Scientific Writing: The Effective Integration of Science and Literature, In and Outside of the Classroom.
If ever there were two academic disciplines which work so often in unison in spite of their being studied largely independently, they are the fields of science and literature. It is easy to see why these areas of study are rarely connected upon casual thought. Science is often seen as being strictly objective, dispassionate, and concerned far more with numeric values and measurements than with words and descriptions, while literature is associated with a seemingly unrelated venue of artistry and creativity. Even though these assessments are correct to some extent, it is also apparent that there is a natural overlap when one considers the vital exercise of communication; that is to say, the expression of scientific facts, theories, and protocols. It has been said that scientists share in a unique culture of science, which is every bit as ancient and intricate as one based on religion or nationality. Language, being a defining feature of a culture, is specifically designed to convey ideas and information. Thus, the written language of science, like all written forms of communication, is ripe with its own unique idiosyncrasies.

To further complicate the matter, scientific writing is in fact a rather diverse subset of literature, which by necessity, exists in various forms. Each form, be it a laboratory report or a science fiction novel, is aimed at a different audience, or at least serves a very different purpose within the scientific community. As such, each requires the use of different literary styles in order to be effective. The purpose of this paper is to offer a comprehensive analysis of the unique challenges, considerations, and benefits of successfully expressing science in a written form, as well as to highlight the formats in which this is most often attempted. It is also important to note that even outside of the obvious areas of overlap, scientific investigations and literary pursuits are not as fundamentally different as they may seem. In fact, coming to understand these similarities leads to the realization that an intermixing of their concepts may enhance students’ understanding and appreciation of both in the classroom.
It goes without saying that scientific literature has always been, and always will be a vital element in the advancement of scientific research and application. Such literature may include textbooks, laboratory reports, and magazine articles, as well as non-fiction or even fictional novels. One must not limit their perception of what scientific writing is and what it achieves to only include esoteric descriptions of complicated experiments, written by experts, and understood only by their intellectual peers. In fact, readers (and even authors) of many forms of scientific literature include everyone from young children to adults with no scientific aspirations whatsoever.

One of the most common exposures to science literature that a young person is likely to experience occurs in the classroom. The traditional format is that of the textbook. Textbooks designed for students of any age are similar in that their primary purpose is to introduce the readers to concepts and techniques in science which are probably unfamiliar to them, and in doing so, instill some level of understanding and appreciation for the subject matter. In this respect they serve to introduce new initiates into the so-called culture of science. As such, the author must himself/herself be a senior member of the scientific community. Furthermore, his/her writing must meet specific criteria; including clear definitions of unfamiliar terms, and descriptions which are easily understandable, though not oversimplified to the point of insufficient educational value. The text must also be carefully written so as to avoid some of the common flaws that have been observed in many textbooks. For example, it has been argued that the style of most textbooks is often too impersonal and objective to be easily accessible to young readers. Also, they seldom illuminate the connections between the ideas
that are introduced from one chapter to the next. Authors often fail to address these issues, instead choosing to emulate the traditional style of their predecessors at the request of their publishers.

In educational systems where laboratory experimentation is included in the science curriculum, students often find themselves exposed to science literature from the perspective of an author as they write reports of their own experiments. At the grade school and even undergraduate university levels, the writing of these reports serves as an exercise in objectively describing and interpreting scientific observations and hypotheses in a manner which is comprehensible to the author’s peers. In other words, this form of scientific writing is an intellectual precursor in style, format, and purpose, to the more sophisticated papers written by those in the upper echelon of the scientific community, and published in accredited science journals. The impartial nature of this style of writing makes it ideal for shedding light on observed phenomena in a scientific context.

Somewhat less formal, though still generally reputable scientific information exists in the realm of non-fiction books, which are not to be confused with textbooks or scientific journals. While typical non-fiction science books are written by experts in their field, they usually express ideas in such a way as to be intriguing and accessible to a reader with almost any level of familiarity with the subject matter. One of the main differences between this format and those previously mentioned is that the author, who is writing something which comes closer to mainstream literature, is less strictly bound to rigid impersonality. For example, on the first page of his book A Brief History of Time, acclaimed physicist Stephen Hawking engages his readers directly with a series of challenging questions including, “What do we know about the universe, and how do we know it? Where did the universe come from,
and where is it going?" Although these questions are not entirely rhetorical, since it is presumably the purpose of the author to answer them as best as he can, they would most likely not find their way into forms of science writing where efficient exchange of information is the primary goal. This is perhaps the fundamental distinction between classes of science literature: there are those that exist only to pass on comprehensible information to other scientists and scientists-in-training, and there are those that are more suited to the needs of laypeople. The former is limited primarily to academic circles, while the latter has steadily risen in popularity among the general public. In addition to the mainstream works of respected scientists such as Stephen Hawking, Stephen Jay Gould, and Carl Sagan, another form of science writing has earned a comfortable niche among scientists and laypersons alike. Countless magazines and newspapers dedicate pages to articles that discuss the latest scientific breakthroughs, or at least, those discoveries and theories which may be of direct relevance to their readers. Popular though they may be in a society where many citizens have come to realize the potential personal and large-scale benefits of scientific advancements, these ‘general interest’ articles are also restricted by the needs of their audience, authors, and publishers. In order to appeal to non-scientists, it is essential that they not be overly lengthy or technical. This is all the more necessary due to the fact that the articles are often written by authors who are not scientists themselves. Thus, the fact that their readers are often more interested in learning about the benefits or hazards that may have been discovered by a certain study rather than the details of the science behind it, does not pose a problem to the authors. Unlike scientific journal articles where the transfer of scientific information is paramount, mainstream articles are designed to quickly grab and hold attention, and often depend on clever titles and direct, if not shocking,
opening lines to do so. The degree to which they are based on scientific truths, or half-truths is less important than the fact that they intrigue and draw in readers.

