NOVARE
SCIENCE & MATH
MASTERY. INTEGRATION. KINGDOM.

Too Many Words; Not Enough Pictures

A report from the field—forward this to your colleagues in the Grammar School and the Humanities Department.

John D. Mays

News about efforts to reform education in this country—a topic that has been in the news for 50 years—continues to be depressing. Just this morning I read an article about the ongoing clash between those promoting the "test-driven mentality of No Child Left Behind" and the "hardy band of educators and parents" who oppose it. I am not going to hold my breath in expectation that the new rebellion will lead to any substantive improvement in public education in America.

But I do have news to report indicating that in Christian schools we are doing some things right. This information should be affirming and inspiring to those teaching our students how to read—at all grade levels.

As regular readers of this newsletter know, I have embarked on a project to change the way science and math are taught, and part of this new mission is the production of a new line of science textbooks. It was in the process of marketing two of my books that the incidents occurred that I will relate here. Please forgive me for the fact that to put these two stories in context I will have to touch on our marketing efforts just a bit.

The first story relates to *The Student Lab Report Handbook*, which I published in 2009. *The Handbook* was recently reviewed by the journal of the National Science Teachers Association (NSTA). The last paragraph of the review reads as follows:

> *The Student Lab Report Handbook is intended for use by students in grades 9 through 12. The high reading level and difficult vocabulary, however, may be very difficult for most typical secondary students. I would recommend The Handbook for instructors of AP classes and college undergraduate science courses as well as teachers seeking a*

continued on page 2

Chair, Table and Lamp

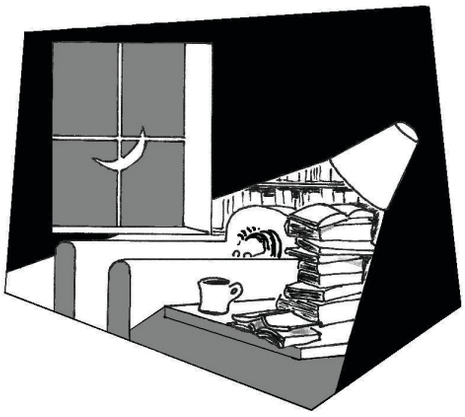
John D. Mays

It has always seemed to me that chemistry teachers get the short end of the stick when it comes to popular treatments in books. There are thousands of books on hot topics in physics and biology, but what is there for chemistry? Well, in this article we will review several books on chemistry—some new and some not so new.

The Disappearing Spoon, by Sam Kean

After the main title, the next clue that we are in for a ride with this book is the subtitle: "and other true tales of madness, love and the history of the world from the Periodic Table of the Elements." This

continued on page 3



primer on writing comprehensive lab reports.

At first glance, these comments seem a bit critical. High reading level? Difficult vocabulary? Very difficult for most secondary students? Wow. Sounds like a graduate text in philosophy or something.

But ordinary grade-level 9th graders at my school (Regents School of Austin) have been using this book, or unpublished preliminary versions of it, for about a decade. Not once in all that time has any of these students ever indicated that the reading level was even an issue. Instead, they all just read it. They study about how to write a lab report, and then they proceed to write their first lab report.

Similar experiences are happening outside of my own teaching environment. High school students at other Christian schools have been using *The Handbook* now for four years. Many of these schools and families report experiences similar to ours at Regents. The 9th graders get their copies, they read them, and off they go writing lab reports.

So here's the exciting message behind the reviewer's left-handed compliment: *students at our schools know how to read*. They do not perceive an ordinary instruction manual to be "difficult" or suitable only for students in AP classes. If I were an English teacher at one of our schools I would find this report very satisfying indeed.

The second story relates to the new middle school text I just finished, *Novare Physical Science*. Three months ago, when we had only the first few chapters for people to look at, we were displaying these sample chapters in our booth at very a large national conference for independent schools. As one teacher was looking it over, we asked her what she thought. Her reply gave us pause: "Oh, our students could never use this book. Too many words; not enough pictures."

