The Stockpile

HARRY C. STUBBS

IT IS NO NEWS to a parent, teacher, or a librarian that the younger generation tends to react negatively to being told what to do, read, say, play, or like; and there seems little doubt that younger generations always have been this way. The result, or at least one result, is that the education and entertainment industries share a common problem—they want people to listen to them and be impressed —although the professionals in both groups might prefer not to put it that way.

I am aware of this from the viewpoint of both fields, having been a science teacher for more than a quarter of a century and a science fiction writer for even longer.[1] Both facts determine how much, and in what direction, the following article is slanted. I am certainly not a completely objective writer (if there is such a thing), so it seems only fair to provide some data on my more probable prejudices.

The teacher's most conscious aim is to indoctrinate his students with a reasonably large body of usable fact and a set of attitudes reasonably compatible with his culture. In the physical and biological sciences, the "facts" must include the fact that not everything is known yet, and that there are a few techniques available for learning more. The attitudes for learning these techniques should include strong curiosity, a certain dissatisfaction with any given state of knowledge or public affairs, and as complete an absence of personal arrogance as is consistent with an adequate supply of self-confidence. An imagination able to solve problems as they arise is needed, but not needed are any more of the types who feel justified in stopping everything else while the world implements their particular plan.

The science teacher and the librarian share the problem of deciding what parts of the really overwhelming supply of existing knowledge are important enough to demand student attention and consideration, or at least to be available to maturing (and to already mature) citizens. Both professions have their limits: the teacher has only so much time to

Harry Stubbs is a Science Teacher, Milton Academy, Milton, Massachusetts.

monopolize the pupil's attention, and the librarian only so much space for book storage and money for book acquisition. Both, therefore, tend to dip into the entertainer's budget of techniques, and compete for that part of the public wealth and student time usually budgeted for recreation and amusement. I do not criticize this at all; to the extent that acquiring useful knowledge and attitudes can be made fun, everyone is better off. Some may regret that one important criterion for *any* book is how much fun it is to read, but that must be accepted and lived with.

Another fact, of course, is that no one has time to read everything, even if there were nothing else to do. Far too many books are published to permit this. As a teacher I am required to form opinions on between three and four hundred books a year, and certainly cannot claim that every one of them is read from cover to cover in the process. A professional librarian must, I assume, make decisions on several times as many. We need not only criteria for final choice, but criteria for where to start looking.

One criterion heavily used by librarians, but not heavily tapped by teachers is customers' suggestions. Students do read, their bases of selection often being rather obscure to the over-thirty mind, and they sometimes like what they read. From the science teacher's viewpoint they may like some pretty silly stuff, since the human tendency to fall for fads and jump on bandwagons seems to develop rather early, but if they have read it and been impressed by it, the teacher has no choice but to know something about it. He may even find it advisable to have copies available so that more than one of his students may join in the debate. (Also, it is extremely unwise to risk giving the impression that you do not want people to read some item. The banned-in-Boston rating was eagerly sought by publishers in the days when things were still banned in Boston.)

Of course, reading the material may not be fun—although there is always a fair chance it will be. Nothing in this article is going to suggest an *easy* way to choose or advise on books. However, even the most irritating "science" books can be put to use (Velikovsky's *Worlds in Collision,*[2] which I had to put down every few pages to recover my temper, springs to mind). Specific claims or statements make good practice exercises in scientific reasoning, demanding both thought and further reading from the student. Therefore, while I would certainly not go out of my way to acquire every science book in which a student had expressed interest, I tend to jump at any chance to get a youngster into a thoughtful argument. There is astrology, most of the flying

saucer material, pyramidology, the various health food fads—I grant that these should not take up too much of one's library shelf space, since there is far more valuable material to be housed, but neither the science teacher nor the librarian should permit himself to fossilize so thoroughly that nothing of the sort is available to his customers.

The students do not see everything, though, and often are not tempted by things we think they should study, so we cannot just wait for them to make suggestions. We have to do some picking of our own, and must therefore have some criteria determined by our own objectives and hopes—and not merely by asking "should they?" but also by asking "can they?" and "will they?" *Difficulty* is therefore a factor to consider.

The science teacher has some advantage in making this decision, but cannot claim the last word. Ideally, he wants a spectrum ranging from material pleasurable to his slowest students to things which will challenge his best. However, there are several factors which combine to make up the rather broad concept of "difficulty."

A subject itself may be inherently complex, abstract, or both, like quantum mechanics or psychology; but a book on these or any other subjects may still vary widely in difficulty because of the writing. Here, the librarian may actually be able to make a better judgment than the subject matter teacher.

