14. Competing Mentalities: Situating Scientific Content Literacy Within Technical Communication Pedagogy

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Abstract: Technical communication students may need to learn how to manage scientific information for a general audience because documents written by and for theoretical and applied scientists, as well as data outputs, provide essential source material for many technical communicators. Hence, technical communication instructors and students might benefit from understanding the production and pedagogy of such scientific textual materials. A key disjunction was identified in the late twentieth century by Carolyn R. Miller and Charles Bazerman (among others): scientific writing does not look, or operate, like humanistic writing, which opens the possibility for criticism and critique rather than understanding and respect. By recognizing that reading practice in the sciences consists largely of scanning for key information and assembling useful datasets, the logic of scientific writing pedagogies becomes more apparent. Technical communication pedagogies can leverage existing advice in the sciences to help students gain fluency in reading texts that are intentionally constructed using difficult jargon in order to maintain the integrity of scientific information.

Keywords: scientific writing, technical communication pedagogy, layered literacies

Key Takeaways:

- Scientific literacy relies on content mastery and statistical reasoning rather than more writerly concerns, which represent competing mentalities.
- Technical communicators can enrich their pedagogical practices by fostering a deeper understanding of scientific materials and their modes of production, producing more effectively layered literacies.
- Students may benefit from understanding the subtleties of scientific writing within expert discourses.

Competing Mentalities

Tom Johnson's (2019b) keynote address at the Symposium on Communicating Complex Information suggested that certain types of technical writing jobs are declining relative to the growth of the software industry (a field informed

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by theoretical and applied sciences), largely as a result of rapidly increasing technical specialization. In other words, technical communication programs may not be keeping up with increasingly sophisticated technology, which may indicate that their pedagogies could better address the complexity of scientific and technical information.

Johnson's observations highlight a site of intellectual tension often embodied in a dispute between Carolyn R. Miller's (1979) case for technical communication as a humanistic discipline and work by those who see technical writing as an expression of proficiency and scientific literacy. Miller (1979) calls for readers to understand both humanities and science as motivated by rational practices. Current readers will, no doubt, be aware that Miller's comments enjoy huge traction in technical communication pedagogy. Yet few current scholars refer to Miller's cogent remarks on the "communal rationality" (p. 617) of the science that underpins technical communication. In fact, many current scholars behave as though Miller's remarks begin and end in considering technical communication to be humanistic. Thus, pragmatically-grounded technical or scientific praxis is now often considered a type of "contextless logic" (p. 617), even though Miller clearly debunks the idea that science operates in this intellectually limited way. What is lost in this maneuver is a connection to the materially grounded practices of workplaces—laboratory, office, pilot plant, hospital, research center—or what Paul R. Meyer and Stephen A. Bernhardt (1997) refer to as "workplace literacy" (p. 86). I suggest that the type of scientific knowledge that is recognizable to scientists is an essential underpinning of successful technical communication that should be better incorporated into its pedagogies.

This chapter presents some advice for technical communication pedagogies to encourage a better understanding of scientific content and writing practices on their own terms, that is, considering the ways that people who participate in various scientific discourse communities constitute what they consider to be good communication. Current technical communication pedagogies might benefit from considering scientific inquiry as invention, following Miller, and also how writing pedagogy by scientists tends to approach specific, practical problems of composition and critique. Thus, the argument below is organized in response to a specific question: Given that scientific texts often provide an essential body of knowledge for technical communication professionals, how can understanding pedagogies and textual production in scientific disciplines strengthen technical communication pedagogy? One answer was suggested by Kevin Garrison (2014) in "The Scientist, Philosopher, and Rhetorician: The Three Dimensions of Technical Communication and Technology": to balance the "competing mentalities" (p. 359) he cites in the title of his paper in order to form a better foundation for technical communication pedagogies. Garrison cautioned readers that his framework required ongoing examination and revision, and this paper is one such follow-on. In the subsequent pages, I will explain why I think that increased attention to scientific material is warranted, justify my central question, and describe some underexamined scientific materials that could be of use for technical communicators, all to inform a heuristic for technical communication pedagogies that accounts for both humanistic and scientific understanding.