Other forms of science literature are less obvious as such, but nonetheless important to the scientific community. With its modern form owing much to the late Luxembourg born writer and radio expert Hugo Gernsback, the genre of science fiction literature has proved to be a driving force in scientific advancement, and a source of inspiration to practicing and aspiring scientists. Gernsback, who many came to know as the father of science fiction after he coined the term in 1923, strongly believed in science fiction as a vehicle of prediction, and has since been proven correct⁴. In the decades since the era of Gernsback, novels such as Arthur C. Clarke’s *2001: A Space Odyssey*, which presented insight into space flight and artificial intelligence in the late 1960s, and even more contemporary works such as Michael Crichton’s *Jurassic Park*, which looked ahead to the implications of animal cloning years before it was actually achieved, have opened countless young minds to the study of science, even as they challenged veteran scientists to turn fiction into reality. It has therefore become the domain of science fiction to not only entertain on a superficial level, but also to reveal new avenues for real science to explore. It is thus seen that science literature serves in the enculturation of aspiring scientists not only by teaching them the language and concepts, but also by being a source of inspiration. Science fiction achieves this by creating a sense of wonder at the seemingly limitless reaches of applied science.

In contrast, biographical literature about scientists themselves encourages the formation of an intellectual connection between the reader and the subject. These biographies usually discuss not only the discoveries and theories of well-respected scientists, but also the events in their lives that led to them. In this manner, biographical literature provides something which
no other form of science literature can: insight into the lives of those who practice science. This insight often proves to be both fascinating and encouraging to those who would attempt to follow in their footsteps, and those who are already doing so. Seeing just how varied the lifestyles and circumstances of successful scientists can be not only raises the question of to what extent is the progress of science based on the personal experiences of those who perpetuate it, but also encourages aspiring scientists to view their seniors as genuine role models, rather than simply names in a book.

The relevance of literature in science is indeed readily apparent in the various formats of science writing, but even where they do not directly overlap, the two disciplines share a number of fundamental similarities. Few individuals have been as uniquely qualified to comment on the relationship between the two as the English author and physicist, C.P. Snow. The assessment that he made of the situation in 1959 is best summarized by his statement, “Literary intellectuals at one pole -- at the other scientists. Between the two a gulf of mutual incomprehension.” Snow’s sentiment of mutually exclusiveness among the cultures of scientists and literary scholars continues to carry weight among both even now, but it is by no means definitive. The opposite view, that of seeking common ground and integration, proves to be more promising. Once again, language is a common denominator. C.S. Peirce wrote, “Every symbol is a living thing, its meaning inevitably grows, incorporates new elements and throws off old ones. Science is continually gaining new conceptions.” Thus it was observed by Peirce and others before and since, that the terminology and written symbols employed in science literature represent the evolving language of science, which is comparable to any other constantly evolving written language. A scientist must share a similar mindset with his literary
counterpart as he learns to express and recognize complex ideas in sentences consisting only of equations. Variables and symbols such as “π”, “λ”, and “α”, which originate in the Greek alphabet, are seamlessly incorporated into science writing much to the same effect as letters, punctuations, and words in other forms of writing.

Imaginative and scientific literature are both largely concerned with the expression of ideas. The key difference lies in the fact that in the former this transfer of thoughts is simply the means to an end of entertaining or illuminating, while for the latter, it is usually the end itself. Therefore, the same literary tricks tend to be applied differently in each case. For instance, rhetorical statements are abundant in imaginative and persuasive prose, but are usually frowned upon in most forms of formal scientific writing. Rhetoric, whether simple or grandiose, is a device that is designed to trigger some desired response in the reader. This is of course contrary to the aims of strictly formal science literature as discussed previously, which relies on an objective presentation of information. It would only hinder the progress of scientific studies if the merits of theories came to be based on the quality of their presentation rather than the quality of the pertinent research involved. Nonetheless, rhetoric is often used for the purpose of addressing those outside of the scientific community as a means of piquing curiosity and interest. The difference is presumably that non-scientists require more than just passive, detached, expression in order to gain personal appreciation.

