wish to foster a public capable of understanding science in the news, we must recognize that understanding science in the news is a complex process that requires its own practical prescription. Moreover, we must acknowledge that understanding science in and of itself is a necessary, though not sufficient, means of understanding science in the news. In the following chapter, then, I step away from issues of knowledge and understanding to examine one of the principle motivations behind this appeal: the distinction between *science in the news* and *science*.

References

Anderson, A.A., Brossard, D., and Scheufele, D.A. (2010). The changing information environment for nanotechnology: Online audiences and content. *Journal of Nanoparticle Research, 12*, 1083-1094.

Allum, N., Sturgis, P., Tabourazi, D., and Brunton-Smith, I. (2008). Science knowledge and attitudes across cultures: A meta-analysis. *Public Understanding of Science, 17*, 35-54.
American Association for the Advancement of Science (AAAS). (1993). *Benchmarks for science literacy*. New York, NY: Oxford University Press.

Aufderheide, P. (1997) Media literacy: From a report of the National Leadership Conference on Media Literacy. In Kubey, R.W. (Ed.), *Media Literacy in the Information Age: Current Perspectives* (79-88). New Brunswick, NJ: Transaction.

Brossard, D. and Shanahan, J. (2006). Do They Know What They Read?: Building a scientific literacy measurement based on science media coverage. *Science Communication, 28*(1), 47-63.

Brown, J.D. (2002a). Mass media influences on sexuality. Journal of Sex Research. *Special Issue: Promoting Sexual Health and Responsible Sexual Behavior, 39*(1), 42-45.

Brown, J.D. and Stern, S.R. (2002b). Mass media and adolescent female sexuality. In Wingood, G.M. and DiClemente (Eds.), *Handbook of Women's Sexual and Reproductive Health, Issue in Women's Health* (93-112). New York, NY: Springer.

Brumfiel, J. 2009. Supplanting the old media? *Nature, 458*, 274–277.

Einsiedel, E. and Thorne, B. (1999). Public responses to uncertainty. In Friedman, S.M., Dunwoody, S., and Rogers, C.L. (Eds.), *Communicating Uncertainty: Media Coverage of New and Controversial Science* (43-57). Mahwah, NJ: Lawrence Erlbaum Associates.

Eriksen-Terzian, A. (1992). Who's holding the camera? Television/video and gender representation. In Bazalgette, C., Bevort, E., and Savino, J. (Eds.), *New Directions: Media Education Worldwide* (61-69). London, UK: British Film Institute.

Friedman, S.M. (1986). The journalist's world. In Friedman, S., Dunwoody, S., and Rogers C. (Eds.), *Scientists and Journalists: Reporting Science as News* (17-41). New York, NY: Free Press.

Hazen, R.M. and Trefil, J. (1991) *Science matters. Achieving scientific literacy*. New York, NY: Anchor Books Doubleday.

Hilgartner, S. (1990). The Dominant View of Popularization: Conceptual problems, political uses. *Social Studies of Science*, *20*(3), 519-539.

Hirsch, E.L. (1987). *Cultural literacy: What every American needs to know.* Boston, MA: Houghton Mifflin.

Hobbs, R. (1998). The seven great debates of the media literacy movement. *Journal of Communication, 48*(1), 16-32.

Horrigan, J.B. (2006) The Internet as a resource for news and information about science. Pew Internet & American Life Project. Retrieved from http://www.pewinternet.org/Reports/2006/The-Internet-as-a-Resource-for-News-and-Information-about-Science.aspx.

Irwin, A. (2008). Risk, science, and public communication: Third-order thinking about scientific culture. In Bucchi, M. and Trench, B. (Eds.), *Handbook of Public Communication of Science and Technology* (199-212). New York, NY: Routledge.

Jarman, R. and McClune, B. (2007). *Developing scientific literacy*. Maidenhead, UK: Open University Press.

Jenkins, H. (2006) *Convergence Culture: Where old and new media collide*. New York, NY: New York University Press.

Jungermann, H., Pfister, H., and Fischer, K. (1996) Credibility, information preferences, and information interests. *Risk Analysis, 16*(2), 251-261.

Koelsche, C. 1965. Scientific literacy as related to the media of mass communication. *School Science and Mathematics, 65*, 719-725.

Korpan, C.A., Bisanz, G.L., and Bisanz, J. (1997). Assessing literacy in science: Evaluation of scientific news briefs. *Science Education*, *81*, 515-532.

Korpan, C.A., Bisanz, G.L., Bisanz, J., and Henderson, J.M. (1997). Assessing literacy in science: Evaluation of scientific news briefs. *Science Education, 81,* 515-532.

Laugksch, R.C. (2000) Scientific literacy: A conceptual overview. *Science Education , 84*(1), 71–94.

Lemke, J.L. (1990). Talking science: Language, learning, and values. Westport, CT: Ablex Publishing.

Livingstone, S. (2004). Media literacy and the challenge of new information and communication technologies. *The Communication Review, 7*(1), 3-14.

Lippmann, W. (1922). *Public Opinion.* New York, NY: Harcourt, Brace.

Masterman, L. (1985). *Teaching the media*. London, UK: Routledge.

McClune, B. and Jarman, R. (2010). Critical reading of science-based news reports: Establishing a knowledge, skills, and attitudes framework. *International Journal of Science Education, 32*(6), 727-752.

Millar, R. and Wynne, B. (1988). Public understanding of science: from contents to processes. *International Journal of Science Education*, *10*(4), 388-398.

Miller, J. D. (1983). Scientific literacy: A conceptual and empirical review. *Daedalus, 112*, 29-48.

Miller, J. D. (1986) Reaching the Attentive and Interested Publics for Science. In Friedman, S., Dunwoody, S., and Rogers C. (Eds.), *Scientists and Journalists: Reporting Science as News* (55-69). New York, NY: Free Press.

Miller, J. D. (1998). The measurement of civic scientific literacy. *Public Understanding of Science, 7*, 203-23.

Norris, S.P. (1995). Learning to live with scientific expertise: Towards a theory of intellectual communalism for guiding science teaching. *Science Education, 79*, 201-217.

Norris, S.P. and Phillips, L.M. (1994). Interpreting pragmatic meaning when reading popular reports of science. *Journal of Research in Science Teaching, 31*(9), 947-967.

Norris, S. P. and Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, *37*, 224 – 240.

Norris, S.P., Phillips, L.M., and Korpan, C.A. (2003). University students' interpretation of media reports of science and its relationship to background knowledge, interest, and reading difficulty. *Public Understanding of Science*, *12*, 123-145.

Osborne, J. (2002). Science without literacy: A ship without a sail? *Cambridge Journal of Education, 32*(2), 203-218.

Peters, R.G., Covello, V.T., and McCallum, D.B. (1997). The Determinants of Trust and Credibility in Environmental Risk Communication: An Empirical Study. *Risk Analysis, 17*(1), 43-54.

Pew Research Center for the People & the Press. (2010). *Americans spending more time following the news*. Retrieved from http://www.people-press.org/2010/09/12/section-1-watching-reading-and-listening-to-the-news/.

Piette, J. and Giroux, L. (1997) The theoretical foundations of media education programs. In Kubey, R.W. (Ed.), *Media Literacy in the Information Age: Current Perspectives* (89-134). New Brunswick, NJ: Transaction.

Phillips, L.M. and Norris, S.P. (1999). Interpreting popular reports of science: What happens when the reader's world meets the world on paper? *International Journal of Science Education*, *21*(3), 317-327.

Ratcliffe, M. (1999). Evaluation of abilities in interpreting media reports of scientific research. *International Journal of Science Education, 21*(10), 1085-1099.

Rudolph, J.L. (2000). Reconsidering the 'nature of science' as a curriculum component. *Journal of Curriculum Studies, 32*(3), 403-419.

Ryder, J. (2001). Identifying science understanding for functional scientific literacy. *Studies in Science Education*, *36*, 1-44.

Ryder, J. (2002). School science education for citizenship: strategies for teaching about the epistemology of science. *Journal of Curriculum Studies*, *34*(6), 637-658.

Shavelson, R., Ruiz-Primo, M.A., Li, M., and Ayala, C.C. (2003). Evaluating new approaches to assessing learning. *CSE Report 604*. Los Angeles: University of California, Los Angeles, Center for the Study of Evaluation (CSE).

Shen, B. S. P. (1975). Science literacy and the public understanding of science. In S. B. Day (Ed.), *Communication of scientific information* (44 – 52). New York, NY: S. Karger and A. G. Basel.

Tyner, K. (1992). The tale of the elephant: Media education in the United States. In Bazalgette, C., Bevort, E., and Savino, J. (Eds.), *New directions: Media education worldwide* (170–176). London, UK: British Film Institute.

Wynne, B. (1991). Knowledges in Context. *Science, Technology & Human Values*, *16*(1), 111-121.

Zimmerman, C., Bisanz, G. L. and Bisanz, J. (1998). Everyday scientific literacy: Do students use knowledge about the social context and methods of research to evaluate news briefs about science? *Alberta Journal of Educational Research, Theme Issue, Literacy in the 21st Century, 44*, 188-207.

Zimmerman, C., Bisanz, G .L., Bisanz, J., Klein, J .S., and Klein, P. (2001). Science at the supermarket: A comparison of what appears in print, experts' advice to readers, and what students want to know. *Public Understanding of Science, 10,* 37-58.

Chapter 4: Establishing "Science in the News" as a Separate Entity from "Science"

A fundamental objection to how the notion of understanding science in the news is currently conceived is that it is defined in terms of what students and the public should know about *science*, rather than *science in the news*. Although it is true that understanding science in the news requires *some* knowledge of *science*, there are issues related to its function as a product of mass media that distinguish *science in the news* from *science*. The distinguishing features of *science in the news*, however, are frequently overlooked by researchers, policymakers, and educators when they describe both the need for a public capable of understanding science in the news and the "understanding" implicit in "understanding science in the news" itself. Typically, these efforts define *science in the news* as a coherent and unproblematic version of *science*. Yet while *science in the news* may quite literally be defined as *science* that appears in context of the news, this is a gross oversimplification of the process of science communication. *Science*, after all, does not simply "appear" in the news—it is first shaped by journalists, editors, publishers, and even scientists (Dunwoody, 1986; Friedman, 1986; Nelkin, 1995). Moreover, the arena of science is vast. News media must choose which science-related topics to report and which to leave unobserved (Gans, 1979; Hilgartner and Bosk, 1988; Weigold, 2001). I call the result of this influence and winnowing *science in the news* and, as I will argue, it is a separate entity from *science.*

Before continuing on, it is important to explain exactly what I mean by *science* here. By arguing that *science in the news* stands apart from *science*, I would seem to be implying that there is some universal characterization of *science* that *science in the news* might exist in relation to. There is not. This is true from the perspective of sociologists of science like Ziman (1991) and Wynne (1991), who caution that *science* means different things to different people in different contexts. In fact, scholars from an array of fields, from multicultural education to philosophy of science to feminism, suggest there are multiple competing accounts of *science* (e.g. Haraway, 1989; Galison and Stump, 1996; Cobern and Loving, 2000; Carter, 2008). Yet much of the difficulty in determining what counts as *science* in this particular instance resides in the very manner *science in the news* itself has traditionally been conceived. Past research related to understanding science in the news has typically used *science in the news* to assess and define varying aspects of science and scientific enterprise, not one unified notion of *science*. Although a majority of this work tends to focus on what might be called the more technical aspects of science—its concepts, theories, and findings—still others envision *science in the news* as a means of addressing the social and other features of *science*. For the most part, the *science* referred to in these works is "traditional" or "Western" science. In light of this perspective, when I refer to *science*, I am referring to the specific vision put forth by researchers with an interest in understanding science in the news that imagines *science* as a wider scheme that consolidates these aspects into an "empirically based way of describing or explaining nature" (Aikenhead, 2006, p. 2). Although this view ignores various indigenous knowledge systems or other non-Western views of the natural world, engaging in debate about the nature and definition of *science* is not my goal here. Instead, my interest lies in the questions related to the nature and definition of *science in the news*.