The Need for Scientific Literacy in Technical Communication

An opening question might be what scientific information has to do with technical communication pedagogies. One reason is that Miller's observation that scientific information might be subject to intervention and analysis via technical communication scholarship continues to hold true. Organizations such as the Special Interest Group on Design of Communication (SIGDOC) of the Association for Computing Machinery (sigdoc.acm.org), the Society for Technical Communication (stc.org), or tekom (technical-communication.org) define technical communication as an attempt to convey useful information, either technical or instructional, in traditional textual or electronic formats. In other words, technical communication *translates* complex scientific or technical information for people who might need to use it. Thus, technical communication differs from specialist scientific and highly complex technical writing, such as regulatory documentation (Benau, 2020) in its purposes and audiences. Technical communication scholars may not know how scientists, who often see their inquiry as necessarily interdisciplinary, adapt their work for varied audiences and genres. This circumstance presents challenges for those who need to present complex information to the general public by troubling the ability to clearly define a boundary between scientific fields or even between those fields and applied practice.

The primary ethos of much technical communication centers on usability and user experiences (UX), which evolved from earlier practices such as alpha and beta testing and user-friendliness in computing design (Seffah & Metzker, 2004). For example, computer specialists Sari Kujala and colleagues' (2011) scientific discussion of UX as centering on adoption rather than use, notes a lack of useful definitions, but merely cautions the reader not to conflate different usages. In contrast, technical communication scholars like Lisa Melonçon (2017) and Kirk St.Amant (2017) suggest both practical solutions and useful common vocabulary when they promote patient-based UX design (PXD) and intercultural PXD (I-PXD) in healthcare contexts. When Kujala and colleagues identify deficits in UX terminology without correcting them, this signals a tolerance for discursive problems, while St.Amant and Melonçon display attention to language rather than a tacit acceptance of an unclear general literature. Technical communication, thus, attempts to displace responsibility for comprehension from the reader to the writer, a pattern of behavior consistent with the humanistic values Miller describes.

Of course, what may be lost in a focus on humanistic values is the practical and scientific content of technical writing. And this point is well taken, given the proliferation of scientific information and technologies since the late twentieth century. Richard Van Noorden (2014a) observed that the global scientific publication output doubles every nine years, and this information has increased in complexity as well as volume. As Johnson (2019b) comments, subject-matter expertise, much more than writing and thinking, is highly valued in many technical writing settings. Technical communication pedagogies, thus, should help students manage both the increasing complexity of scientific and technical information as well as follow through on an enhanced attention to user experiences.

The Need for Layered Literacies

A key hurdle in translating scientific and technical information for users is understanding this information in the first place, or what might be considered a type of content literacy that augments general and workplace literacies. For example, Johnson (2019a) advises technical training to offset the tendency for technical communication degree programs to "drift" toward the humanities. Such drift may occur even in pedagogy that seeks to account for multiple literacies. For example, Kelli Cargile Cook's (2002) model of "layered literacies" (p. 5) for technical writers calls on instructors to impart models of understanding rhetorical, technological, ethical, and critical content and approaches. Cargile Cook 's model omits specific attention to scientific literacy, situating technological literacy in social, rather than pragmatic, terms. Her reference list reflects a strong trend toward literary and social theory, supporting its participation in the production of new humanistic knowledge. Similarly, J. Harrison Carpenter's (2011) update of layered literacies for scientific writing concentrates not on the acquisition of scientific knowledge but on graphical, technological, sociocultural, and communicative values in science. Hence, layered literacy approaches ultimately position themselves as liberal arts , remaining within only one of the types of competing mentalities Garrison describes. Neither Carpenter nor Cargile Cook consider how to layer scientific literacy as understood by scientists, or even other workplace literacies as described by Meyer and Bernhardt, into technical communication pedagogies. I believe that encouraging scientific and workplace literacies is essential for many sites of technical communication pedagogy and should be an added layer in this milieu of competing mentalities.