Once again, at hearing this comment I was initially taken aback. But within a couple of weeks, comments begin coming in from the schools reviewing (i.e., *reading*) the book: "written at just the right level for 7th graders" and "looks great so far."

"Reading is the key that unlocks all other academic learning—the sine qua non, you might say, of every school."

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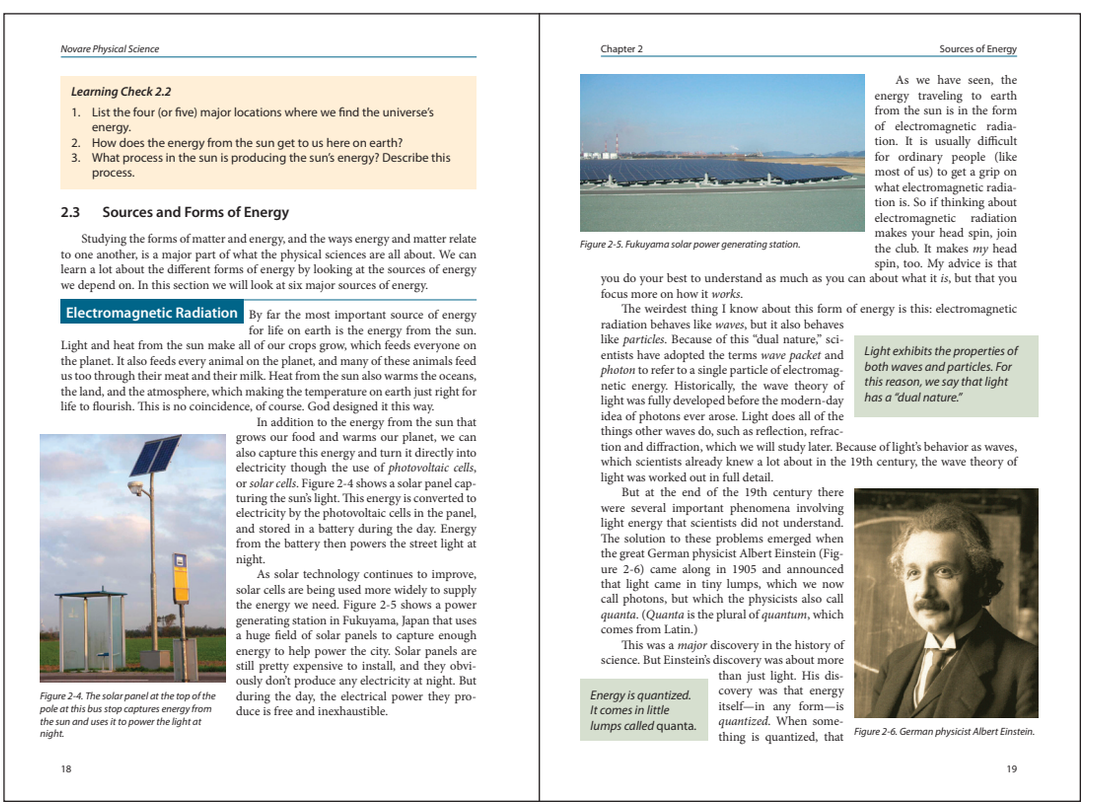
To me, the contrast between these remarks was even more remarkable than the comments of the NSTA reviewer. The teacher looking at the new book at our booth was from an independent school. I don't know any more than that (although Christian education was seriously under-represented at the conference). One tends to assume that independent schools—in general—offer an education based on robust academics. But here was a teacher dismissing the book for too few pictures—without even reading it.

To place this teacher's remarks in context, below is a two-page spread from Chapter 2 in *Novare Physical Science*. The balance between pictures and text on these two pages is typical of the entire book.