Current Definitions of "Science in the News"

Similar to *science*, there is no universal characterization of *science in the news*. To be sure, many researchers have critically examined science-related news reports (e.g., Millar and Wynne, 1988; Dornan, 1990; Pellachia, 1997; Burns, O'Connor, and Stocklmayer, 2003; Clark and Illman, 2006). These efforts, however, have been primarily concerned with cataloging or critiquing journalists' treatment of *science*. Few have considered the idea that the science-related content that appears in news reports might be considered as anything other than *science*. Yet in surveying this research literature, one finds that there is a version of *science in the news* embedded in this work. The descriptions of news reports about science put forth in this research, then, provide the conceptual basis for *science in the news*.

There is a range in variation among these inadvertent visions of *science in the news*—from the conceptual to the practical, from the implicit to the explicit. One way to find order among such variation is to recognize that a majority of these visions can be sorted into two categories. Research in the first category tends to view *science in the news* as a means of studying some other issue or phenomena, such as literacy (e.g., Norris and Phillips, 2003) or public engagement with and understanding of science (e.g. Millar and Wynne, 1988; Ryder, 2001). Here, *science in the news* is primarily identified as a channel for transmitting information about science and science professionals. Norris and Phillips, for example, use *science in the news* not because they are particularly interested in how students read newspapers, but because reading newspapers is presumably one way students will interact with science as adults. Alternatively, the second category of research regards *science in the news* as constituent to an issue or phenomena (e.g., Jarman and McClune, 2002; Brossard and Shanahan, 2006; Kachan, Guilbert, & Bisanz, 2006). That is, this research addresses *science in the news* as an essential element of the issue or phenomena in question. Certainly researchers in this category view *science in the news* as a means of transmission, but their interest in *science in the news* extends beyond its role as an instrument of access to consider a range of other topics and concerns as well. These include what key stakeholders feel is necessary for critical engagement with science in the news (e.g., McClune and Jarman, 2010) and the ability to read, understand, and evaluate media reports of science for their own sake, instead of the more generalized sense of literacy described above (Korpan, 2009).

Regardless of approach, research from both categories takes the meaning of *science in the news* more or less for granted, often defining it broadly in terms of *science*. As a result, the visions of *science in the news* found within these works typically overlook the news component of *science in the news* and focus on the science component instead. The difficulty here is twofold. First, by conceptualizing *science in the news* in terms of *science*, this research ignores the well-established insight in the field of mass communication that the news is a product shaped by the practices of journalism. That is, news reports about science are largely the result of interpretation by journalists, not science professionals and, as a result, they reflect the values of journalism, not science (Dunwoody, 1986; Nelkin, 1995; Gregory and Miller, 1998). The second difficulty lies in the very manner the concepts *science* and *news* have been traditionally been conceived. The visions of *science* and *news* embedded in current working notions of *science in the news* are oversimplified representations of two multiply ambiguous concepts—each is more abstract and difficult to recognize than it has previously been portrayed. A more authentic way of conceptualizing *science in the news*, then, is as (1) a product of the norms, values, and practices of journalism and (2) a composite of *science* and *news*. I discuss each aspect in greater detail below.

"Science in the News" is a Product of Journalism

The idea that *science in the news* is a product of the norms, values, and practices of journalism is not new. Indeed, the influence of journalism and journalists on news reports about science has been an object of concern for many since science first was first established as a news "beat" in the 1920s and 1930s (Dunwoody, 1986). Since that time, there has been a great deal of research on the effects of mass media on the relationship between science and society, including public perceptions of science (e,g., Gerbner, Gross, Morgan, & Signorielli, 1985; Brewer and Ley, 2010; Dudo, Brossard, Shanahan, Scheufele, Morgan, Signorielli, 2011); the process of science communication (e.g., Irwin and Wynne, 1996; Einsiedel and Thorne, 1999; Wynne, 2006), and the public understanding of science (e.g., Miller, 1986). Still others have been spurred by concerns about science in mass media to examine the practice and process of journalism itself—its constraints, its nature, and its role in the development of what I call *science in the news*.

One prominent area of research related to the practice and process of journalism is the study of what media scholar Dorothy Nelkin (1995) has called “the filter of journalistic language and imagery” (p. 2). Over time, this “filter” is has been represented a number of ways in the field of mass communication. One of the most enduring models has been the *popularization* of science, the somewhat controversial process of translating technical and scientific information into “simpler” terms for a public audience (Lewenstein, 1992, p. 45). Hilgartner (1990) provides an apt description of the two sides of this controversy stating, “popularization is, at best, ‘appropriate simplification’ science for non-specialists. At worst, popularization is ‘pollution’, the ‘distortion’ of science by such outsiders as journalists, and by a public that misunderstands much of what it reads” (p. 519). More recently, the “filter” of journalism has been imagined as a function of media frames (e.g., Scheufele, 1999; Nisbet and Mooney, 2007; Nisbet and Scheufele, 2007; Nisbet, 2009a). “Frames” are “interpretative packages” that communicate why an issue matters (whether it is science-related or not) and what is at stake in public debates about that issue (Gamson and Modigliani, 1989, p. 2). According to Nisbet and Scheufele (2009), “frames help simplify complex issues by lending greater weight to certain considerations and arguments over others, translating why an issue might be a problem, who or what might be responsible, and what should be done" (p. 1770). The practice of "framing" is thought to be particularly effective in the communication of complex socioscientific issues, including climate change (Nisbet, 2009b), stem cells (Nisbet, Brossard, and Kroepsch, 2003), and nanotechnology (Scheufele, 2007).

Of course, journalists are not solely responsible for shaping science news—publishers, editors, scientists, and even the public also contribute to the process. The values, knowledge, and attitudes of each group, however, do not equally affect what is reported as science news or how science news is reported. Most often, it is those professionally involved in journalism—publishers, editors, and journalists—who make these types of decisions. As a result, the science news has historically adhered to "news values" like deadlines, audience demands, and others (Table 3) (Galtung and Ruge, 1965, 1973; Price and Tewksbury, 1997; Jarman and McClune, 2007). The news selection process has also been influenced by factors such as whether or not a news outlet has a designated science section, the need to increase advertising revenues, or the interests of journalists and editors themselves (Dunwoody, 1986; Friedman, 1986; Bader, 1990; Pellechia, 1997; Dunwoody, 2008). Friedman notes that journalists and editors tend to value stories that contain drama, human interest, relevance, or application to the reader. As a result, technical details, like research methods and funding provenance, are sacrificed for the more striking or timely aspects of a story (Nelkin, 1995; Gregory and Miller, 1998). For example, Nelkin observes that the "competitive quest for dramatic stories affects the pace for daily newswork, encouraging a focus on 'breaking news'" (p. 105). Although a scientist would likely argue that just because something is "new" does not mean it is significant, a journalist, on the other hand, knows that whoever breaks a story first is given far more credit that those who do follow-up reports. As a result, journalists tend to focus on reporting "new" scientific findings.

News Values
Timeliness Has the story just happened? Is it of interest right now?
Relevance Does it relate to your life, you family, or your community?
Impact Does the story affect a large number of people? Are the consequences serious?
Proximity Did the story take place nearby or does the story related to local interests or concerns?
Prominence Does the story deal with well-known or powerful people or countries
Clarity Is the meaning clear; do you think that most people will be able to understand the story?
Personalization Is it a human interest story?
Conflict/Controversy Is this an issue about which people strongly disagree?
Emotion Does the story produce strong emotions such as fear or suspense?
Uniqueness/Unexpectedness Is the story about something unusual, unexpected, or odd?
Co-Option Is there a relationship with other news stories?

Table 3. Description of News Values. Jarman and McClune's (2007) "student-friendly" description of news values (p. 19).

News values are one example of what Dorothy Nelkin (1995) calls "constraints of the journalistic trade" (p. 105). In her brief history of media coverage of AIDS, Nelkin remarks on these constraints while explaining the difficulties of presenting science in the media:

> writing about [AIDS] required the time and budget to cover a complex subject and to develop interpretations in the face of technical uncertainties and scientific disagreements. Journalists sought angles that would hold the attention of readers and appeal to editors. They had to accommodate public sensitivities and social biases. And they were vulnerable to sources of information with conflicting agendas. *These constraints, implemented through editorial policies and practices, affect the work of journalists in all*

> *fields, but they pose special problems for those reporting on the complex, uncertain, and often slowly evolving events that characterize may aspects of science news.* [Emphasis added] (p. 104-105).

One consequence of these constraints has been that *science in the news* is cast according to the norms and values of journalists and their institutions, not those of scientists, educators, or the public. This has been a point of persistent tension between media and the scientific community. Indeed, scientists and journalists have long disagreed on just how closely the content of the science news should adhere to *science*, particularly with respect to what counts as "accurate" (Dunwoody, 1986). While both agree that accuracy is important, as regards the science news, they have conflicting opinions about what constitutes accuracy. Dunwoody tells us that scientists generally feel that the science news should be held to the same standard as a peer-reviewed journal. Journalists, on the other hand, have a more permissive stance. For example, a report in *USA Today* might report that the milk supply has been contaminated with "radioactive iodine" instead of "iodine 131."

Nelkin (1995) originally described the constraints of journalism in her influential book *Selling Science*. In that book, Nelkin depicts the limits journalists must adhere to despite personal avowals to honor scientific sources or ideals of science. Although the field of journalism has changed dramatically since the publication of *Selling Science*, Nelkin's constraints of journalism, detailed below, still adequately describe the nature and practice of science journalism and its subsequent role in the construction of *science in the news*.[4]

Newswork

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[4] I have updated where necessary, but, for the most part, Nelkin's work stands. What is not discussed here is how the rise of new media, particularly blogging and bloggers, has affected journalism and journalists. This is because there has been little research on the influence of blogs on science journalism. For an overview of how blogs have affected journalism in general, see Lowery (2006).

Newswork describes the customs and practices of science journalists, such as obtaining news material and competing for news. Newswork informs the quality, thoroughness and content of the news. One prominent example of how newswork affects *science in the news* is the emphasis the field of journalism places on breaking news, a practice Nelkin calls "detrimental to good coverage of science" (p. 105). The competition between journalists to obtain breaking news discourages the coverage of long-term issues or issues that require extensive technical background (Gregory and Miller, 1998). Deadlines are another critical part of newswork that greatly impact on the quality and quantity of reports of science. For example, deadlines limit the number of sources a journalist can interview, and past research has shown that half of the articles produced at a scientific meeting by reporters who had daily deadlines cited only one source (Dunwoody, 1980).

Newswork also determines, in part, they types of science that does and does not get reported in the science news. The work of media scholar Sharon Dunwoody (1980) provides a historical example of one way newswork shapes *science in the news*. In the mid-1970s, Dunwoody studied the newsgathering behaviors of "top U.S. mass media science writers" at the annual meeting of the American Association for the Advancement of Science (AAAS) (p. 14). She found that the science writing community at AAAS was dominated by a relatively small group of science writers that had formed a "close knit, informal social network" she refers to as an "inner club" (p. 14). This club, Dunwoody observed, largely determined what the public had read about science and significant science events since the 1960s.

Editorial Constraints

According to Nelkin "editors choose and edit stories to fit their judgments about how to maximize reader interest. With the exception of those few who were once science reporters themselves, most editors are trained in the liberal arts and are not very familiar with science" (p. 108). Importantly, editors do not honor science, they honor the news. For example, editors, faced with reporting the latest scientific advancement or news about the economy, often choose to leave the science story out of the news altogether in favor of what they felt their readers would want to know.