Layered literacies should require an articulation of specific disciplinary knowledge that highlights the function of such contents within specific rhetorical activities. In "Articulation: A Working Paper on Rhetoric and *Taxis*," Nathan Stormer (2004) explains the historically constituted and performative nature of rhetorical constructions. For Stormer, articulation is a means of understanding the material practices of rhetoric as arising from "shared acts" (p. 257) as well as a means of "bringing together the material world, language, and spatial arrangement in one act" (p. 263). Attention to the specific means of building and ordering information may provide a framework in which layered understandings might operate more effectively. Two features of Stormer's argument are germane here: first, that articulation is historically situated and second, that language scholars should attend to the arrangement and ordering of elements within rhetorical activities. I suggest that an inadvertent omission of scientific literacies in technical communication pedagogies could contribute not only to the "drift" Johnson (2019a) describes but also to an apparent loss of job share in the technical sector (Johnson, 2019b). One way of remedying this problem is by enhancing our understanding of how scientific literacy plays out in scientific writing advice and teaching by and for scientists. Below, I present a heuristic for technical communication pedagogies before discussing what scientists—as opposed to humanists or even social scientists—might mean by scientific literacy and how those differing understandings may be used to enrich technical communication pedagogies.

In Table 14.1, I offer some practical suggestions for operationalizing science as an element of layered literacy and a competing mentality in the technical communication classroom. This model is based in part on existing work, such as Melody A. Bowdon and J. Blake Scott's (2003) volume on service learning in technical communication, which already advises technical communicators to consider the various positions and needs of users, readers, and writers. Layered literacies and a recognition of competing mentalities are excellent models for technical communication pedagogies, as long as teachers and students understand various modes of ordering textual and conceptual elements as a type of performance, as Stormer indicates. The heuristic below is compatible with the advice of the technical communication scholars quoted above as well as information shared within scientific education communities, creating a site for effecting layered literacies that better account for scientific knowledge. Each of these activities may be analyzed as a type of rhetorical performance.

Technical communicators can use scientific information and scientific writing pedagogies to improve teaching and practice in order to better inform and develop activities like those in Table 14.1. It is important to note that the activities in Table 14.1 are not intended to replace the work already being done in the field. In other words, these exercises are intended to enhance and develop scientific literacy and to enable teachers and students to articulate scientific literacy more effectively into existing technical communication pedagogies. The following sections identify obstacles to scientific literacy that can impede the work of technical communicators and offer information to help situate humanistic and scientific approaches to writing study.

Table 14.1. A heuristic for technical communication pedagogies using scientific information

Step to Take	Reason for Taking the Step	Example Activities
Follow scientific advice for reading scientific materials (Pain, 2016): scan for main points, take notes, review tables and figures carefully.	Scientists construct documents to be managed in specific ways; practicing these skills enhances knowledge.	Build annotated bibliographies of scientific works, including key tables or figures, before reflecting on their contents. Read scientific papers from generalist and specialist journals to identify differences in placement of key information.
Closely examine table and figure legends and footnotes. Consider how the placement of titles legends, captions, and footnotes functions in different discursive situations (manuscripts, slides, posters, for example).	Scientists rely heavily on these types of text to understand data.	Use figure legends from scientific papers to identify elements of study design and key results, including statistical analysis. Review guidelines for figure legend, caption, and table heading composition from various journals or sources. Compare placement of titles, captions, legends, and footnotes in different journals.
Examine the role of mathematical and quantitative literacies in technical communication.	Scientists distinguish between mathematical and quantitative reasoning; the former is a strong predictor for success in science.	Ask students to define mathematical and quantitative competencies using specific examples from the scientific literature. Build a heuristic of mathematical versus quantitative literacy in a specific field, discipline, or technical setting.
Review uses of jargon/ pull new copies of papers often.	Scientific work undergoes constant revision; terminology may drift over time.	Identify different uses of the same term by authors over time. Identify different uses of the same term in different fields.
Understand scientific context by examining citation practices.	Scientific conversations occur over multiple papers.	Identify scientists in a field, their affiliations and citation habits. Develop a "citation map" of thinkers who cite one another's work.

Step to Take	Reason for Taking the Step	Example Activities
Think about plain language.	Scientific writing is not intended for mainstream audiences and needs translation to be useful.	Translate key elements of a paper—like figure and table legends—into plain language versions. Analyze what might be lost in translating technical or scientific content into plain language.
Recognize the wisdom in Miller's 1979 paper (and other key works in technical communication).	Miller finds ways to value both humanistic and scientific modes of thinking.	Identify evidence of communal rationality in a group of scientific papers.
Identify the components needed to support an argument across multiple scientific papers.	Humanistic values emphasize argumentation; identifying the needed components to make a humanistic-type argument can help students understand scientific writing genres and their role in communication.	Have students find a literature review and then read several of the cited papers to identify how they were adapted for the purposes of review.
Identify historical/chronological relationships between texts and ideas.	Scientific communication and humanistic studies of scientific discourses are ongoing conversations; students will benefit from understanding how ideas build on one another.	Build a timeline of key works about a scientific topic, then build a parallel timeline of work in technical communication over the same time period.

Scientific Literacy in Scientific Terms

A major obstacle to developing scientific literacy is a primary disjunction between scientific and humanistic habits of mind—competing mentalities that might impede the project of developing layered literacies. These patterns of thought inform the accepted standards for logic and convincing evidence. For example, mathematical aptitude and training predict success in science majors, even in disciplines like biology, that require relatively little mathematical training (Shapka et al., 2006). Kyla Flanagan and Jillian Einarson (2017) identified mathematical confidence as a more critical factor for success in college biology than "grit" (p. 1) or tenacity: as students gained mathematical confidence, their overall performance increased regardless of stick-to-it-iveness. Importantly, confidence was strongly associated with actual mathematical skills, which meant that students had low confidence ***because*** they lacked certain skills, as reflected in exam results (Flanagan & Einarson, 2017). Thus, mathematical skills might be a valuable literacy to layer into technical communication pedagogies that could be incorporated into the activities in Table 14.1.

Yet, according to the American Association for the Advancement of Science (AAAS; 1990), mathematical skills are only one important habit of mind that characterizes scientific literacy. Computation and estimation skills must be augmented by curiosity, openness to new ideas, informed skepticism, and material practices like manipulation and observation, as well as effective communication (AAAS, 1990). Since AAAS initiatives are aimed at primary and secondary schoolchildren, the AAAS values might be compatible with the aims of technical communication by enhancing the ability of all Americans to understand scientific information. Unfortunately, another stumbling block emerges here. While it may seem to humanists that the habits of mind described by the AAAS already characterize their own engagement with technical or scientific materials, scientific discourses reveal fundamental differences.

Such differences might derive from what scientific writing expert Scott L. Montgomery (2017) identifies as a contrast between writing training in the humanities and in the sciences in *The Chicago Guide to Communicating Science.* Montgomery, clearly addressing what he views as an audience of fellow scientists, notes that "a major difference between the humanities and sciences is that composing, critiquing and revising papers forms a central part of learning in the former, while in science it does not" (p. 5). Montgomery explains that scientists are "supposed to pick up" good habits of writing "either from a course or two in technical writing while at school, or through osmosis after entering the caffeine-riddled world of professional research" (p. 5). Montgomery reiterates a common truth for the culture of science, which Miller (1979) comments on as well, that writing is often understood as an obstacle to true science, an "opponent" (p. 6) that competes with content knowledge.

Montgomery (2017) also contrasts patterns of reading in humanities and the sciences, noting that attention to historical texts is a hallmark of the humanities but not the sciences. Of course, scientific findings often have a short self-life, being displaced quickly in the light of new discoveries, and even current reading is very demanding. As Allen H. Renear and Carole L. Palmer (2009) observe, scientific reading has long been tactically complex, requiring "strategically working with many articles simultaneously to search, filter, scan, link, annotate, and analyze fragments of content" (p. 828). And because scientists glean "fragments of content" (p. 828) for varied purposes, the writer cannot presume to dictate to the reader how or when to make use of the information provided. In effect, the process of reading is constructed as an act of scientific discovery, which might help explain Kujala and colleagues' acceptance of unclear terminology—they assume the caution will be enough because of the way they view reading.