One kind of difficulty which also stems from the writer rather than the subject, however, must be left to the subject matter specialist; and since the type of book in question is likely to be tempting both to student and librarian, the science teacher has a responsibility in helping with the selection. This is the sort of book which bears, usually, a give-away title of the general nature *Golf* (or *Oil Painting,* or *Calculus,* or *Cooking) Made Easy.* The writer of this type of book is claiming to supply shortcuts to achieving a difficult skill, or easier ways to express a difficult subject, or more familiar analogies for some abstraction. He may actually have accomplished this, and I say nothing against the attempt in any case although I am sufficiently middle-aged and corrupted by the Puritan work ethic to doubt that anything really can take the place of conscientious practice and careful thought.

The risk in the process is the loss of precision which accompanies simplification and the substitution of broad-meaning everyday words for the more specialized and precise scientific ones. My stock example is the child's (or amateur's) astronomy book which tries to explain orbital motion with the statement that "centrifugal force exactly balances gravity" so that the orbiting object neither falls nor escapes.

This statement is not exactly wrong, although many physicists would

be bothered by the term "centrifugal force," which is merely one aspect of inertia, and the word "balance" is certainly ambiguous in this connection. Even though not wrong, however, the sentence has led to much misunderstanding because of its lack of precision. I have seen written expression, by literate adults, of the fear that sending spacecraft to the moon would upset this "exact" balance and send our satellite crashing to the earth or out into space. (If any of the present readers fall in this group, please read a work on astronomy which does not claim to be easy—e.g., a college freshman text.)

Simplifying or clarifying difficult scientific subjects is a tricky job, as is recognizing when the job has been well done. Even the best scientist or science teacher cannot spot all the possible ways in which a book, a paragraph, a sentence or even a word may be misunderstood. Simplification demands of the writer a good, clear understanding of the subject itself at the *professional* level, not just the level of the proposed reader. It demands a high degree of skill with language, or very close cooperation with an illustrator, or preferably both. The scientist who cannot write well and the writer who is not a scientist are both poor candidates for the job. It is quite common in present-day science books for children to put an impressive list of scientific consultants somewhere near the title page, but one sometimes wonders how much these people actually influence the final choice of words and illustrations. I tend to be somewhat more impressed when the scientist is listed as "coauthor," although this is not a really firm criterion.

I fear that a science book must be judged at least three ways: for accuracy by a scientist, for clarity by a nonscientist, and for effectiveness on the basis of ideas and understanding that it actually engenders in students. The last, I grant, does make things a little hard on author and publisher.

A widespread tendency exists to equate "simplified" with "nonmathematical." Indeed, I have seen the latter term used in textbook advertising as though it were a virtue. Using *advanced* mathematics in a science book intended for students untrained in the field is, of course, as pointless as employing any other language they have not yet studied. However, the physical sciences are essentially quantitative, and all students have had *some* mathematics. Mathematical notation is the clearest and most concise method of explaining any point which involves questions of "how much?" or "how many?" or "how big?"

The notation may merely involve written numbers for the child who has just learned to count, or numerical examples for the one just

learning arithmetic, but it can and should also involve basic algebra, trigonometry, logarithms, or calculus if the intended reader can reasonably be expected to have any training in the use of these tools. I know about, and resent, the widespread antimathematical bias in the U.S. population, and feel strongly that something should be done to counter it. If the science writer makes it obvious that mathematical terminology is the easiest way to express and solve quantitative problems, we may hope that an occasional student will be stimulated to learn its use. I suggest that to the science teacher selecting books, the phrase "completely nonmathematical" on the jacket or in the sales literature is *not* a point in a book's favor.

The preceding criterion tended to overflow somewhat into the question of accuracy, which is also a point for independent consideration. I get the impression that librarians worry more about this aspect of a science book than do most science teachers, not because the latter care less, but because they feel more sure of themselves in judging the matter. I can offer the librarians some comfort.

Without belittling the importance of accuracy, please remember that no book has ever been written with *no* scientific mistakes—at least, there is no way to say that one has been, because we do not really know how many mistakes remain in our picture of the universe. Furthermore, if one ever is written it will be dated very quickly. As a science teacher I am not seriously bothered by an occasional misstatement of fact in a book, although I admit that some books go much too far in this direction.

There is, in fact, a variety of mistake, which rather pleases me, however much it embarrasses the author. This is the slip in internal consistency. I will name no names, but when a book says on one page that the year of Mars is more than twice as long as that of the Earth, and on another page that the year of Mars is 687 Earth days in length, I sit happily back and wait for my more alert students to spot the inconsistency and start finding out for themselves which of the statements (if either) is correct.

When two books intended for the same level of reader disagree on some point, I am equally happy. I regard it as extremely important that students learn, as early as possible, that scientific "knowledge" is constantly changing as new information comes in, and that unlike chess or baseball, there is no human authority in a position to state absolutely the rules of the universe we live in.

I realize and regret that this knowledge can lead to insecurity in some people. I consider this danger as much smaller than the one arising

from *lack* of this bit of truth. A person who has grown up under the impression that everything he has learned (or even that *anything* he has learned) is unassailably correct is on thin ice. He is likely to suffer far more from his collision with a nonconforming fact than is his classmate from an inability to make decisions (I realize that this view is disputable). I feel that much of humanity's social and political troubles stem from people's misplaced confidence in the validity of their own beliefs and viewpoints.

Librarians should not be overly concerned about spotting all the scientific errors in a newly acquired book. If a young reader comes up indignantly to point a new one out to you, would you really want to deprive him of the pleasure? And science teachers should delight in the useful classroom situation where two students cannot agree on whether a certain book statement is correct. I am not proposing that a whole library, or even a whole shelf, should be devoted to horrible examples. But those too stuffy about accuracy and updating will not have a library.

I have not and will not mention any specific books; no such list could be very complete, and would date far too rapidly. The production of "recommended lists" is a specialty in itself. There are many sources of suggestion—the American Association for the Advancement of Science puts out evaluation lists every few months; there is *Appraisal* from the Harvard School of Education; there are reviews in *Science, Scientific American*, and *The Horn Book Magazine.*

There is, however, one other general criterion which should be mentioned—that of subject matter. I mentioned above that there should be a wide range of difficulty available to the student, which naturally demands shelf space. This demand is greatly increased by the enormous variety of subjects calling themselves sciences. Someone must decide on a balance between the traditional subjects on one hand and the borderline and bandwagon ones on the other. It might seem at first that this responsibility belongs chiefly to the science teacher, but there is a danger here. Some of my esteemed colleagues, including myself, have trouble controlling the urge to dismiss a book as nonsense when it does not fit the conventional pattern. This may be the conservatism of age, or a considered opinion that basics should come first. In either case, we risk omitting books that many students will feel should be on hand; and student trust in and respect for the library as a source of information is very, very important.

I happen to be on the basic side myself; I felt that *Silent Spring* was much too emotional, and still resent the instant ecologist who does not

seem to realize that the first blow at the "balance of nature" was not the Flit gun but the garden.

Nevertheless, students become interested in such things, and professionally I have no choice but to qualify myself to discuss them. I cannot afford to exclude all this from the library, if only because I cannot afford to have students thinking that I am trying to censor their reading.

What I can do, and all I can do, with student food faddists is to have books on scientific nutrition available, backed up by basic chemistry and biology texts. For astrologers there are the astronomy texts, plus mathematical works on the analysis of observational errors and cause-and-effect criteria. For ecologists who disapprove of the Alaska pipeline there are books on ecology by professionals, again with chemistry, biology and meteorology backups.

I teach at the high school level, but make it a point to have at least a few college and graduate school books available in the library; I feel fortunate at being close enough to Boston to be able to use a number of local university libraries for backup. Teachers should attempt to make the library's scope as wide as possible, and think twice before rejecting a book because it is palpable nonsense.

I have emphasized chemistry, biology, and the like in the foregoing paragraphs, and have emphasized belief in the importance of basic studies in depth. I do not mean by that to discount the interdisciplinary fields which keep springing up. We need them, however negatively I may react to the bandwagon syndrome. We need people who can come as close as humanly possible to viewing the whole picture at once. We also need, however, people who are aware of the vast body of detailed fact which must be uncovered and the appalling amount of work which has to be done before we can *ever* decently utter a sentence beginning with the words "I know."

There is the person who makes public pronouncements on ecological matters without knowing the difference between a microtome and a chromosome, or being able to balance a simple chemical equation. There is also the person who writes a tale of nautical adventure without knowing the difference between a sloop and a lugger, and believes that splicing the main brace is something done with rope.

The important difference between these two idiots is that the first is less likely to be found out (many readers of sea tales know something about ships) and more likely to do irreparable damage (we are irrevocably part of this planet's ecology ourselves) if he is a persuasive

talker. Even if we do not produce an entire generation of scientists, it is up to us—writers, teachers, librarians, parents—at least to produce citizens competent to recognize the scientific faddist when he starts to talk. After all, it is now about two centuries since we committed ourselves to the technology-or-starve branch of history's roads. Maybe we should not have done it, but it is much too late to complain now.

Libraries have limited space and funds, and teachers have limited time, but both should do their best to provide reading collections of broad scope in both difficulty and subject matter. They must keep their ears, eyes, and minds open. They should remember that any book which can start debate has some potential use in communication bridges.

References

1. Science fiction fans know him as Hal Clement.—Ed.
2. Velikovsky, Immanuel. *Worlds in Collision.* New York, Macmillan, 1950.