As with the first story, there is an unspoken message here, tacit but clearly audible nevertheless. On the one hand are teachers at Christian schools with strong reading programs saying the book is just right, while on the other hand an educator from elsewhere in the educational landscape matter-of-factly states that 13-year olds aren't yet ready for books with 300 words on a page (the typical number of words per page for this book). It is hard to imagine what history texts and works of literature they use with their students. Picture books, I guess.

It is clear from these two events that the Grammar School teachers and secondary English teachers in schools with strong reading programs, and in some home schools as well, are doing well at teaching our students to read. And reading is the key that unlocks all other academic learning—the *sine qua non*, you might say, of every school.

As a science educator, I have thought a lot about how important it is to integrate English language skills into science instruction, and I have certainly designed my own texts with this in mind. But the take-home message in the present article is that we secondary science teachers would be severely restricted in what we could accomplish if it were not for the teachers who have been faithfully doing the good work of teaching our students how to read well for seven or nine years before we ever see them. Let's tell them so.



Novare Physical Science

Learning Check 2.2

1. List the four (or five) major locations where we find the universe's energy.
2. How does the energy from the sun get to us here on earth?
3. What process in the sun is producing the sun's energy? Describe this process.

2.3 Sources and Forms of Energy

Studying the forms of matter and energy, and the ways energy and matter relate to one another, is a major part of what the physical sciences are all about. We can learn a lot about the different forms of energy by looking at the sources of energy we depend on. In this section we will look at six major sources of energy.

Electromagnetic Radiation By far the most important source of energy for life on earth is the energy from the sun. Light and heat from the sun make all of our crops grow, which feeds everyone on the planet. It also feeds every animal on the planet, and many of these animals feed us too through their meat and their milk. Heat from the sun also warms the oceans, the land, and the atmosphere, which making the temperature on earth just right for life to flourish. This is no coincidence, of course. God designed it this way.

In addition to the energy from the sun that grows our food and warms our planet, we can also capture this energy and turn it directly into electricity though the use of *photovoltaic cells*, or *solar cells*. Figure 2-4 shows a solar panel capturing the sun's light. This energy is converted to electricity by the photovoltaic cells in the panel, and stored in a battery during the day. Energy from the battery then powers the street light at night.

As solar technology continues to improve, solar cells are being used more widely to supply the energy we need. Figure 2-5 shows a power generating station in Fukuyama, Japan that uses a huge field of solar panels to capture enough energy to help power the city. Solar panels are still pretty expensive to install, and they obviously don't produce any electricity at night. But during the day, the electrical power they produce is free and inexhaustible.

Figure 2-4. The solar panel at the top of the pole at this bus stop captures energy from the sun and uses it to power the light at night.

18

Chapter 2 Sources of Energy

Figure 2-5. Fukuyama solar power generating station.

As we have seen, the energy traveling to earth from the sun is in the form of electromagnetic radiation. It is usually difficult for ordinary people (like most of us) to get a grip on what electromagnetic radiation is. So if thinking about electromagnetic radiation makes your head spin, join the club. It makes *my* head spin, too. My advice is that you do your best to understand as much as you can about what it *is*, but that you focus more on how it *works*.

The weirdest thing I know about this form of energy is this: electromagnetic radiation behaves like *waves*, but it also behaves like *particles*. Because of this "dual nature," scientists have adopted the terms *wave packet* and *photon* to refer to a single particle of electromagnetic energy. Historically, the wave theory of light was fully developed before the modern-day idea of photons ever arose. Light does all of the things other waves do, such as reflection, refraction and diffraction, which we will study later. Because of light's behavior as waves, which scientists already knew a lot about in the 19th century, the wave theory of light was worked out in full detail.

Light exhibits the properties of both waves and particles. For this reason, we say that light has a "dual nature."

But at the end of the 19th century there were several important phenomena involving light energy that scientists did not understand. The solution to these problems emerged when the great German physicist Albert Einstein (Figure 2-6) came along in 1905 and announced that light came in tiny lumps, which we now call photons, but which the physicists also call *quanta*. (*Quanta* is the plural of *quantum*, which comes from Latin.)

This was a *major* discovery in the history of science. But Einstein's discovery was about more than just light. His discovery was that energy itself—in any form—is *quantized*. When something is quantized, that

Energy is quantized. It comes in little lumps called quanta.

Figure 2-6. German physicist Albert Einstein.

19

book lives up to its titles—it's been quite a while since I read a romp like this, and it's even rarer to read a *science* romp.

The Disappearing Spoon is so much fun to read it is difficult to put down. The subject matter is all over the place in virtually every discipline in science, and the list of scientists Kean discusses is a veritable who's who of science.

Here's a sample of topics, just to illustrate my point: poisons; superacids (pH of –31); P. T. Barnum; nuclear physics; Schlockley, Bardeen and Brattain and the invention of the transistor; proteins; chemical weapons and ammonia in the WWI era; the mines in Colorado that supplied molybdenum to the Germans in WWI; the tungsten from Portugal that supplied the Germans in WWII; DNA; the Los Alamos atomic bomb project; the 16-year old who built a nuclear reactor "in a potting shed in his mother's back yard"; taste receptors in the tongue; spiral galaxies; and the aluminum cap placed atop the Washington Monument in 1884 because at the time aluminum was the most expensive metal in the world.

The Disappearing Spoon is one of those books that you want to read again as soon as you finish it. If you haven't read it, definitely get a copy in time to take with you on your summer vacation.

Creations of Fire, by Cathy Cobb and Harold Goldwhite

This book, too, has an enticing subtitle: "Chemistry's Lively History from Alchemy to the Atomic Age." One reason I was attracted by the subtitle dates back to 2001. I was looking for a history of chemistry to read, and although *Creations of Fire* had already been published at that time, I did not come across it in my search. Instead I purchased the well-known *A Short History of Chemistry* by J. R. Partington. Partington's book is pretty dry reading, and I don't think I made it past the first couple of chapters before I gave it up. So when I came across Cobb and Goldwhite describing the history of chemistry as "lively" I bought the book immediately.

Creations of Fire is a lot of fun to read. The first hundred pages is a tour through the ancient world, from the beginning of recorded history up through 1600, when Boyle and modern chemistry come on the scene. This is fascinating reading, touching on clay-firing, soap making, metal reduction, fermentation, and many other ancient technologies. This section includes an interesting tour through the alchemists, just the right length to get some good background without having to commit to a major treatise on the subject.

Beginning with the modern era, the narrative is driven almost entirely by the individual personalities involved, and the authors frequently quote from their journals. I found this scientists-oriented approach to be just the ticket for keeping the book readable and interesting.

If you are interested in a single book to give you a complete, chronological history of chemistry, I don't think you can do better than *Creations of Fire*.

The Elements, by Theodore Gray

Once again, the subtitle is a must: "A Visual Exploration of Every Known Atom in the Universe." *The Elements* is a coffee table picture book, not one you are going to take with you to the beach. But one of the first things that becomes clear upon opening this lovely book is that it was obviously prepared by someone who has an ongoing love affair with the elements.

The first 95 elements are each presented with a dedicated, two-page photo spread, loaded with stunning photos of the element and the technologies in which it has been

continued on page 4

used. A brief narrative—always whimsical—accompanies each presentation. Just as a sample, here is the opening paragraph for Yttrium, element 39:

> Yttrium is something of a hippy element. First, it is named after a village in Sweden, a notably loose country. Second, it is beloved by new age practitioners, who feel that it aids in communication between the spiritual and the practical realms, especially when incorporated into fluorite crystals. (But just to be clear, since this is a book about reality, yttrium really could not care less about our metaphysical states; it's an element, not a transdimensional energy being or whatnot. And by the way, unbeknownst to the new age practitioners who worship them, fluorite crystals actually hate our guts.)

Very entertaining stuff. Elements 96 – 100 are presented in spreads with photos of their namesakes, and elements 101 – 118 are summarized nine to a page. Brief comments on each of these elements focus on the discovery of the elements and the stability of their nuclei. On the page for berkelium (element 97), the author outlines the nuclear decay series that transmutates berkelium atoms into lead.

If you can't afford a copy to keep around at home, at least get your school library to purchase one. Then you and your colleagues can take turns checking it out for the students to look at. I have really enjoyed reading the copy, as well as looking at the lovely pictures.

"'Yttrium is something of a hippy element.'"

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Please come visit us next month at our booth!

We will be at the Association of Classical and Christian Schools Repairing the Ruins Conference in Atlanta, June 20–22.

We will also be at the Society for Classical Learning Summer Conference in San Antonio, June 26–29.

The Joy of Chemistry, by Cathy Cobb and Monty L. Fetterolf

I believe it was last year at the ACCS Summer Conference in Dallas where I first heard of this book. Someone mentioned it to me while we were talking at the Novare Science and Math booth. This book is a good read, and I do recommend it. However, there are a few drawbacks. We will start with a look at the book's strengths.

By far, the book's greatest strength is the author's drive to unpack the chemistry of as many ordinary, household things as possible. In fact, as long as we are talking about subtitles, the one for this book is "The Amazing Science of Familiar Things." The reader is treated to explanations for all sorts of common things, such as why beer is stored in brown bottles, why the insides of ice cubes are opaque, the difference between Tums and Rolaids, and why the pH in swimming pools needs to be buffered.

The Joy of Chemistry also does a decent job explaining a number of elementary topics in chemistry. The introduction to the mole is excellent, and there are pretty good (though sometimes too brief) explanations of topics such as surface tension, dissolving, and chemical equilibrium. In fact, one of the authors' goals is to provide a sort of layman's chemistry text—a book that presents the chemical basics for those who aren't up for plowing into a textbook. To accomplish this, the authors cover a lot of the qualitative information one would find in an introductory chemistry text, with none of the math.

This is where some of the book's shortcomings are apparent. Sometimes the explanations raise more questions than they answer. Other times analogies are oddly chosen, and seem to obfuscate more than elucidate. On some occasions a graph would help, but the authors' insistence on remaining qualitative prevents it. On other occasions a color photo or two would have been nice, but the book is almost devoid of graphics except for a handful of crude molecular representations.

Finally, the book includes a "home experiment" at the front of each chapter. These experiments all make use of common household products. This would seem to be a big plus, especially for home school families and others who do not keep stocks of standard chemicals around. But I had mixed success with the few of these that I tried. It is easy to make a nice copper sulfate solution from crystals of copper sulfate pentahydrate purchased from a chemical supplier. Making it from a copper scrubbing pad, aquarium pH-lowering solution purchased at a pet shop, and salt peter from a grocery store will require a lot of time shopping around, and is likely to make a lot of stinky mess and precious little copper sulfate.

Overall, *The Joy of Chemistry* can be a good resource for those who do not know much chemistry and want to learn more without turning to the pedantic rigor of textbooks. Or, people might want to wait a year or two for the release of my *Science for Every Teacher, Volume 2: Chemistry*. If I am able to fit that volume into my writing schedule, I will try my own hand at writing a layman's introduction to chemistry. *The Joy of Chemistry* is an admirable performance to try to beat.

Postscript

Please forward this newsletter to anyone who might benefit from it. If it was forwarded to you and you would like to receive future issues directly, please let us know. If you do not wish to receive future issues, please let us know that, too. All comments and queries are appreciated. Complete information about Novare Science and Math may be obtained at the website, novarescienceandmath.com. All correspondence, including proposals for contributions to the newsletter, should be directed to John D. Mays, Novare Science and Math, at info@novarescienceandmath.com or P. O. Box 92934, Austin, Texas 78709-2934.

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