Van Noorden (2014b) also notes that scientific work is continually subject to revision, even once published, creating a burden for readers to go back and double-check specifics. Further, given that training in scientific reading reinforces the skills Renear and Palmer cite, it is not only possible, but likely, that humanistic reading expectations are not a strong driver for scientific writing. To recur to Stormer's model of articulation and taxis, then, the ordering of items in scientific texts might be seen to function not as the formation of a specific argument so much as to allow other scientists to glean useful fragments for their own research. Scientific writing pedagogies like Bruce Schulte's (2003) "Parallel Hourglass Structure in Form and Content," hence, emphasize students' ability to place information where other researchers can expect to find it. Technical communication pedagogies should, at the least, acknowledge this reality.

Humanistic Critique and Scientific Literacy

A challenge to understanding scientific habits of communication and an obstacle to completing some of the activities in Table 14.1 may arise from humanistic reader expectations. Humanistic studies of scientific writing do not see the fragmentation and continuous revision of scientific materials that Montgomery, Renear, Palmer, or Van Noorden describe as value-neutral. This is a significant site of competing mentalities that has significant implications for developing scientific literacy. For example, in *Shaping Written Knowledge: The Genre and Activity of the Experimental Article in Science*, a critical text in writing studies and rhetoric of science, Charles Bazerman (1988) comments on the shift from argumentative to structured papers by the American Psychological Association as cause for complaint. For Bazerman, the fragmentation of argument not only across sections of a paper, but across multiple papers, increases reading burdens that should be undertaken by the author. And Bazerman further questions authors' knowledge in discontinuous narratives that present an introduction, methods, results, and discussion because "the author escapes the need for transitions to demonstrate the coherence of the enterprise" (p. 260). For Bazerman, certain rhetorical formulae are necessary to prove coherence and soundness of thinking, suggesting a fundamental disparity between his position and that of scientists well-acculturated to the reading practices Renear and Palmer or Montgomery describe. As Schulte (2003) explains, a certain logic informs the presentation of an introductory rationale for a study, its methods and results, followed by a discussion that highlights successes and failures and suggests next steps. So, Bazerman calls for specific modes of rhetorical articulation that provide a "complete" argument, which highlights the expectations that inform his humanistic mentality in such reading. Fostering this sort of expectation would limit the ability of students to develop scientific reading literacy on its own terms. And while Bazerman's book appeared several decades ago, it remains a foundational text in humanistic studies of scientific information, continuing to influence new generations of thinkers.

Bazerman (1988) also takes an approach Montgomery (2017) describes as characterizing humanities approaches to writing, as previously observed in "Owning Our Limits: Composition and the Discourse of Science" (DeTora, 2012). Beginning with the 1665 *Philosophical Transactions of the Royal Society*, Bazerman traces the development of the structured scientific format. More recent texts by rhetoric and writing studies experts like Alan Gross (2006), Jeanne Fahnestock (2005), or Michael Zerbe (2007) also present a history of scientific writing through the works of famous scientists like René Descartes, Sir Isaac Newton, and Crick and Watson, historical works that also feature in seminal linguistic studies by M. A. K. Halliday and J. R. Martin (1993). These scholars articulate a coherent, linear history that scientists might call into question. Such humanistic studies of scientific writing might also, like Zerbe's and Bazerman's, go on to criticize the rhetorical shortcomings of structured formats.[1] These studies drift from Miller's (1979) earlier remarks, casting scientific writing as positivist and instrumental rather than as an independent intellectual endeavor that intentionally articulates its writing practices in certain ways. Fahnestock characterized such moves as a "desire to dethrone science" (p. 272), calling for greater understanding to enrich rhetorical studies of science. Students in technical communication programs might benefit from reading this work in the context of the work of scientists as distinct modes of articulation and rhetorical performance rather than as a corrective.

Another generative pedagogical approach for technical communicators might be to explain and examine both the utility and the limitations of the works briefly reviewed here. For example, the retrospective historical progression of scientific writing manufactures an independent historical discourse of science that does not fully account for intellectual conditions before the disciplines became differentiated in the nineteenth century. As also previously noted (DeTora, 2012), critical discussions about the establishment of scientific education by figures such as Matthew Arnold and T. H. Huxley explicitly addressed the relationship between the sciences and humanities. Another limitation of historical progressions of scientific writing is a tendency to group works intended for popular and scientific audiences. For instance, Halliday and Martin (1993) use *Scientific American* and other popular texts in their linguistic analyses, which limits their applicability for scientists engaged in highly technical discourses of the types Montgomery, Van Noorden, Renear, and Palmer describe. Analyzing this tendency could provide better insights into work respected within technical communication contexts and create a model for understanding scientific discourses on their own terms.

Finally (and perhaps surprisingly for technical communication students), the current structured scientific format, again as Montgomery (2017) indicates,

1. Most scholars in writing studies, rhetoric, and technical communication would more strongly differentiate the authors I have grouped here. For example, Zerbe describes how to use rhetorical studies in freshman composition pedagogies, while Gross' and Fahnestock's works are more commonly read by scholars and students of rhetoric. Yet each of these authors, with the possible exception of Zerbe, can be seen to have influenced early discussions in technical communication, especially insofar as studies of the scientific format are concerned.

is only one dominant and longstanding communication model for scientists. Letters, brief communications, white papers, editorials, perspectives, and reviews each have an important place in the overall milieu of scientific writing, and all antedate the structured scientific format as currently published. While Bazerman (1988) describes differences across these genres as ongoing "innovations" (p. 319), Montgomery sees these same works as adhering to specific conventions and expectations that are grounded in a longer history. For example, *Science* specifies various article formats:

- Peer-reviewed research articles, reports, or reviews
- Commentaries
- Perspectives
- Book and media reviews
- Policy forums
- Letters
- eLetters
- Technical comments

Each of these formats follows specific aims, scope, and word counts, as well as the maximum number of tables, figures, and references. Many other journals share these formats and expectations. This circumstance suggests that what Bazerman (1988) views as invention in scientific writing formats actually follows fairly proscriptive rules. In fact, the structured research paper is intended as an aid to allow targeted reading by always presenting the same type of information in the same place. Editorials and reviews and perspectives, which gather information broadly, are vehicles for more complete arguments of the type Bazerman values. It could also be that similar opportunities for invention exist within structured formats but are more difficult to perceive for those less fluent in such communications. Thus, scientific writing literacy might be articulated not merely through humanistic understanding but also through the material and textual practices described by the AAAS, Montgomery, Schulte, Renear, and Palmer. These practices could be understood as one of what Garrison (2014) might call "competing mentalities."

How Scientists Construct Literacies

As Montgomery, Renear, Palmer, and others have noted, textual expectations among scientific audiences rely on certain habits of mind, which foster particular reading practices. Advice for students learning to read scientific literature often provides a heuristic for gleaning needed information with minimal expenditure of time and effort (Pain, 2016). Such heuristics often advise reading the abstract in a database to decide whether to review the full paper. And when reading a paper, tables and figures are often most worthy of initial review, making captions and legends crucially important. Discussions, results, methods, and introductions are less critical unless a reader is trying to replicate an experiment or use the data in some other way. These reading habits might seem alien to those used to reading linear narrative arguments. Of course, even the iterative and recursive modes of reading suggested in these forms are only stepping stones to fluent scientific readership: true expert readers can manage dozens of publications at once, as Renear and Palmer (2009) observe. A further challenge for developing fluency in scientific reading is managing vocabularies that vary from paper to paper. An effect of being left to pick up good practice, as Montgomery (2017) indicates, is a proliferation of vocabulary.

Scientists also develop novel vocabularies for writing about writing. For example, George D. Gopen and Judith Swan (1990)—whose "The Science of Scientific Writing" is widely used as a teaching tool in humanities-based science writing classes—introduce a vocabulary, borrowed from linguistics, for describing the functions of "units" of scientific discourse and the concept of "stress positions." They comment that even grammatically correct sentences can resist reading if they contain too much information or place details in a counterintuitive order. Ultimately, Gopen and Swan propose three essential "rhetorical principles": "grammatical subjects should be followed as soon as possible by their verbs," "every unit of discourse . . . should serve a single function or make a single point," and "information intended to be emphasized should appear at points of syntactic closure." They also discuss reader expectations: presenting what is known before what has been discovered, for example. Yet, Gopen and Swan also aim to retain jargon and complexity. Indeed, Gopen and Swan see "plain English" for "the general public" as a means of diluting science, an idea that runs counter to prevailing humanistic notions in technical communication.

A recent example of writing pedagogy by scientists is Tracy Ruscetti, Katherine Krueger, and Christelle Sabatier's (2018) "Improving Quantitative Writing One Sentence at a Time." This work exemplifies a trend in evidence-based scientific writing instruction that links writing success to specific content measures and/or test scores (see, for example, Morgan et al.,2011). The authors, teaching biologists, quantify the quality of quantitative statements in student laboratory reports, then use calculations to identify specific shortfalls for each student. Ruscetti et al. concluded that targeted feedback improved writing quality, that student writing quality decreased as content complexity increased, and that science teachers must adjust writing instruction for more complex conceptual tasks.

Of note and in contrast to Gopen and Swan (1990), Ruscetti et al. (2018) used writing studies texts as a means of contextualizing their findings. This indicates that scientists may seek to triangulate their findings by as many means as are available to them, which offers a vantage point for technical communication interventions. Morgan and colleagues' (2011) scientist/writing studies collaboration found that greater content comprehension translated into better student writing, indicating that the anecdotal scientific perspective that good writing stems from strong science mastery is not incorrect. What remains is to offer some specific means of translating this wisdom into pedagogical practice in technical communication.

While Table 14.1 has some suggestions, these are only a starting point. The most effective pedagogies might be those where students are offered models like those in Table 14.1 and asked to develop their own ideas as to how they might best leverage scientific knowledge in technical communication projects. In other words, another option for using Table 14.1 is as pre-work or preparation for specific projects.

Conclusion

Humanistic and scientific interpretations of the same genre conventions differ profoundly, which is a symptom of what Garrison (2014) might have termed competing mentalities. Thus, significant work is required to create a layered literacy model that includes scientific content literacy. Significant evidence supports the idea that humanists want to understand scientific textual practice in the same terms as they understand belletristic or critical texts, while scientists understand the same materials quite differently. This creates a fundamental disjunction that speaks to Meyer and Bernhardt's (1997) ideal of workplace literacy. Since technical communication often aims to translate complex information, like scientific data, into suitable forms to meet user needs, recognizing the disjunction between scientific textual expectations and humanistic ones is an important first step in meeting practical and pedagogical user needs. In other words, the scientific literacy that should be layered into these activities requires a recognition of the basic modes of scientific expression. The goal of technical communication to reconstruct desired humanistic formats from scientific ones can only be furthered by understanding source texts. Since calls for better attention to workplace realities are not possible by current technical communication pedagogies without recourse to the humanistic values that now inform the field, reconciling these competing mentalities would be an important first step.

Technical communication constituted as a humanistic major must provide pedagogical solutions for students to manage scientific information for a general audience. Documents written by and for theoretical and applied scientists, as well as data outputs, provide essential source material for many technical communicators. Hence, technical communication pedagogies might benefit from understanding the production and pedagogy of such scientific textual materials. A key disjunction in this process was identified in the late twentieth century by Miller (1979) and Bazerman (1988): scientific writing does not look, or operate, like humanistic writing, which opens the possibility for criticism and critique rather than understanding and respect. By recognizing that reading practice in the sciences, as Renear and Palmer (2009) indicate, consists largely of scanning for key information and assembling useful datasets, the logic of scientific writing pedagogies becomes more apparent. Technical communication pedagogies can leverage existing advice in the sciences, like Pain's (2016) model for scientific reading, to help students gain fluency in reading texts that, as indicated by Gopen and Swan (1990), are intentionally constructed using difficult jargon in order to maintain the integrity of scientific information.

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