Editors generally see science as a way of selling newspapers and, in an attempt to clarify or avoid uncertainty, often change words (Gregory and Miller, 1998). For example, "may" is often changed to "is" in the interest of style, thus neglecting to inform public of the tentative nature of new scientific findings and removing any sense of uncertainty from scientific research. Also, an editor may screen out a word, not appreciating the inaccuracy the substitution has caused. The discrepancies created by editorial constraints such as these shape the news and the subsequent understandings of science and scientific research.

Audience Assumptions

The term *audience assumptions* is not derived from what the audience assumes, but rather what journalists and editors assume about the audience. These assumptions influence the preferences of journalists and the selection and style of science news. Nelkin reports there is some expectation among the journalism community that the audience often prefers sensationalism:

> While most journalists try to avoid a sensationalist and titillating style, they do tend to magnify events and to overestimate if not sensationalize their significance. Research applications, after all, make better copy than qualifications. "Revolutionary breakthroughs" are more exciting than "routine findings." And controversies are more newsworthy than routine events (pp. 112-113).

Audience assumptions affect more than just vocabulary choices, they also influence the tone of the news. Reports of science tend to focus on drama, aberration, and controversy and news about technology is often presented with "all the attributes of fiction, as a story with heroes and villains, conflict and denouement" (Nelkin, p. 113). To maintain its audience, news language also tends to take on a positive and simplistic tone (Einsiedel, 1992). Gregory and Miller (1998) report that, "to be relevant and meaningful, news reports often emphasize the potential applications and outcomes of scientific results, rather than the process by which they were developed" (p. 116). The loss of science content is often the cost of considering the audience. Journalists and editors shape the science news to reflect what they feel best represents what the public wants to see or hear. This, in turn, can shape what the public understands to be science and scientific research.

Economic Pressures

The necessity for profit drives many decisions made by the media. When *Selling* Science was published, a typical newspaper derived approximately 80 percent of its income from advertising (American Newspaper Publishers Association, 1982; as quoted in Nelkin). The arrival of the Internet and the recent economic downturn, however, have obliterated the "80/20 rule" that says newspapers get 80 percent of its income from advertising and 20 percent from circulation. Overall newspaper ad revenue has been on a decline for more than a decade, down from nearly $50 billion in 2000 to $24 billion in 2009 (American Newspaper Publishers Association, 2010). In an interview with the Nieman Journalism Lab at Harvard, the publisher of the *Dallas Morning News* reported that the paper currently receives 38 percent of its revenue from circulation, 54 percent from advertising, and 8 percent from other income sources (President and Fellows of Harvard College, 2010). The distress of the newspaper industry means that whole cities and regions of the United States no longer have a reliable source of news about science that speaks to the needs of the local community (Brumfiel, 2009). Of course, the science news extends beyond newspapers—television, radio, and online news sources all depend on increasingly scarce advertising dollars as well.

An Example of the Constraints of Journalism and News Values in Practice

For clarity, an example of how the constraints of journalism and news values impact *science in the news* is perhaps in order. The following news article conveys the influence of news language—an aspect derived from newswork, audience assumptions, and editorial constraints. In 2008, the launch of the world's largest particle collider, the Large Hadron Collider (LHC), did not go as planned. Meant to begin hurtling protons around a 17-mile underground loop in September of that year, the $9 billion physics machine was famously stalled by electrical problems multiple times, prompting many to speculate that it might never be launched at all. At the time, there were countless articles published about this delay. I have chosen an article from the *New York Times*, originally published on August 3, 2009, to demonstrate exactly what I mean by the constraints of journalism. Titled "Giant Particle Collider Struggles", this article by journalist Dennis Overbye reports that physicists "are confident that the European machine will produce groundbreaking science—eventually," and quotes a scientist who helped build the collider, who notes that, "these [setbacks] are baby problems." Overbye continues, "Many physicists say they would be perfectly happy if the collider never got above five trillion electron volts. If that were the case, said [one theorist], 'It's not the end of the world. I am not pessimistic at all.'" This article presents the LHC and its ensuing difficulties in particularly positive language, using phrases like "baby problems" "perfectly happy" and "not the end of the world." The positive tone and language here is one example of how the practices of mass media shape the science in the news. In fact, science news articles have a history of being positive in tone and consequence (Einsiedel, 1992). For example, Lewenstein, Allaman, and Parthasarathy (1998) (cited in Weigold, 2001) analyzed news reports of biotechnology from 1970 to 1996 and found that coverage has in general emphasized positive outcomes.[5]

"Science in the News" is a Composite of "Science" and "News"

A second difficulty with current conceptualizations of *science in the news* concerns the limited way the concepts of *science* and *news* have been imagined. Many visions of *science in the news* are underpinned by an assumption that the *science* implicit in *science in the news* is easy to define, recognize, and know. A similar assumption is often made about distinguishing *news* from other sources of scientific information. However, as they relate to *science in the news*, both the terms *science* and *news* are more abstract and complex than they have previously been portrayed. Their boundaries are obscure and neither is a homogeneous object. For instance, past research has shown that students have a difficult time identifying scientific claims reported by mass media. In a study conducted by Manuel (2002), students commonly failed to identify statements based on facts and those based on opinion or inferences in *Popular Science*. In another study, Norris, Philips and Korpan (2003) found that first and second year college students had difficulty distinguishing between a "casual explanation" of a scientific phenomenon and the "actual" phenomenon (p. 23).[6]

This idea—that recognizing what counts as *science* and *news* is a less-than straightforward task—is partially derived from Hilgartner's argument against the "dominant view" of

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5 The LHC is also the very definition of the news value I call "sexy science." Little else can compete with a multi-billion dollar international effort to unlock the secrets of the universe. The LHC is fraught with the sort of danger and intrigue journalists love and that attracts the attention of the public—from its complicated construction to its novel mission to the (very slight) possibility that just by flipping the on-switch, we will all be sucked into a black hole.

6 Norris *et al.* define "casual explanation" as an explanatory strategy used by reporters to explain difficult ideas to non-experts. Those in the field of mass communication might also call this "popularization."

popularization (1990). Hilgartner argues that the dominant view assumes a two-stage model: first, scientists develop "genuine" scientific knowledge—facts, theories, laws, and concepts. Second, mass media disseminates popular accounts of that knowledge to the public (p. 519). Hilgartner observes that the distinction between "popular science" and "genuine science" suffers from conceptual problems that become clear when one tries to fix the precise location of the boundary between genuine scientific knowledge and popular representations. Embedded in a majority of the demand for a public capable of understanding science in the news is a similar assumption about recognizing what counts as *news* and *science* is a fairly straightforward process. However, when one looks for, in Hilgartner's terms, the "precise location" of the boundary of what does and does not qualify as *news* or *science* one runs into some difficulty (p. 519). As I will show, this difficulty stems from the fact that the concepts of *news* and *science* are neither fixed nor uniform.

Expanding the News Component of "Science in the News"

Many discussions about the definition of news begin with the following quotation from Arthur MacEwen, the first editor of the *San Francisco Examiner*, "News is whatever a good editor chooses to print" (cited in Boorstin, 1961, p. 8). While many journalists may disagree with this sentiment (they do have *some* say in what is news), it expresses a fundamental truth—all events are not necessarily newsworthy. What we call "news" results from a process of selection (Thoman and Jolls, 2003). That selection is based on values that are professionally, socially, and culturally derived. As I have outlined above, these values, called *news values*, tacitly shape every process of news production, from selecting a topic to choosing its title to selecting its accompanying graphics.

As I mentioned above, Hilgartner (1990) cast the problem of recognizing *science in the* *news* itself as an issue of differentiating "popular science" from "genuine science". As part of his argument, he provides a figure that places the contexts in which science is communicated on a continuum (Figure 6). These range from the "upstream" examples of papers in scientific journals to the "downstream" examples of mass media. Hilgartner's aim in making this continuum was not to suggest that there are no differences between scientific papers and news reports, but instead that popularization is matter of degree. I use Hilgartner's continuum here to propose one way to think about the *news* component of *science in the news.*

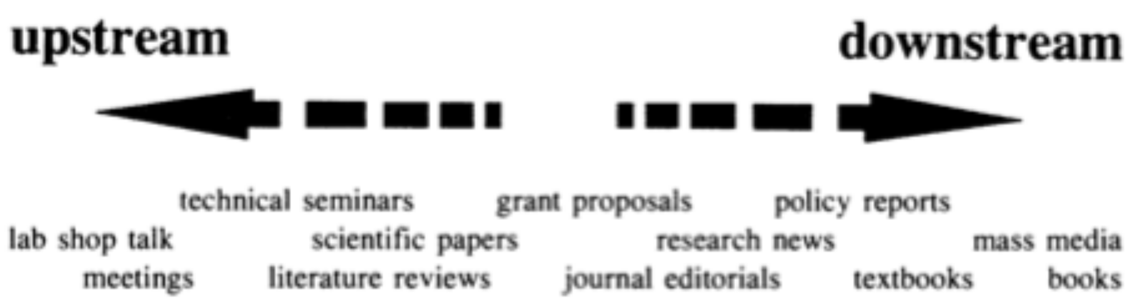

Figure 6. Hilgartner's (1990) contexts in which scientific knowledge is communicated. This figure illustrates upstream (scientific journals) and downstream (mass media) examples of where science is communicated (p. 528).

Hilgartner views mass media as one point on the continuum of science communication contexts. I argue that the category of mass media itself can be further dismantled into its own array of contexts (though these don't necessarily align themselves along a continuum). On this theoretical array of mass media, the *news* is one point—other points might include social media or entertainment media. *News* itself, however, can then be arranged along *another* continuum—one that depicts news sources as "upstream" or "downstream." For example, one could reasonably expect to see more in-depth science coverage in an "upstream" source like *Scientific*

American than in a "downstream" source, like *USA Today*. I hesitate to arrange news sources on an upstream-downstream continuum here, although it might be useful to illustrate my point, because my aim is not to definitively state what is and is not an "upstream" or a "downstream" source of scientific information. Instead, it is to demonstrate that the characteristics of *news* vary depending on outlet and audience. Consider, for example, the following two passages about how milk gets contaminated by radiation fallout. The first is from *Scientific American*:

> The thousands of children who became sick in the aftermath of the Chernobyl disaster were not harmed from direct radiation or even from inhalation of radioactive particles, but from drinking milk contaminated with iodine 131. The isotope, released by the Chernobyl explosion, had contaminated the grass on which cows fed, and the radioactive substance accumulated in cows' milk. Parents, unaware of the danger, served contaminated milk to their children (Bai, 2011, para. 17).

The second is from *USA Today*:

> Cesium is absorbed by plants and works its way through the food chain, getting into meat and milk. Unlike radioactive iodine, which has a short half life, cesium lingers in the environment. "Radioactive iodine will be gone in a month," Hoffman said. "Cesium's going to be around for decades" (Sternberg, 2011, para. 13).

Arguably, both examples display similar levels of Hilgartner's "simplification." Unless the science reported by either type of source is distorted or oversimplified, the difference between "upstream" and "downstream" sources is arguably a matter of degree.

Of course, there are other ways *news* might be categorized other than in Hilgartner's terms of "upstream" and "downstream." Indeed, in the mass communication literature *news* has been characterized according to several broad foci, including sources, messages, and channels (e.g. Friedman, Dunwoody, and Rogers, 1986; Shanahan and Morgan, 1999; Nisbet, Scheufele, Shanahan, Moy, Brossard, and Lewenstein, 2002). I have chosen to overlook these more traditional categories because each addresses the question "What is news?" in more specific way than I intend to here. I mean to show that *news*, in its function as a component of *science in the news*, is ambiguous, flexible, and dependent on context in the broadest terms possible.

Expanding the Science Component of Science in the News

As I have previously outlined, the idea that the public should understand science in the news rests on the assumption that the *science in the news* may be defined in essentially the same terms as *science.* The science component of *science in the news* is often defined in similar terms, according to the type of *science* a news article contains. Friedman, Dunwoody, and Rogers (1986), for example, define “science writing” as the coverage of “the biological, life, and physical sciences” as well as “the applied fields of medicine, technology, and engineering” (p. xv). This definition works as a way of describing the science topics covered by science journalists. As a means of identifying the science that appears in the news, however, it is insufficient, as *science in the news* is a more expansive concept than these categories permit. The question of what counts as *news science* extends beyond issues of identification—the degree of science content must also be taken into account. There are two aspects to consider here. First, a *science*-related object, phenomena, or event may or may not be the primary subject of a news report. As a result, *science in the news* may not necessarily be reported in scientific terms, be reported by a science journalist, or appear in a news section, segment, or publication devoted to science. A story about the economic impact of H1N1 on the American pork industry, for example, may appear in the business section of the *Washington Post* and, given its economic angle, may contain very little *science*-related content. Second, not all news reports are of equivalent depth and breadth regarding science content. As I described in the *news* portion of this chapter, there are an array of news sources. These news sources range from “upstream” to “downstream,” from the more specific to the less specific. *Science in the news* can be categorized in the same manner, from more to less specific. For example, the *science in the news* reported in *Scientific American* is arguably more specific than the *science in the news* that appears in *USA Today*. That means, in general, the *science in the news* that appears in *USA Today* is less technical than that of *Scientific American*. Of course, the issue of "simplification" is not limited to "downstream" sources. It occurs across the spectrum of news sources.

Again, an example may be the best way to demonstrate what I mean by degree of science content in *science in the news*. Consider the *New York Times* report on the Large Hadron Collider (LHC), described above. In addition to the reporting of scientists' reactions to the delay of the collider's launch, this article also contains a number of scientific terms and concepts, accompanied by varying levels of explanation. For example, the article describes the collider's main goals as "producing a particle known as the Higgs boson thought to be responsible for imbuing other elementary particles with mass, or identifying the dark matter that astronomers say makes up 25 percent of the cosmos" (Overbye, 2009, para. 7). Overbye also writes, "The collider was built to accelerate protons to energies of seven trillion electron volts and smash them together in search of particles and forces that reigned earlier than the first trillionth of a second of time, but the machine could run as low as four trillion electron volts for its first year" (para. 10). Now consider the following statements from a news editorial about the LHC published on the opinion page of the *Wall Street Journal*:

> But why, some ask, is this machine being built in Europe, and not the U.S.? President Ronald Reagan originally wanted to build a much larger machine, called the Super Conducting Super Collider, outside Dallas, Texas, to maintain U.S. leadership in advanced physics. Congress allotted $1 billion to dig a huge circular hole for the machine. But Congress got cold feet and cancelled it in 1993. Then Congress gave physicists another $1 billion to fill up the hole! As a consequence, Congress guaranteed that leadership in advanced physics would pass from the U.S. to Europe (Kaku, 2008, para. 6).

Here, there are few technical science terms or concepts to be found. Instead, the economic and social aspects of scientific enterprise, i.e. congressional spending and national competiveness, are emphasized.

These two examples demonstrate the variety of ways *science* may be conveyed in the news—the scope of *science in the news*. Although both articles are from what many would consider "upstream" sources, they exhibit different aspects of *science* and emphasize *science* to varying degrees. From these examples, two things become clear: first, the identification of what counts as *science in the news* does not cleanly map onto current categorizations of either *science* topics or news "beats"; and, second, *science in the news* has something to do with *science* but it also has something to do with *news*. Thus, it is a more broad and ambiguous entity than current thinking would suggest.

Conclusion

In the pursuit of a public capable of understanding science in the news, researchers, policymakers, and educators frequently overlook the distinguishing features of *science in the news*. Instead, they tend to envision *science in the news* as a relatively benign substitute for *science*. At best, they portray *science in the news* as an important means of assessing or defining some aspect of the relationship between *science* and society. At worst, they consider *science in the news* no more than a medium that transmits information about *science*. Yet as I hopefully shown, the distinguishing features of *science in the news* do indeed matter. *Science in the news* is not value-free. It is a product of mass media, composed of both *science* and *news*; it is assembled according to the social, cultural, and professional practices of journalists and their institutions; and, it is beholden to the norms and values of journalism. These *news values* shape what, how and when *science* is reported, tacitly selecting what, how, and when the public meets *science.* Indeed, one valuable aspect of distinguishing *science* from *science in the news* is that it creates a conceptual space for the knowledge required to make sense of these types of media issues (what mass communication researchers refer to as *media effects*). It also provides a means of separating *science* from the “thing” broadcast by mass media that has something to do with *science*, but is clearly not the equivalent of *science*. When stakeholders talk about the need for understanding science in the news, they arguably are not implying the public should understand that science as if it is context-free. It is likely they mean to yoke science to some social, cultural, or other function of news, in a gesture toward scientific literacy or public engagement with science. A type of meta-knowledge about science communication is sometimes referenced within these motions (see Ryder, 2001), but rarely in a meaningful sense. Arguably, a more effective way of thinking about this “thing” and its related knowledge is to consider it a separate entity from *science* with its own prescription for understanding.

Clarifying the characteristics of *science in the news*, however, is only one part of eliminating the confusion and disagreement over what it *means* to understand science in the news. I will examine another key instance of oversight—regarding interactions between the public and *science in the news*—in the next chapter.

References

Aikenhead, G. (2006). *Science education for everyday life*. New York, NY: Teachers' College Press.

Bader, R.G. (1990). How science news sections influence newspaper science coverage: A case study. *Journalism Quarterly, 67*(1), 88-96.

Bai, N. (2011, March 15). How radiation threatens health. *Scientific American.* Retreived from http://www.scientificamerican.com/article.cfm?id=how-radiation-threatens-health.

Boorstin, D. (1961). *The image: A guide to pseudo-events in America.* New York, NY: Vintage.

Brewer, P.R. and Ley, B.L. (2010). Media use and public perceptions of DNA evidence. *Science Communication*, *32*(1), 93-117.

Brossard, D. and Shanahan, J. (2006). Do They Know What They Read?: Building a scientific literacy measurement based on science media coverage. *Science Communication, 28*(1), 47-63.

Brumfiel, J. 2009. Supplanting the old media? *Nature, 458*, 274–277.

Burns, T.W., O'Connor, D.J., and Stocklmayer, S.M. (2003). Science communication: A contemporary definition. *Public Understanding of Science*, *12*, 183-202.

Carter, L. (2008) Sociocultural influences on science education: Innovation for contemporary times. *Science Education, 92*(1), 165-181.

Clark, F. and Illman, D.L. (2006). A longitudinal study of the *New York Times* science times section. *Science Communication, 27*(4), 496-513.

Cobern, W.W. and Loving, C.C. (2001). Defining "science" in a multicultural world: Implications for science education. *Science Education*, *85*, 50-67.

Dornan, C. (1990). Some problems of conceptualizing the issue of "science and the media." *Critical Studies in Mass Communication, 7*, 48-71.

Dudo, A., Brossard, D., Shanahan, J., Scheufele, D., Morgan, M., and Signorielli, N. (2011). Science on television in the 21st Century: Recent trends in portrayals and their contributions to public attitudes toward science. *Communication Research*, *38*(6), 754-777.

Dunwoody, S. (1980). The science writing inner club: A communication link between science and the lay public. *Science, Technology & Human Values, 5*(30), 14-22.

Duwoody, S. (1986). The scientist as source. In Friedman, S., Dunwoody, S., and Rogers C. (Eds.), *Scientists and Journalists: Reporting Science as News* (3-16). New York, NY: Free Press.

Dunwoody, S. (2008) Science journalism. In Bucchi, M. and Trench, B. (Eds.), *Handbook of Public Communication of Science and Technology* (15-26). New York, NY: Routledge

Einsiedel, E. (1992). Framing science and technology in the Canadian press. *Public Understanding of Science, 1*(1), 89-101.

Einsiedel, E. and Thorne, B. (1999). Public responses to uncertainty. In Friedman, S.M., Dunwoody, S., and Rogers, C.L. (Eds.), *Communicating Uncertainty: Media Coverage of New and Controversial Science* (43-57). Mahwah, NJ: Lawrence Erlbaum Associates.

Friedman, S.M. (1986). The journalist's world. In Friedman, S., Dunwoody, S., and Rogers C. (Eds.), *Scientists and Journalists: Reporting Science as News* (17-41). New York, NY: Free Press.

Friedman, S.M., Dunwoody, S., and Rogers, C.L. (1999). *Communicating Uncertainty: Media Coverage of New and Controversial Science* (43-57). Mahwah, NJ: Lawrence Erlbaum Associates.

Galison, P. and Stump, D.J. (Eds.) (1996). *The Disunity of Science: Boundaries, contexts, and power*. Stanford, CA: Stanford University Press.

Galtung, J. and Ruge, M.H. (1965). The structure of foreign news. *Journal of Peace Research*, *2*(1), 64-91.

Galtung, J. and Ruge, M.H. (1973). Structuring and selecting the news. In Cohen, S. and Young, J. (Eds.), *The manufacture of news: Social problems, deviance, and the mass media.* London, UK: Constable.

Gamson, W.A. and Modigliani, A. (1989) Media discourse and public opinion on nuclear power: a constructionist approach. *American Journal of Sociology, 95*, 1-37.

Gans, H. *(*1979*). Deciding what's news.* New York, NY: Patheon.

Gerbner, G., Gross, L., Morgan, M., and Signorielli, N. (1985) *Science and television*. A Research Report by the Annenberg School of Communications.

Gregory, J. and Miller, S. (1998). *Science in Public: communication, culture and credibility*. New York, NY: Plenum.

Haraway, D. (1989) *Primate visions: Gender, race, and nature in the world of modern science.* New York, NY: Routledge.

Hilgartner, S. (1990). The Dominant View of Popularization: Conceptual problems, political uses. *Social Studies of Science*, *20*(3), 519-539.

Hilgartner, S. and Bosk, C. (1988) The rise and fall of social problems: A public arenas model. *American Journal of Sociology, 94*, 53-78.
Irwin, A. and Wynne, B. (1996). *Misunderstanding science? The public reconstruction of science and technology*. Cambridge, UK: Cambridge University Press.

Jarman, R. and McClune, B. (2002). A survey of the use of newspapers in science instruction by secondary teachers in Northern Ireland. *International Journal of Science Education, 24*(10), 997-1020.

Kachan, M.R., Guilbert, S.M., and Bisanz, G.L. (2006) Do teachers ask students to read news in secondary science?: Evidence from the Canadian context. *Science Education, 90*(3), 496-521.

Kaku, M. (2008, September 13). Don't Buy in to the Supercollider Hype. *The Wall Street Journal*. Retrieved from http://online.wsj.com/article/SB122126297197130483.html.

Korpan, C. (2009) *Science literacy: What do students know and what do they want to know?* Retrieved from http://www.ccl-cca.ca/CCL/Research/FundedResearch/20100218Kropan.html.

Lewenstein, B.W. (1992). The meaning of 'public understanding of science' in the United States after World War II. *Public Understanding of Science, 1*, 45-68.

Lewenstein, B.V., Allaman, T., and Parthasarathy, S. (1998) Historical survey of media coverage of biotechnology in the United States 1970 to 1996. Paper presented at the annual meeting of the Association for Education in Journalism and Mass Communication, Baltimore, MD.

Lowrey, W. (2006). Mapping the journalism-blogging relationship. *Journalism, 7*(4), 477-500.

Manuel, K. (2002). How First-Year College Students Read *Popular Science*: An Experiment In Teaching Media Literacy Skills. *SIMILE: Studies in Media & Information Literacy Education, 2*(2), 1-12.

McClune, B. and Jarman, R. (2010). Critical reading of science-based news reports: Establishing a knowledge, skills, and attitudes framework. *International Journal of Science Education, 32*(6), 727-752.

Millar, R. and Wynne, B. (1988). Public understanding of science: from contents to processes. *International Journal of Science Education*, *10*(4), 388-398.

Miller, J. D. (1986) Reaching the Attentive and Interested Publics for Science. In Friedman, S., Dunwoody, S., and Rogers C. (Eds.), *Scientists and Journalists: Reporting Science as News* (55-69). New York, NY: Free Press.

National Newspaper Association (2010). *Annual Advertising Expenditures* (Data file). Retrieved from http://www.naa.org/Trends-and-Numbers/Advertising-Expenditures/Annual-All-

Categories.aspx.

Nelkin, D. (1995). *Selling science: How the press covers science and technology.* New York, NY: Freeman.

Nisbet, M. (2009a). Framing science: A new paradigm in public engagement. In Kahlor, L. and Stout, P. (Eds.), *Understanding science: New agendas in science communication* (40-67). New York, NY: Taylor & Francis.

Nisbet, M. (2009b). Communicating climate change: Why frames matter to public engagement. *Environment, 51*, 12-23.

Nisbet, M., Brossard, D., and Kroepsch, A. (2003). Framing science: The stem cell controversy in an age of press/politics. *Harvard International Journal of Press/Politics*, *8*, 36-70.

Nisbet, M. and Mooney, C. (2007). Policy forum: Framing science. *Science*, *316*, 56.

Nisbet, M. and Scheufele, D. (2007). The future of public engagement. *Scientist*, *21*, 38-44.

Nisbet, M. and Scheufele, D. (2009). What's next for science communication? Promising directions and lingering distractions. *American Journal of Botany, 96*(10), 1767-1778.

Nisbet, M.C., Scheufele, D.A., Shanahan, J., Moy, P., Brossard, D., and Lewenstein, B.V. (2002). Knowledge, reservations, or promise?: A media effects model for public perceptions of science and technology. *Communication Research*, *29*(5), 584-608.

Norris, S. P. and Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, *37*, 224 – 240.

Norris, S.P., Phillips, L.M., and Korpan, C.A. (2003). University students' interpretation of media reports of science and its relationship to background knowledge, interest, and reading difficulty. *Public Understanding of Science*, *12*, 123-145.

Overbye, D. (2010, August 3). Giant particle collider struggles. *New York Times.* Retrieved from http://www.nytimes.com/2009/08/04/science/space/04collide.html.

Pellachia, M.G. (1997). Trends in science coverage: A content analysis of three US newspapers. *Public Understanding of Science, 6*(1), 49-68.

President and Fellows of Harvard College (2010). The newsonomics of the fading 80/20 rule. Retrieved from http://www.niemanlab.org/2010/08/the-newsonomics-of-the-fading-8020-rule/.

Price, V. and Tewksbury, D. (1997). News values and public opinion: A theoretical account of media priming and framing. In Barnett, G.A. and Boster, F.J. (Eds.), *Progress in the communication sciences, Vol.13*. Greenwich, CT: Ablex.

Ryder, J. (2001). Identifying science understanding for functional scientific literacy. *Studies in Science Education*, *36*, 1-44.

Scheufele, D. (1999). Framing as a theory of media effects. *Journal of Communication, 49*, 103-122.

Scheufele, D. (2007). Nano does not have a marketing problem…yet. *Nano Today, 2*, 48.

Shanahan, J. and Morgan, M. (1999). *Television and its viewers: Cultivation theory and research.* Cambridge, UK: Cambridge University Press.

Sternberg, S. (2011, March 17) U.S. radiation experts try to decipher reports from Japan. *USA Today.* Retrieved from http://www.usatoday.com/news/world/2011-03-17-japanradiate17_ST_N.htm.

Thoman, E. and Jolls, T. (2003). *Literacy for the 21st Century. An overview and orientation guide to media and literacy education.* Los Angeles, CA: Center for Media Literacy.

Weigold, W.F. (2001) Communicating science: A review of the literature. *Science Communication, 23*, 164-194.

Wynne, B. (1991). Knowledges in context. *Science, Technology & Human Values*, *16*(1), 111-121.

Wynne, B. (2006). Public engagement as a means of restoring public trust in science – Hitting the notes, but missing the music? *Public Health Genomics, 9*(3), 211-220.

Ziman, J. (1991). Public understanding of science. *Science, Technology, & Human Values, 16*(1), 99-105.

Chapter 5: Interactions Between the Public and Science News

The appeal of a public capable of understanding science in the news is hard to deny. The kind of public this vision causes to spring to mind is equipped with some measure of both scientific understanding and civic, social, and cultural savvy. One can imagine this sort of public participating in dynamic discussions about the science in the news as easily as they might discuss traffic or the weather. To complicate this picture, however, we have reality. The same real-world constraints that impede many efforts to enhance the public understanding of science—time, access, interest, etc.—also prohibit citizens' critical engagement with science in the news (Nisbet and Scheufele, 2009). This vision is also at odds with knowable historical fact—few of us pay attention to the science news (Prewitt, 1982; Miller, 1986; Horrigan, 2006). Since 1986, the Pew Research Center for the People and the Press has collected data about the extent of public interest in major news events of the day. Their results reveal that science and technology news consistently appears among the categories of news that attracts below average attention. In 2008, the most recent year for which data is available, Pew's survey data showed that a mere 13 percent of the American public said they follow science and technology news "very closely."

Impediments like time and attention, however, are rarely mentioned in discussions about understanding science in the news, particularly among those in the science education community. Instead, encounters between the public and news reports about science are typically characterized as a straightforward interaction unhampered by context or purpose. For example, in *Science and the Educated American*, a report from the American Academy of Arts and Sciences, Hoskins (2010) describes students' reliance on mass media for scientific information thusly:

> [Students] now get much of their science information from television, which alternates between frightening the audience with doomsday scenarios ('Hazards in your breakfast cereal! . . . News at 11') and making heroes out of geeky gurus who solve complex

medical mysteries in sixty minutes of prime time (p. 151).

In the verb "get," Hoskins glosses over a considerable amount of variation—interactions with science in mass media can occur in a variety of ways for a variety of purposes. Missing from much of the talk about understanding science in the news, however, is a sense of just how complex interactions between citizens and news media can be. In an attempt to disrupt this trend, this chapter presents a model of interactions between the public and news reports about science that represents this encounter in a more authentic way.

This model shares a conceptual link with the interactive model of the public understanding of science (see Ziman, 1991; Wynne, 1991; Wynne, 1992; Layton, Jenkins, MacGill, and Davey, 1993; Irwin and Wynne, 1996; Allum, Sturgis, Tabourazi, and Brunton-Smith, 2008). This research indicates that how and why the public engages with science *matters*. Arguably, the two best-known examples of this type of research are Layton *et al.*'s case study of four distinct groups that deal with four different science issues and Wynne's investigation of how farmers respond to local consequences of radiation fallout. Broadly, these studies examined interactions between the public and sources of scientific information for personal or practical reasons. They found that the outcomes of these interactions are rarely based on knowledge alone. They are, in fact, built on complex interactions between personal and practical interests, in addition to social, cultural, and other factors. This idea—that context affects outcome—is a key feature of the present model. Here, I show that the public meets science news in one of two ways: purposefully or on accident, as the opportunity arises.

This model is not a comprehensive map of every instance of interaction between the public and science news, nor is it meant to be. Instead, it is a generalized portrait of the multiple ways one might encounter a news report about science and the erratic path to understanding that occurs as a result. The goal here is to demonstrate that in our pursuit of a public capable of understanding science in the news, the context in which science news is encountered should not be considered some trivial thing. It shapes they way we understand, interpret, and respond to media messages and the science communicated within them. (For a complete conceptual overview of the various models of science communication, see Logan (2001) and Weigold (2001).)

A Model of Interactions between the Public and Science News

According to Lucas (1983), interactions between scientific information and the public can be broadly placed into two categories: intentional and unintentional. The present model expands Lucas's terms, charting the course of each to its various conclusions (Figure 7). There are, of course, countless situations wherein one might encounter the news and unlimited factors that influence that interaction, including attention, interest, and exposure (Chaffee and Schleuder, 1986; Hidi, 1990). Each limits the degree to which news media might impact public knowledge about science. I have set these limiting factors aside here not to minimize their role, but for the sake of clarity.

Unintentional interactions are unplanned interactions with the science news. This category includes both *accidental* interactions, like watching CNN in a dentist's waiting room or reading over someone's shoulder on the bus, and *inadvertent* interactions. Inadvertent interactions occur when one is already engaged with the news and comes across science. There are two categories of inadvertent interactions. The first occurs when there is a science component to a news report that is not necessarily about science, like a story about the economic impact of the H1N1 virus on the American pork industry. The second inadvertent interaction occurs when one happens upon science news, like following a link from a travel-related story to a science-related story, or pausing to read a science story as you flip through the *Chicago Tribune*.

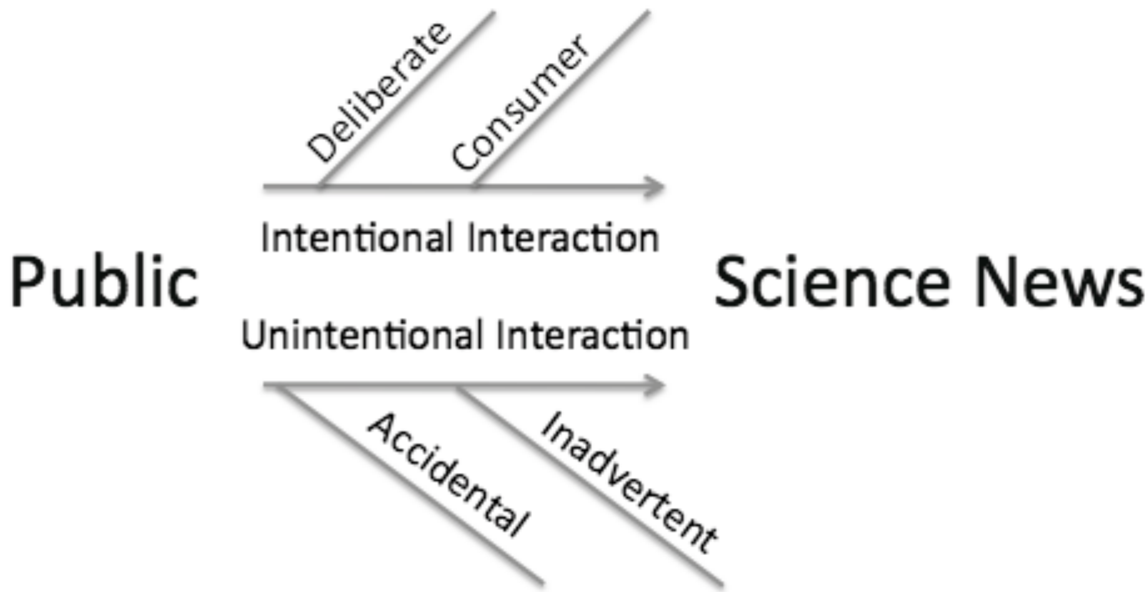

Figure 7. Intentional and unintentional interactions between the public and science in the news. This figure illustrates the number of ways an individual may interact with science in the news. Each of the secondary branches can be further broken down.

The second type of interaction involves actively seeking news about science. This type of interaction is an *intentional* interaction. This category also includes two groups: 1) those who are deliberately searching for information about science and 2) regular consumers of science news. Both of these groups are multiply divisible. For example, a search for information about science or a scientific issue in the news could have its origins in a classroom assignment, a local environmental disaster, a health-related concern, etc. Alternatively, a “regular” science news consumer could engage with one news source once a month or nine news sources once a day, with a variety of intervals in between.

Previously, I stated that this model of interaction is derived from the interpretive model of the public understanding of science. A key feature of the interpretive model is that scientific knowledge does not always flow from experts to laypersons, but is instead multidirectional (Wynne, 1992). Logan (2001) explains that within the interactive tradition, science knowledge is viewed as less certain and, as a result, might be thought of as more of an informal conversation or shared experience between citizens and the scientific community. In looking at the unidirectional model I have presented above, it may seem as if I have abandoned this principle. I have not. The model's form reflects the fact that I am addressing interactions between the public and news as an object, not as an organization or institution. As such, there is no option for feedback or dialogue.

About News Mediums

Although the model described above is meant as a generalized portrait of public interactions with science news, the role of news mediums—television, print, digital media, etc.—should be acknowledged, for not all mediums impact knowledge about science in the same way. For instance, research from Nisbet, Scheufele, Shanahan, Moy, Brossard, and Lewenstein (2002) reports that newspaper reading and television viewing may shape general knowledge of science and technology. Brossard and Nisbet (2007) additionally found that newspaper reading affects knowledge about specific domains of science, like biotechnology. The prominence of online communication has implications for interactions with science news as well. Indeed, it is not hyperbole to state that the advent of the Internet has changed everything about how the public interacts with the news. Information is available online at an unprecedented volume; the boundary between journalists and bloggers is increasingly blurry; and formerly clear distinctions between mediums are disintegrating. David Carr, writing in the *New York Times*, observes that “lines are being erased all over the place. Open up Gawker, CNN, NPR and *The Wall Street Journal* on an iPad and tell me without looking at the name which is a blog, a television brand, a radio network, a newspaper. They all have text, links, video and pictures” (para. 15).

The Pew Research Center for the People and the Press (2010) reports that from June 8-28, 2010 (a random week), roughly a third (34 percent) of the public polled went online for general news (Figure 8). This is equivalent with radio and slightly higher than daily newspapers. When digital sources are added in (cell phones, email, social networks, etc.), 44 percent of Americans polled received their news through one or more digital sources during this time. As for science news, nearly a quarter of Americans (20 percent) say they go online for their news and information about science (Horrigan, 2006). That translates into about 40 million Americans.

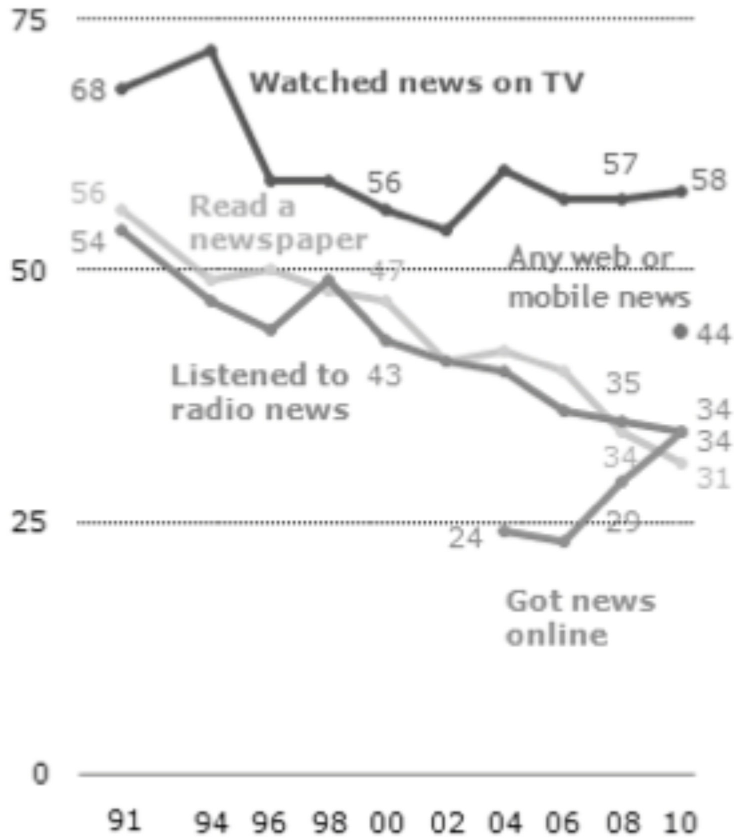

Figure 8. News Sources. A graph from the Pew Research Center for the People and the Press (2010) that shows “where people got their news yesterday.”

Where the Internet perhaps has the greatest impact, however, is in how we search for news about science. As the graph above shows, most of the public still receives a majority of its general news directly from traditional news sources (particularly television news). When they are looking for information about specific science or technology topics, however, they most likely turn to an Internet search engine. That is, we are increasingly turning to Google for information about science, not *The New York Times* or NBC. To wit, a recent survey found that Americans turn to internet search engines first to "look up the meaning of a particular scientific term or concept," "look for an answer to a question [they] have about a scientific concept or theory," and "learn more about a science story or scientific discovery [they] first heard or read about offline" (Horrigan, 2006, p. 5).

What is perhaps most striking about the public's current interaction with online news, however, is *how* it happens. Increasingly, the public is acting as its own news editor. A majority of Americans (51 percent) are what Pew Research calls "news grazers", people who check in on the news from time to time rather than going at regular times (2008). They check for news throughout the day, clicking through multiple links and RSS feeds. These "grazers" shape their own news, rather than having preselected content delivered to them through newspapers or television. The effect of this behavior on the public's attitudes and knowledge is only beginning to be studied. As regards science, research has primarily been directed toward deciphering who uses digital media for what purposes, not how they understand the science it contains (e.g. Anderson, Brossard, and Scheuefele, 2010). What this means for interactions with science in the news in the digital realm is unclear. Yet given that 15 percent of Americans are "attentive" to science, it stands to reason that a majority of the public, if they so chose, could never interact with science in the news at all.

Conclusion

Current working notions of understanding science in the news suggest that the type of understanding that occurs when the public meets the science news is scientific understanding. Yet as straightforward as this explanation might seem, there are difficulties in describing the understanding occurring in this instance as scientific understanding. I have already explained how science news is shaped by the practices and values of journalism, thus creating *science in* *the news*—an entity only partially addressed through scientific knowledge. The present model gives a second cause for hesitation. The context for interactions between the public and science news is multiply ambiguous. That is, science news is not encountered in a vacuum—it is met in a variety of ways for a variety of purposes. Scholarship from the field of science and technology studies suggests that the sort of understanding at work in similar uncertain science-related circumstances is about more than scientific knowledge—it also enlists prior knowledge, personal and practical interests, as well as social, cultural, and other factors (e.g., Wynne, 1992; Irwin and Wynne, 1996; Collins and Pinch, 1998). In looking at the multiple ways the public meets science news, interactions with the science that appears in news media are clearly also about more than making sense of scientific facts and processes. Personal and practical motivations, like learning for self-interest or needing information to interpret one's circumstances, and chance encounters prohibit public interactions with science news from being solely about knowledge.

Yet if, as I am suggesting, public interactions with science news cannot be viewed in terms of knowledge, then it would seem equally unworkable to describe the resulting form of understanding here as understanding science in the news. Arguably, the understanding described above is no more about knowledge about *science in the news* than it is knowledge about *science*. What must be considered, then, is that understanding news reports about science enlists a range of knowledge, is a multifaceted process, and may or may not rely upon knowledge about *science.* To account for the range of ways citizens actually interact with and use science news, we must consider that there is not *one* way to understand the science news, but several. This idea—that the understanding implicit in understanding science news is variable—runs contrary to current working notions that portray this understanding as a fairly straightforward outcome of interactions between the public and science news. Science journalists, for example, tend to view understanding as some unified *thing* that might be accomplished if only science communication was done “better” (Hartz and Chappell, 1997; Nelkin, 1995). It also opposes those who would suggest that scientific knowledge is the primary mechanism for understanding news reports about science (e.g. Nisbet *et al*., 2002). Although it is true that scientific knowledge provides some measure of the understanding necessary to understand science in the news, a more comprehensive way of describing the understanding that occurs when the public meets the science news is as a variable phenomenon dependent on context and purpose. In the next chapter, I describe what exactly this adaptable vision of understanding science in the news might look like.

References

Anderson, A.A., Brossard, D., and Scheufele, D.A. (2010). The changing information environment for nanotechnology: Online audiences and content. *Journal of Nanoparticle Research, 12*, 1083-1094.

Allum, N., Sturgis, P., Tabourazi, D., and Brunton-Smith, I. (2008). Science knowledge and attitudes across cultures: A meta-analysis. *Public Understanding of Science, 17*, 35-54.

Brossard, D. and Nisbet, M. (2007). Deference to scientific authority among a low information public: Understanding American views about agricultural biotechnology. *International Journal of Public Opinion Research, 19*, 24-52.

Carr, D. (2010, October 10). A vanishing journalistic divide. *New York Times.* Retrieved from http://www.nytimes.com/2010/10/11/business/media/11carr.html?_r=1.

Chaffee, S.H. and Schleuder, J. (1986). Measurement and effects of attention to media news. *Human Communication Research, 13*(1), 76-107.

Collins, H. M. and Pinch, T. (1993). *The Golem: what everyone needs to know about science*. Cambridge, UK: Cambridge University Press.

Hartz, J., and Chappell, R. (1997). *Worlds apart: How the distance between science and journalism threatens America's future*. Nashville, TN: First Amendment Center, Freedom Forum.

Hidi, S. (1990). Interest and its contribution as a mental resource for learning. *Review of Educational Research, 60*(4), 549-571.

Horrigan, J.B. (2006) The Internet as a resource for news and information about science. Pew Internet & American Life Project. Retrieved from http://www.pewinternet.org/Reports/ 2006/The-Internet-as-a-Resource-for-News-and-Information-about-Science.aspx.

Hoskins, S.G. (2010). Teaching science for understanding: focusing on who, what, and why. In Meinwald, J. and Hildebrand, J.G. (Eds.) *Science and the educated American: A core component of liberal education* (151-179). Cambridge, MA: American Academy of Arts and Sciences.

Irwin, A. and Wynne, B. (1996). *Misunderstanding science? The public reconstruction of science and technology*. Cambridge, UK: Cambridge University Press.

Layton, D., Jenkins, E., Macgill, S., and Davey, A. (1993). *Inarticulate science? Perspectives on the public understanding of science and some implications for science education.* Leeds, England: University of Leeds.

Logan, R.A. (2001). Science mass communication: Its conceptual history. *Science Communication, 23*(2), 135-163.

Lucas, A.M. (1983). Scientific literacy and informal learning. *Studies in Science Education, 10*(1), 1-36.

Miller, J. D. (1986) Reaching the Attentive and Interested Publics for Science. In Friedman, S., Dunwoody, S., and Rogers C. (Eds.), *Scientists and Journalists: Reporting Science as News* (55-69). New York, NY: Free Press.

Nelkin, D. (1995). *Selling science: How the press covers science and technology.* New York, NY: Freeman.

Nisbet, M. and Scheufele, D. (2009). What's next for science communication? Promising directions and lingering distractions. *American Journal of Botany, 96*(10), 1767-1778.

Nisbet, M.C., Scheufele, D.A., Shanahan, J., Moy, P., Brossard, D., and Lewenstein, B.V. (2002). Knowledge, reservations, or promise?: A media effects model for public perceptions of science and technology. *Communication Research*, *29*(5), 584-608.

Pew Research Center for the People & the Press. (2008). *Key news audiences now blend online and traditional sources*. http://pewresearch.org/pubs/928/key-news-audiences-now-blend-online-and-traditional-sources.

Pew Research Center for the People & the Press. (2010). *Americans spending more time following the news*. Retrieved from http://www.people-press.org/2010/09/12/section-1-watching-reading-and-listening-to-the-news/.

Prewitt, K. (1982). The public and science policy. *Science, Technology & Human Values, 7*(39), 5-14.

Weigold, W.F. (2001) Communicating science: A review of the literature. *Science Communication, 23*, 164-194.

Wynne, B. (1991). Knowledges in context. *Science, Technology & Human Values*, *16*(1), 111-121.

Wynne, B. (1992). Misunderstood misunderstandings: Social identities and public uptake of science. *Public Understanding of Science*, *1*(3), 281-304.

Ziman, J. (1991). Public understanding of science. *Science, Technology, & Human Values, 16*(1), 99-105.

Chapter 6: A Functional Conceptualization of Understanding Science in the News

In early 2009, H1N1, a respiratory disease caused by a new strain of the influenza virus, quickly swept across the globe, infecting millions.[7] News about the spread of H1N1—and the reactions of a panicked public— had an equally swift trajectory. According to analysis by the Pew Research Center's Project for Excellence in Journalism (2009), coverage of H1N1 (then called “swine flu”) accounted for 31 percent of all news reported in the American mainstream press in April 2009, the month the first outbreaks were reported in Mexico. In comparison, the combined coverage of other key events at that time, including a senior Republican senator switching parties and President Obama’s 100th day in office, warranted 30 percent of total news coverage. Bloggers and social media devoted an equal amount of attention to H1N1—Pew’s New Media Index (2009) reports that 32 percent of the links from blogs and social media sites during that time were H1N1-related.

Initially, mainstream news reports about H1N1 were content-focused, covering the sheer number of infections and introducing science-related information about the first influenza pandemic in four decades. Gradually, however, reporting evolved to include angles of human interest and the adverse impacts of the extended, somewhat frantic, media coverage itself. This coverage ranged from concerns about the livelihoods of those in the pork industry to a catalog of precautionary measures, many of which were an overreaction, taken by the public, like avoiding elevator buttons and library books (Grady, 2009; Davey, 2009). On news blogs, attention to H1N1 mainly focused on the preliminary nature of the information available and its effects on human behavior (Pew Research Center’s Project for Excellence in Journalism, 2009). For

[7] The CDC estimates that between 14 million and 34 million cases of H1N1 occurred between April and October of 2009.

example, *The Lede*, a blog hosted by the *New York Times,* noted that many of the fears about H1N1 were "based on misinformation, or an unwillingness to wait until scientists have had time to develop solid information about this new strain of the flu—like where it started, how dangerous it really is and what steps the world might take to stop it from spreading" (Mackey, 2009, para. 1).

What this coverage effectively demonstrates, in addition to the increasingly fluid definition of news media, is the breadth of knowledge needed to understand science in the news—from basic content knowledge (What is a virus?) to making connections among ideas (I cannot get H1N1 from eating pork.) to applying a meta-knowledge of mass media and its practices (Don't panic!). This is, however, not the kind of knowledge referred to by current working notions of understanding science in the news. Instead, those notions, like the one put forth by AAAS's *Project 2061*, typically refer to the types of knowledge necessary to understand *science*—that is, knowledge of scientific facts and theories, the ability to interpret science text, an awareness of the relationship between science and society, etc. Missing, I argue, is knowledge of the practices and processes of journalism that shape *science* into *science in the news*.

The coverage of H1N1 described above also demonstrates that the public interacts with the news in multiple ways and for multiple purposes. Those interactions vary in medium (Newspaper or Internet news?), message (Go to the hospital! No! Stay away from the hospital!), and context (I live near a pork production plant—should I be concerned?). Current conceptualizations of understanding science in the news rarely consider the impact of these variations on understanding. Instead, they assume that science news is easily divorced from its context—both in terms of its function as a product of mass media and the personal circumstance in which it is encountered.

In response to these oversights, this chapter puts forth one way we might think about the concept of understanding science in the news that incorporates knowledge of the practice and process of journalism and the idea that interactions with the news are context-dependent. This conceptualization is based on the description of understanding science in Chapter Two as an amalgam of knowledge and application.

Understanding Science in the News

There is substantial overlap between understanding science in the news and understanding science. Like understanding science, understanding science in the news calls for knowledge of science and the application of that knowledge. For example, to make sense of H1N1 as *science*, one needs a basic understanding of how viruses work. One can then draw upon that knowledge to, say, make a personal decision about eating pork or recognize that using antibacterial soap won't prevent inoculation. Similarly, one needs knowledge of science to make sense of H1N1 as *science in the news*. Yet in addition to knowledge of science, one must also apply at least as much knowledge of journalism (Figure 9). That is, one needs a basic understanding of how viruses work as well as the capacity to recognize that, as a result of its interpretation by journalists, information about H1N1 presented in the news may differ from information presented in other contexts. That difference may be factual, like an untrue statement, or it may be related to journalistic practice, like the overall tone of an article.

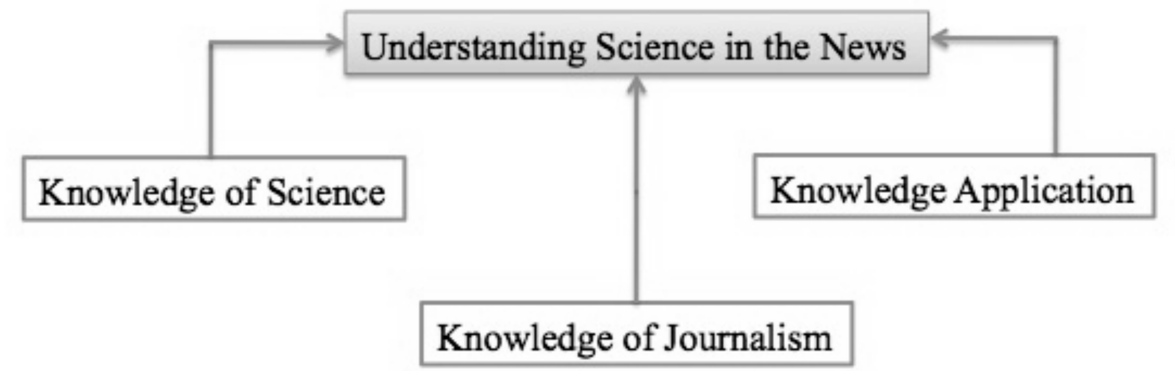

Figure 9. Visualizing understanding science in the news. The understanding implicit in understanding science in the news relies on knowledge of journalism and knowledge of science.

Arguably, the outcomes of understanding science and understanding science in the news look identical—one can make the same decision about eating pork or using antibacterial soap from understanding either *science* or *science in the news*. The "understanding" that leads to this outcome, however, is profoundly different. In addition to knowledge of journalism, knowing when and how to apply knowledge of journalism distinguishes understanding science in the news from understanding science. For example, if one knows that news editors can substitute the word "is" for "may" in the interest of style, one can apply that knowledge to know why *science in the news* can neglect to inform public of the tentative nature of scientific findings and remove any sense of uncertainty from scientific research. Understanding science in and of itself does not support this capacity. One may know that uncertainty is part of science, but the type of understanding called for in this particular instance is not derived solely from knowledge of science—it emanates from knowledge of science *and* journalism. In Chapter Two, I described knowledge of science as knowledge about the natural world and knowledge about science as an institution. Below, I present a conceptualization of *knowledge of journalism.*

Knowledge of Journalism

For the purpose of understanding science in the news, knowledge of journalism entails knowledge about practices and process of journalism and the characteristics of news reports. Broadly, one should know that the news is a construction shaped by news values. A discrete knowledge of these values, while desirable, is not necessary. For example, one need not know the precise definition of the term *timeliness* to understand that a scientific event, object, or phenomenon counts as news because it is happening right now. Rather, the public should have an awareness of the fact that there is a decision-making process involved in news making that does not necessarily reflect a scientific or educational point-of-view or values. As a result, the science that appears in the news is simplified by degrees, can appear in any section/segment, may or may not be central to the story, and may not even be reported in scientific terms.

The framework of “science achievement” conceived by Shavelson, Ruiz-Primo, Li, and Ayala (2003) I previously outlined in Chapter Two can also be used to sort knowledge of journalism in a useful way. Shavelson *et al.* organize knowledge about science into four categories: *declarative* knowledge (“knowing that”), *procedural* knowledge (“knowing how”), *schematic* knowledge (“knowing why”) and *strategic* knowledge (“knowing when, where and how our knowledge applies”) (p.7-8). These same categories can be used to describe the types of knowledge needed to understand the media component of science in the news (Table 4).

Knowledge of Journalism includes:

"Knowing That"	"Knowing How"	"Knowing Why"	"Knowing When, Where, and How"
news is shaped by the norms, values, and practices of journalism	news gets distorted: e.g., misinterpretation, simplification, sensationalism, omission	news has embedded values	*science in the news* differs from *science*
journalists, editors, and publishers have different interests and values than educators, scientists and even the public	science-based news stories are assembled (broadly)	news may contain errors	
not every science-related event, idea, or phenomenon is newsworthy	to distinguish *news* from other sources of scientific information	scientific disputes may be reported as one-sided	
the science-component of *science in the news* may be difficult to define, recognize, and know			

Table 4. Conceptual Knowledge of Journalism. This table describes the kinds of knowledge the public might be expected to know about journalism.

To demonstrate the role of knowledge of journalism in understanding science in the news, consider the following passage from *USA Today* that previously appeared in Chapter Four:

> Cesium is absorbed by plants and works its way through the food chain, getting into meat and milk. Unlike radioactive iodine, which has a short half life, cesium lingers in the environment. "Radioactive iodine will be gone in a month," Hoffman said. "Cesium's going to be around for decades" (Sternberg, 2011, para. 13).

The range of knowledge needed to make sense of this statement includes "knowing that" cesium is an element and "knowing why" the length of an element's half life matters. Yet it also includes "knowing that" the phrase "getting into meat and milk" is an abbreviated way of conveying information about the digestion and absorption of nutrients and "knowing why" *USA Today* is a different kind of information source than, say, the National Institutes of Health (NIH).

To describe the knowledge one must draw on to understand this passage merely in terms of science ignores the nature and larger purpose of understanding science in the news. Educators, scientists, and policymakers call on understanding science in the news *because* it is a product of journalism and a valuable source of science information delivered outside of formal education and technical and professional science publications. Educators, for example, use science news to link the science taught in school and science in the world outside of the classroom (Jarman and McClune, 2002). Yet the very thing that has attracted attention to the science news has been routinely excluded from conceptualizations of its understanding. Although the passage above can be understood more or less in terms of science, it is knowledge of journalism that distinguishes understanding science in the news from understanding science in any other context.

What I call "knowledge of journalism" differs from "knowledge about science communication," a concept encountered in the field of literacy and language studies (e.g. Lemke, 1998; Wellington and Osborne, 2001). Perhaps one of the best known of these efforts is the work of Ruth Jarman and Billy McClune, who have studied how the science news is used in the formal school science classroom for much of the past decade (2000, 2002, 2003, 2005, 2007, 2010). Most recently, they compiled a comprehensive list of the knowledge, skills, and attitudes required for a critical reading of the science news. This list was compiled from interviews with individuals "with recognized expertise or interest in science in the news, drawn from a range of disciplines and areas of practice" (2010, p. 727). Jarman and McClune's work emphasizes the role of literacy in shaping knowledge about "newspaper science." For example, one category on their list is "knowledge of writing and language" and one aim in this category is that students should "understand that critical reading requires the reader's active involvement to make meaning" (p. 738). While Jarman and McClune's framework includes knowledge about news values and the practices of journalism, the barrier to "understanding" here is considered in terms of literacy practices. Jarman and McClune ask: What does the public need to know about journalism when they *read* about science in the news? Alternatively, the present conceptualization of "knowledge of journalism" focuses on knowledge about the practices and processes of journalism that may be applied in any medium and across contexts.

Implications

If, as I am suggesting, the understanding inherent in understanding science in the news is comprised of knowledge about science and journalism, then we have fundamentally misjudged what it means to understanding science in the news. It is not, as educators, scientists, and researchers have previously assumed, essentially the same as understanding science. It is a much more nuanced and complex phenomenon. Therefore, if there is to be any authentic movement toward achieving a public capable of understanding science in the news, these stakeholders must amend their perspective to reflect the true nature of understanding science in the news. This dissertation argues there are two key areas where current perspectives should be revised: 1) how we view the knowledge necessary for understanding science in the news and 2) the very character of science in the news itself.