In contrast, the use of metaphors is a literary tool that is not only acceptable in science, but has historically proven useful as well. One often encounters the comparison between the structure of an atom and that of a solar system. For that matter, countless biologists were no doubt first introduced to DNA in scientific text where it is described as the “blueprint” of an organism. The appeal of metaphors when writing about scientific models and processes is that
they are memorable, and allow for the easier comprehension of otherwise difficult ideas. Furthermore, as Susan Haack of the University of Miami points out, deftly used scientific metaphors are extended, expanded, and explored in the process of obtaining a literally true account.6 One might even say that the flexibility of metaphors makes them the ideal language for communicating the rapidly evolving concepts of science.

Stressing the fact that scientific and imaginative literature share similar principles does not, however, explain why they appear so different on the surface. Where they are different tends to be most apparent in the type of language each uses. A distinction is drawn between the “referential” language which is predominantly used when writing about science, and the “emotive” language of creative writing.7 Referential language includes strictly verifiable statements while emotive language consists of statements that are fictitious, or at least unverifiable.7 Of all the forms of science literature discussed thus far, only science fiction depends primarily on emotive language, since it falls into the realm of imaginative literature as well.

Elucidating the connections between writing and science is not a purely theoretical matter, but also a practical one. For instance, the correlation naturally lends itself to application in the field of education, where in many curriculums, scientific and literary studies are still conducted independently. Integrating the two is not as difficult as it sounds, and may in fact be highly beneficial. Some scholars suggest that poetry provides a natural venue for this cross-over.8 Emily Dickinson was known to write poems about scientific concepts. For instance, Dickinson once wrote,

*The Brain -- is wider than the Sky --*

*For -- put them side by side --*
The one the other will contain

With ease -- and you -- beside...

Here Dickinson poetically describes the vast capacity of the human brain; a subject which has intrigued scientists for many years. Perhaps more science teachers should take a cue from Dickinson, and encourage their students to do likewise.

The merits of poetry to a science student are manifold. In his article *Poetry and Science Education*, Davi Walders suggests that the inherent ability of poems to connect with their readers at a deep emotional level, and their ability to carry meaning through metaphors, make poetry an effective medium for teaching difficult concepts. A poem can present challenging ideas in an entirely new light. Furthermore, one might consider what aspects of science are apparent in poetry itself. Poetry obviously stimulates creativity, which is essential to an aspiring scientist. The complex metaphors sometimes used in poems introduce the concept or paradoxes. One could even say that a key aspect of appreciating poetry, attention to detail, is also a fundamental element of scientific inquiry. Thus, the occasional incorporation of poetry in a science classroom provides a refreshing and stimulating change of pace, and helps students to understand that science need not be studied in intellectual isolation. In a sense, poetry can be described as yet another form of science literature when used as Dickinson has, to make a statement about some facet of the real world. Much like a scientist, the poet questions, probes, and presents some form of truth, be it literal or metaphorical, about the subject. The difference is that the poet need not be inclined to express his or her observations objectively as the scientist does. As observers of the natural universe, scientists and poets may be distant cousins, but they are related nonetheless, and can learn much from each other.
There is no denying that science is dependent on literature to preserve its history and promote its advancement. Therefore, it is the responsibility of all scientists and aspiring scientists to exhibit a degree of literary competence in all of their scientific writing as a service to their peers. Furthermore, literature acts as a bridge that connects the scientific community to the general population. Since most people are not able to speak to scientists who are on the forefront of their fields of expertise on a regular basis, it is only through reading about their accomplishments that they are kept up to date with advancements in technology, medicine, and other areas which affect their lifestyles and rouse their curiosity. Much is said of the responsibility of schools to make their students science literate, but it should not be forgotten that this goal is dependent on science being presented in an intelligible fashion to begin with. For this reason, science literature intended for scientists is not the same thing as science literature for a layperson. They tend to differ in terms of efficiency and complexity of language.

All things considered, the notion of literature and science being alien to one another seems to be rather narrow-minded. Consequently, the placement of an invisible wall between them in schools is shortsighted and restrictive. Since those students who aspire to become scientists themselves are expected to be able to write about science, and all students are expected to acquire at least a fundamental level of science literacy, why go to such lengths to keep the study of science and literature so separate to begin with? If, for instance, a poem can teach something about literary devices as well as something about science, it seems advantageous to exploit that connection. It may be that in the future a bridging of the gap between the scientific and literary cultures will be a first step in opening the door for a new generation of more well-rounded and insightful intellectuals.
References:


