How-To-Do-It

Using Scientific Journals in the Secondary Science Curriculum

Linda K. Ellis

A teacher’s job can be divided into two major parts: the organization of material into manageable units for efficient presentation and the motivation of students to be interested and therefore receptive to the presentation. While most of us have no serious problems with the first aspect, all of us have faced, at best, the vacant stare of boredom or, at worst, the almost hostile “I dare you to interest me” challenge from the students before us.

Scientific journals can help with this more difficult side of teaching. Certainly any journal can provide applicable material that can be modified for individual situations. Students in my Advanced Placement Biology class read two articles from Scientific American—How Receptors Bring Proteins and Particles into Cells (Dauty-Varsat 1984) and The Blood Brain Barrier (Goldstein 1986)—as an integral part of the course. An undergraduate’s article in The American Biology Teacher, An Interview with Nobel Laureate Maurice Wilkens (Johnson & Mertens 1989), was used to encourage students to make an early attempt at writing for journals. Several years ago, National Geographic published a photographic essay of computer-enhanced electron micrographs titled Our Immune System: The Wars Within (Jaret 1986). I have used it ever since and it has never failed to elicit interest.

Most of us have made use of these sources, but I suggest the concept be expanded to include professional scientific journals. Their use not only provides the material you need, it also introduces your students to the world of scientific literature—the backbone of scientific research. Because you can choose from diverse topics, you can be sure to find interesting, dramatic examples of the concepts you wish to illustrate. A teacher-led discussion of the material will emphasize the points you wish to make to meet your curriculum’s objectives. Keep in mind that isolated excerpts (figures, graphs, etc.) are to be presented to students, principally in the form of overhead transparencies. High school students should not be assigned the intimidating task of attempting to read from the journals I have suggested.

Because my own interest and expertise is in the biomedical sciences, I have chosen medical journals to illustrate how this has been accomplished in the College Preparatory Chemistry and Advanced Placement Biology courses I teach.

Lab Reports

Science courses seem to universally require students to prepare a written report on laboratory activities. While we all define the scientific process and the importance of reporting research results, we often fall to successfully reinforce the idea that the lab report in a science class is no different from what occurs, albeit on a more sophisticated level, in the “real world” of science.

The New England Journal of Medicine provides a section titled “Information for Authors” in the first edition of each month. While these guidelines cover areas not required in a high school lab report (e.g., drug names, permissions, key words), they give credibility to our directions on titles, units of measure, abstracts, references, etc. Because I subscribe to this journal, I have enough issues to provide each student with a copy and they follow along as I go over each of the items included in the report. Students

<table>
<thead>
<tr>
<th>Yr of diagnosis</th>
<th>Total No. of patients</th>
<th>Excluded</th>
<th>Included</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Autopsy cases</td>
<td>No follow-up</td>
</tr>
<tr>
<td><strong>Colon cancer</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1960-1964</td>
<td>8,231</td>
<td>1,386</td>
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<tr>
<td>1965-1969</td>
<td>10,044</td>
<td>1,911</td>
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<td>1970-1974</td>
<td>11,550</td>
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<tr>
<td>1975-1979</td>
<td>12,625</td>
<td>2,250</td>
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<tr>
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<td>764</td>
<td>76</td>
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<tr>
<td>Total</td>
<td>47,914</td>
<td>8,823</td>
<td>925</td>
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<tr>
<td><strong>Rectal cancer</strong></td>
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<td></td>
<td></td>
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<tr>
<td>1960-1964</td>
<td>4,985</td>
<td>443</td>
<td>121</td>
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<tr>
<td>1965-1969</td>
<td>5,735</td>
<td>663</td>
<td>97</td>
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<tr>
<td>1970-1974</td>
<td>6,191</td>
<td>865</td>
<td>38</td>
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<tr>
<td>1975-1979</td>
<td>6,858</td>
<td>706</td>
<td>27</td>
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<tr>
<td>1980-1981</td>
<td>3,035</td>
<td>240</td>
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<tr>
<td>Total</td>
<td>26,804</td>
<td>2,917</td>
<td>284</td>
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</tbody>
</table>

Total, colon and rectum: 74,718

Table 1. Number of patients with cancers of colon and rectum in Sweden in 1960-61. Reprinted from The Journal of the National Cancer Institute.

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students are then given a few minutes to examine the reports, relating their presentation to the requirements we have just reviewed. This also allows us to differentiate between a report and an article, as both are found in The New England Journal of Medicine.

It might be useful to obtain a copy of Uniform Requirements for Manuscripts Submitted to Biomedical Journals. This was originally published in the June 12, 1982, issue of both the British Medical Journal and Annals of Internal Medicine. Either journal is available in a medical school library. This does more than just impress students with the existence of guidelines for writing scientific reports. By discussing the credits given by authors for others’ work and by stressing the difference between the reporting of data in the results section and its interpretation in the discussion we can make students aware of the need for intellectual honesty and of the cooperative nature of research.

Graphing

Proper labeling of axes, the need for an explanatory title, how to develop an appropriate scale and drawing valid conclusions from graphs are all problems for beginning science students. There is a wealth of material in almost every issue of thousands of journals. Once you find a few that are particularly suited to your own needs, there is no real need to continue your search. Look for a topic that will attract attention or that clearly demonstrates the point you wish to make.

For example, demonstrate the advantage of a graph over a table by showing data to students both ways. Cancer survival and our ability to improve it are of great interest to students, so I have chosen data from a paper published in The Journal of the National Cancer Institute (Enblad, et al. 1988) to demonstrate this point. Projecting the data in Table 1 on an overhead will do little to convey the information in the study to high school students, but a transparency of the graph in Figure 1 is a different story. After just a few minutes of study, students will understand that while the study shows improvement in survival rates in the early months following colo-rectal cancer detection, the overall longterm survival rates have not been improved upon since 1960. (HR represents “hazard rate,” the calculation of which is defined in the text. Be sure you read necessary background material.) The lesson here is that graphs give readers an overall concept in quick, succinct fashion.

While Granulomatous Disease is not necessarily a topic guaranteed to “knock their socks off” this graph from The New England Journal of Medicine (Ezekowitz, et al. 1988) is a good one for several reasons. With you providing just a little background infor-

Figure 1. Annual Hazard Rate (HR) for cancer of colon by diagnostic period and year of follow-up. Reprinted from The Journal of the National Cancer Institute.

Figure 2. Bacterial killing of granulocytes from patients with chronic granulomatous disease, both before and 14 days after treatment with interferon gamma and by granulocytes from normal (untreated) control. The ordinate indicates the percentage decrease in S. aureus colony-forming units after 90 minutes of incubation with the indicated cells. Reprinted with permission from The New England Journal of Medicine.
mation—each line represents an individual patient, IA and IB are siblings, Staphylococcus aureus is a type of bacteria and normal granulocytes kill bacteria—the title of the graph and the labels on the axes provide enough information for students to draw a conclusion regarding the efficacy of Interferon Gamma treatment on patients with abnormally functioning granulocytes (Figure 2).

The size of the print and simplicity of the graph make it non-threatening, allowing students to gain a sense of accomplishment when you point out to them that they are reading and understanding material from a very prestigious journal. (Overcoming the intimidating nature of science should be an important goal of all high school science teachers. We lose too many potential scientists by fostering an elitist attitude.)

Graphs shown in various advertisements can be used as a stimulus for developing an experimental design, either in the abstract in a class discussion or in the lab, such as a recent ad claiming an over-the-counter antacid acts faster and more efficiently than several competitors.

You can also find samples of various kinds of graphs—bar graphs and scattergrams, for example—that demonstrate the variety of techniques and their applicability to different data.

Teaching Aids

Some of these journals are unparalleled as sources for teaching aids. Hospital Practice has a section titled Clinical Experience. Like other topics covered in this section, Anaphylactoid Reactions to Iodinated Contrast Media (Hildreth 1987) contains an illustration that provides all you need in an AP Biology lecture to illustrate the concept of the immune response. The basic concepts of immunoglobulin binding to antigen and cell surface receptors are clearly demonstrated in Figure 3. The second messenger system of cAMP and the role of histamine in the allergic response also are demonstrated. While our course doesn’t cover all the details included in the illustration, it is important to emphasize how complicated our immune responses are and how important an understanding of chemistry is to those considering a career in medical science.

Many of these articles contain figures that clearly and colorfully illustrate some of the basic physiology we cover in advanced high school courses. College biology, anatomy

Figure 3. Series of biochemical reactions which occur in a mast cell following the binding of an antigen-IgE complex to cell surface receptors. Reprinted from Hospital Practice.
and physiology professors can find some real treasures here too. Medical journals are a great source of pedigrees, made more interesting by the fact that they represent real families, often with interesting genetic diseases. A recent study in *The New England Journal of Medicine* (Wertelicke, et al. 1988) involved a large family with a form of the disease made famous in the play and subsequent movie "The Elephant Man" (Figure 4). (This is a bit of a dirty trick, because the features of Neurofibromatosis 2 are different in their manifestation than that of Neurofibromatosis 1, from which that unfortunate man suffered, but all’s fair in motivating high school students.)

This incredibly complete pedigree shows the members of seven generations. Because of the minute detail, students should be given a photocopy in addition to the overhead transparency. Ask students to explain how the pedigree shows the autosomal dominance of this affliction. They can define the term “obligate carrier” based on the appearance of the disease in certain individuals. They can calculate the odds of a given individual’s being at risk. In a different context, the numbers of individuals in each generation can be used to demonstrate the nature of population growth. Finally, the very shape of this pedigree can be used to demonstrate the flexibility that can be used to accommodate such a large amount of information. Imagine the painstaking nature of the investigative process that generated all this data. How long do you think gathering this information took? Scientists must be patient! In addition to the questions you raise in leading the discussion, students often bring up points you haven’t thought of, thereby stimulating even more discussion. (You can add these to your repertoire; they are often quite clever.)

The correspondence section of many journals provides an example of the difference of opinions among experts on current topics. One of the most useful I have found appeared fortuitously in *The New England Journal of Medicine* (Rainey 1988) at the time I was trying to teach solution concentrations in competition with spring and all its attendant attractions. The letter, from Yale School of Medicine, pointed out that while the state defined legal intoxication as a weight/weight percent, alcohol blood levels are sometimes measured as a weight/volume percent. The two are not equivalent. For a brief moment, the high school juniors in my chemistry

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Figure 4. Family pedigree of patients with neurofibromatosis 2. Reprinted with permission from *The New England Journal of Medicine.*
class were intrigued by the difference between wt/wt percent and wt/vol percent of blood alcohol levels.

Making use of specific gravity to convert volume to mass and recalculating the percent of blood alcohol to determine if a person is truly intoxicated in the legal sense was something worth doing, given the interest students of this age have in driving while intoxicated (DWI) laws. It also provided another opportunity to emphasize the importance of these laws and stress the responsibility we have to ourselves and to each other when it comes to drinking and especially to drinking and driving.

Careers

Each of the journals you choose to make use of contain a wealth of information on careers. Many have a classified section where students can find out what kind of openings are available. Ask them to choose one and research the educational requirements necessary to qualify for it. Scanning advertisements will make students aware of the tremendous opportunity in pharmaceutical advertising and sales as well as business opportunities connected to the health professions. The journals themselves employ editorial boards and art departments where writers and artists with a knowledge of the life sciences can find career opportunities.

Vocabulary

Medical terminology has an intimidating effect on the general public, but these terms can be readily translated by those with a knowledge of the basic roots, prefixes and suffixes. Read a carefully chosen title out loud to the class. Watch their reaction. Eyes roll back in their heads, comments like “I’m sure” and even laughter are common responses. Write the title on the board and translate it as you would a foreign language. This is a great source of material for the family dinner table when parents ask the routine question, “What did you learn in school today?” Kids can really make an impression with an answer like “unilateral exophthalmos” or “poly-morphonuclear leukocyte.”

In closing, scientific journals provide the science educator with more material than he or she has the time to pursue. In addition, every week or month provides us with a new source of material and ideas. For teachers of chemistry and the biological sciences, medical journals provide a broad selection of material. Any number of them can be acquired at no charge simply by asking your physician to hold issues for you. Depending on your own interests and resources (or those of your department) you may find a subscription to a particular journal both a convenience and a source of intellectual stimulation. Suggestions include American Scientist, BioScience, The New England Journal of Medicine, Hospital Practice, Post Graduate Medicine and American Family Practice, to name a few.

Finally, without dwelling on it, students are made aware of the critical role of scientific literature. For this reason it is important to use current journals, emphasizing their publication dates. Lab reports may even be seen in their legitimate role as an intricate part of the scientific process and not merely a bothersome assignment created by teachers for the ultimate misery of science students.

References


Enblad, P., et al. (1988). Improved survival of patients with cancer of the colon and rectum? The Journal of the National Cancer Institute, 80, 588-598.


How-To-Do-It

Oil Spills

Dwight Moody

Problem

What happens when oil is spilled or dumped in the ocean and what are the consequences? Are there techniques and/or materials that can be used to safely clean up oil spills?

Background

On March 24, 1989, the super tanker Exxon Valdez, carrying 1.2 million barrels of crude oil, collided with a reef off the coast of Alaska. The result was the largest oil spill ever in the U.S. The long term effect may be the destruction of the once pristine coastal waters of southern Alaska.

The effects an oil spill has on living organisms have been witnessed ever since modern man began shipping oil across the seas via tankers. However, the short term and long term effects have not been reported or even observed as having a uniform or predictable influence on aquatic life. Conflicting evidence stems, in part, from the fact that no two spills are exactly the same. Crude oil and refined oil, for example, differ markedly, each a collection of hundreds of different substances. The time of year, tidal currents, wave action, the quantity of oil and the distance it was spilled from a shoreline all impact the consequences differently.

There are some things we do know about oil and life. The short term and immediate result is the death of planktonic life forms through contact with low boiling, aromatic hydrocarbons. The larval stages of crustaceans and fish, fish eggs and co-