The first area where current thinking about understanding science in the news needs revision is how we view the knowledge necessary for understanding science in the news. This is true in that understanding science in the news is not only about understanding science. Yet it is also true in that there is no fixed prescription for understanding science in the news. The body of knowledge necessary for understanding science in the news is a flexible thing, shaped by context and displaying nuance. The changeable nature of the knowledge needed for understanding science in the news is due partly to the multiple ways the public interacts with science news—different contexts require different types and levels of knowledge. Prior knowledge, personal circumstance, and other contextual factors may modify knowledge established independently of its context of application (Jenkins, 1994).

The second area I argue current thinking must be adjusted regarding how science in the news is currently defined. In particular, there are two areas that we must consider in a more critical way. The first is how we think about the relationship between *science* and *science in the news*. The science in the news is clearly related to science, but differs in significant ways that should not be overlooked. The science in the news is a product of mass media, assembled according to the social, cultural, and professional practices of journalists and their institutions and, ultimately beholden to the norms and values of journalism. The second aspect of science in the news that calls for further investigation is the character of the terms "science" and "news" in the context of science in the news. There is an assumption that both are homogenous and easy to recognize, but I argue that both terms are more obscure than has previously been known.

The reform of how we think about understanding science in the news takes on new importance when one considers that when formal science education ends, mass media is the public's primary source of information about scientific discoveries, controversies, events, and the work of scientists (Friedman, Dunwoody, and Rogers, 1986; Nelkin, 1995; Korpan, Bisanz, and Bisanz, 1997; Zimmerman, Bisanz, Bisanz, Klein, and Klein, 2001; Nesbit, Scheufele, Shanahan, Moy, Brossard, and Lewenstein, 2002; Kennedy and Overholser, 2010). Science news also informs scientists themselves about fields outside of their own. Bauer (1992) found that scientists and others who pursue careers in science rarely follow the primary literature for all scientific disciplines. Scientists and non-scientists alike, then, must rely on *science in the news* to some extent for information about science. Given this key role, recognizing how and why *science in the news* varies from *science* matters because of it sets the tone and nature of the interface between science and society. In turn, it also has profound implications for how educators, policymakers, and scientists regard understanding science in the news as a learning goal. No longer will it be a throwaway objective, but instead, a valuable end in own right.

For science educators, the transformation of understanding science in the news from its current neglected state into a complex learning goal is a fairly straightforward process. It begins with the recognition that the science news is neither context- nor value-free. It is a product of mass media that is 1) assembled according to the social, cultural, and professional practices of journalists and their institutions and 2) beholden to the norms and values of journalism. In the science classroom, then, activities that involve science news should, in addition to relying on knowledge of science should also involve some dimension of knowledge of journalism. One can imagine a lesson that aims to enhance students' critical evaluation skills wherein the instructor questions both types of knowledge. For example, a lesson about the H1N1 virus that uses the science news might ask students to evaluate the relationship between the tone of the article (knowledge of journalism) and the facts about H1N1 presented in the article (knowledge of science). Is the tone positive or negative? Does the tone of the article "match" the facts presented in the article? Why might that relationship matter?

In pursuit of an enhanced public understanding of *science*, it may seem unwarranted, even inappropriate, to call for an understanding of values, norms, and practices of journalism.

Indeed, it seems the detailed knowledge required to recognize even the smallest effect of journalism—its constraints, nature, practices, and character—lies far afield from both the school science curriculum and the Public Understanding of Science (PUS) Movement. I would argue, however, that encouraging the types of skills and knowledge necessary for recognizing the distinction between *science in the news* and *science* fits squarely on the agenda of both. Thus far, educators, scientists, and researchers have asked students and the public to recognize and know what counts as *science* according to their understanding of science content, process, or socio-scientific knowledge. In the particular instance of *science in the news*, these types of knowledge are simply not enough. Science news stories present technical aspects of science, provide information about the social context of scientific work, and report on the wider social implications of scientific knowledge. For all intents and purposes, the science reported in the news appears as *science.* These reports, however, innately reflect news values—that is, they promote the visions of journalists, editors, publishers, and their institutions rather than those of science professionals and theirs. Although this version of science is related to *science,* it is its own entity, called *science in the news*. To gain the insights and knowledge about *science* imparted by *science in the news*, some knowledge of mass media is arguably equally necessary.

For researchers, the role of knowledge of mass media in understanding science in the news is important to recognize for one key reason. The insight and knowledge needed for understanding science in the news are often described as some measure of scientific literacy. These measures of scientific literacy have been developed to gauge multiple conceptualizations of “science.” The difficulty here resides in the fact that the results obtained through the use of this measure inaccurately depict the nature of the knowledge being called upon. Missing is an account of how participants make sense of what I call the news component of science in the news. For example, in Jon Miller's (1998) conceptualization of civic scientific literacy, the most widely cited conceptualization of civic scientific literacy, he suggests understanding science in the news is as relatively straightforward as understanding the science terms that appear in mass media. While this certainly reveals whether or not one can recognize and know science terms, it discloses nothing about how one makes sense of the news frame those terms are embedded within. That is, this research discloses vocabulary prowess, not the capacity to understand science in the news.

In addition to providing a way of thinking about the knowledge required to understand *science in the news* on its own terms, the present conceptualization can also be used to communicate about understanding science in the news across disciplines. Educators, policymakers, scientists, and researchers can use this model to identify exactly what they are referring to when they suggest the public should understand science in the news. These groups can now "point," in a theoretical way, to exactly the kind of knowledge they mean. Do they mean knowledge of science? Knowledge of journalism? Some measure of both? While this function may seem small, its duty is considerable. For nearly a century, the notion of understanding *science in the news* has been put forth across multiple disciplines as a worthy educational aim and social objective. One of the primary obstacles in the path of its achievement, however, has been the diverse array of opinion from across multiple disciplines about what the public should know about the science in the news and why they should know it. This conceptualization offers, for the first time, a way these visions and their respective fields might be brought into alignment.

Conclusion

Calling for a radical revision of how we think about understanding science in the news, however, is a relatively easy task. The real challenge resides in gaining acceptance across multiple disciplines and implementing foundational changes to a well-established educational and social aim. To spur this revolution, perhaps a new question is in order. Instead of asking: What does it mean to understand science in the news? The more pressing question might be: What are the consequences if we don't? In future studies, then, I plan to examine the role of understanding science in the news in civic and social participation. How, if at all, does understanding science in the news affect citizens' decisions to take action (broadly defined) on a science-related event or issue? How, if at all, does that participation differ from decisions made based on understanding science in other contexts? I also plan to explicitly address the conceptual disconnect between the fields of science education and science communication. Of course, some disagreement is to be expected between fields. But what is most striking in this particular disagreement is that it has, for the most part, been ignored. This is partially due to the nature of the relationship between these two fields. Despite their common concerns, the science education and science communication literatures rarely overlap. What exactly are these common concerns? And what exactly are the consequences of this division?

As an enduring goal of science education, understanding science in the news has been deeply misunderstood. In our pursuit of a public that can critically evaluate and respond to science, we have narrowly seized what it means to understand the science in the news. As a result, we have 1) neglected other forms of significant understanding that may be gained therein and 2) overlooked the multiple challenges to linking understanding science in the news to scientific understanding in general. The real value of understanding science in the news, I argue, resides in its unique function as a means of connecting society with the ideas, traditions, and people inspired by science. Though the science news, we are granted the opportunity to engage with the most fantastic, curious, and human parts of science. To define science in the news merely in terms of what one should know about science, then, forgoes the astonishing vision of what one could.

References

Bauer, H.H. (1992). *Scientific literacy and the myth of the scientific method*. Chicago, IL: University of Illinois Press.

Davey, M. (2009, April 30). Thousands face a balancing act over flu fears. *New York Times.* Retrieved from http://www.nytimes.com/2009/05/01/health/01fear.html.

Friedman, S., Dunwoody, S., and Rogers C. (1986). *Scientists and Journalists: Reporting Science as News.* New York, NY: Free Press.

Grady, D. (2009, April 30). W.H.O. gives virus a name that's more scientific and less loaded. *New York Times.* Retrieved from http://www.nytimes.com/2009/05/01/health/01name.html

Jarman, R. and McClune, B. (2002). A survey of the use of newspapers in science instruction by secondary teachers in Northern Ireland. *International Journal of Science Education, 24*(10), 997-1020.

Jarman, R. and McClune, B. (2003). Bringing news reports into the classroom: Citizenship and science education. *School Science Review, 84*(309), 121-129.

Jarman, R. and McClune, B. (2005). *Science newswise: A guide to the use of newspapers in science teaching*. Belfast, UK: Queen's University Belfast.

Jarman, R. and McClune, B. (2007). *Developing scientific literacy*. Maidenhead, UK: Open University Press.

Jenkins, E.W. (1994). Public understanding of science and science education for action. *Journal of Curriculum Studies, 26*(6), 601-611.

Kennedy, D. and Overholser, G. (2010) *Science and the media.* Cambridge, MA: American Academy of Arts and Sciences.

Korpan, C.A., Bisanz, G.L., and Bisanz, J. (1997). Assessing literacy in science: Evaluation of scientific news briefs. *Science Education*, *81*, 515-532.

Lemke, J. L. (1998). Metamedia literacy: Transforming meanings and media. In Reinking, D., McKenna, M., Labbo, L.D., and Kieffer R. (Eds.), *Handbook of literacy and technology: Transformations in a post-typographic world* (283-302). Mahwah, NJ: Erlbaum.

Mackey, R. (2009, April 28). Alarm about swine flu spreads online. *New York Times.* Retrieved from http://thelede.blogs.nytimes.com/2009/04/28/following-swine-flu-chatter-online/.

McClune, B. and Jarman, R. (2000). Have I got news for you: Using newspapers in the secondary science classroom. *Media Education Journal, 28*, 10-16.

McClune, B. and Jarman, R. (2010). Critical reading of science-based news reports: Establishing a knowledge, skills, and attitudes framework. *International Journal of Science Education, 32*(6), 727-752.

Miller, J. D. (1998). The measurement of civic scientific literacy. *Public Understanding of Science, 7*, 203-23.

Nelkin, D. (1995). *Selling science: How the press covers science and technology.* New York, NY: Freeman.

Nisbet, M.C., Scheufele, D.A., Shanahan, J., Moy, P., Brossard, D., and Lewenstein, B.V. (2002). Knowledge, reservations, or promise?: A media effects model for public perceptions of science and technology. *Communication Research*, *29*(5), 584-608.

Pew Research Center's Project for Excellence in Journalism. (2009). *Swine flu coverage around the world*. Retrieved from http://www.journalism.org/node/16125.

Pew Research Center's Project for Excellence in Journalism. (2009). *Pig flu and politics dominate the blogosphere.* Retrieved from http://www.journalism.org/index_report/pig_flu_and_politics_dominate_blogosphere.

Shavelson, R., Ruiz-Primo, M.A., Li, M., and Ayala, C.C. (2003). Evaluating new approaches to assessing learning. *CSE Report 604*. Los Angeles: University of California, Los Angeles, Center for the Study of Evaluation (CSE).

Sternberg, S. (2011, March 17) U.S. radiation experts try to decipher reports from Japan. *USA Today.* Retrieved from http://www.usatoday.com/news/world/2011-03-17-japanradiate17_ST_N.htm.

Wellington, J.J. and Osborne, J. (2001) *Language and literacies in science education.* Buckingham, UK: Open University Press.

Zimmerman, C., Bisanz, G .L., Bisanz, J., Klein, J .S., and Klein, P. (2001). Science at the supermarket: A comparison of what appears in print, experts' advice to readers, and what students want to know. *Public Understanding of Science, 10,* 37-58.