Characteristics of Good Science Materials for Young Readers

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PERHAPS THE FIRST and most important question to ask oneself when beginning to write a book for children is: Why have I chosen this subject? Is it because children are particularly interested in it? Is it because there is a need for a book about this particular content? Does it offer an unusual opportunity to present accurate understandings of science as a method or as a way to make discoveries?

If the answer to at least one of these questions is positive there is good reason to proceed to develop the manuscript in the best possible way. If, however, the answers to all of the questions are negative the would-be author needs to reconsider the reasons for wishing to write the book. Maybe the subject is chosen because the writer is particularly interested in the subject and writing about it is an attempt to fill a personal need. In this case another body of content for the book should be explored unless the author is confident the book can be developed in a way that would satisfy the requirements of a good science book and create an interest on the part of the young reader and, just perhaps, demonstrate that there is a need for such a book. It should be remembered that a good science book provides opportunities for children to feel the excitement of discovery and the dignity of performance in an acceptable scientific manner.

Having satisfied oneself that the book meets the needs of a good science book and that it should be added to the literature, a more detailed selection of content is in order. The selected content should lend itself to an orderly and logical sequence. It should also be selected with consideration for the possibility of presentation with complete accuracy. If there is danger of incompleteness or overgeneralization in a way that would lead to error in the understanding of any part of the content, that particular part should be omitted.

The following demonstrates how a statement may appear to be accurate but actually lead to inaccurate inferences or understandings.

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Plants use carbon dioxide and give off oxygen whereas animals use oxygen and give off carbon dioxide. As stated this is accurate, but it is a dangerous statement to make because one possible but inaccurate inference is that plants in no way need oxygen and that animals in no way need carbon dioxide.

It is true that to write about science, authors need to know science. The above example illustrates that the author needs to know science to write about it, and it also illustrates that the author needs to consider the basic processes of science as he prepares his manuscripts. Some high school teachers have found it necessary to teach and reteach the needs of plants and animals for the gases of the air because of such errors as the one described. It may be wiser to decide against including this particular content unless it can be presented so that the reader can read it without danger of false inferences.

There are other ways in which material can be oversimplified. Statements such as, "All mammals give birth to their young" is for the most part correct, but there is one and maybe more exceptions. Thus the word *all* makes the statement incorrect. Adding the word *almost* in front of the word *all* is a safer way to present the idea and would make it read, "Almost all mammals give birth to their young." Other examples of more accurate phrasing are "Robins usually fly south in the winter from the place where Jane lives," or "Jane almost never sees robins at her feeding station in winter." Phrases such as almost all, nearly always, and usually are often more accurate than the more exact words such as all, always, and never.

Children need to become familiar with the idea that the natural environment is an orderly one and that there are definite patterns, but that there are also constant and newly found exceptions to almost all of the rules and/or laws which make up the patterns.

There is currently much discussion about science being more than a treatment of facts. Many of the new elementary science programs go beyond the content as such and deal with methods of science in terms of process development; some of them are weighted heavily on the side of process development. This is also true of junior and senior high school science curricula. This development has implications for the would-be author of science books for children of all ages.

Using any of the five senses is a basic way of obtaining information. Observing with all of the five senses is one, if not the most, basic process of science. It is not uncommon to make reference to observing, but it is uncommon to pay attention to particular observation skills such as looking, listening, touching, smelling, and tasting. All reference to

observed activities or facts should be actual observations made by one or more of the senses and not inferred ones. Observations identify characteristics that are directly perceived through one or more of the five senses, whereas inferences involve an interpretation of the observations.

Consider the following: "The little raccoon went into the woods where he was safe from his enemies." The first part of the sentence can be easily observed in a picture, but whether or not the little raccoon was safe from his enemies is an inference. The sentence might better have been written as follows: "The little raccoon went off into the woods where he is most likely safe from his enemies." If the author wishes to stress the use of the process names, the sentence could have been written thus: "The little raccoon was seen to go off into the woods where it can be inferred it will be safe from its enemies." This author, however, is not recommending that process names be used on all possible occasions. This practice could easily result in very dull reading.

Another process needing careful consideration as authors prepare manuscripts is classifying—a way of imposing an order on a collection of things or objects. Many trade books and textbooks make reference to classification facts which have been handed down from scientists over a period of many years. For example: vertebrates are divided into five groups—mammals have fur, birds have feathers, fish have fins, reptiles have scales and lungs, and amphibians live part of their life in water and part on land. It is easy to leave the reader with the idea that vertebrate animals can only be classified in this way. Actually children are able to find many ways to classify animals and in so doing get a much better idea of classifying as a process.

There is no harm, however, in helping children to learn how scientists have classified vertebrate animals. Neither is there harm in presenting children with the system of classifying rocks in a way scientists have done it—igneous, sedimentary and metamorphic groups. It is wrong to give them the idea that this is the only way that rocks may be classified. Given proper activities children find other ways to classify them, i.e., characteristics such as color, hardness, or by texture. Classifying as a process can best be illustrated if more than one way to classify is presented. Presenting classification in this way has the advantages that children may get the idea that there is no one right way to classify and that their own ideas are valuable and useful; thus participation in individual thought and activity is encouraged.

Measurement is another process that plays an important part in science investigations and should be given a much more important

place in science trade books than it often is. Experience in the use of the metric system, selection of units of measure, use of fractions to help interpret sizes and scale drawings are all important and should be incorporated in the manuscripts any time they add to the clarity of the presentation. Most science programs are putting particular emphasis on the use of the metric system since it has become more and more generally accepted in this country. It has been found that small children are able to use the system either as their only system of measurement or in addition to the British-American system with no apparent difficulty. In view of this it is entirely appropriate in the preparation of trade books to express measurement in the metric units only or in addition to the British-American units.

There are skills in the area of communication which are especially important in science. Graphing, illustrating, recording, and reporting are some of them. An author should make use of all opportunities in preparing a manuscript to use any of these and/or other communicating skills in an appropriate way.

Words are a medium of exchange in communicating. They should be carefully selected, especially as they relate to a technical vocabulary which is sometimes necessary in science. At an early age children are able to read and interpret graphs and can present their own ideas and findings in graphic form. A trade book which provides such experiences is a valuable addition to their literature. Any opportunity to help children get experience in interpreting data and making predictions from recorded data should not be overlooked. Such experiences often result in activities in which children can become actively involved. The temptation to present a dictionary definition should be avoided, even though there may be nothing wrong with the definition except that it will not fit into the text and thus not provide an accurate meaning. It is much more productive to develop an operational definition of the new words as they become useful.

Many basic processes such as those described or indicated are included in experimentation. Any time an author has included descriptions of experiments already done or can propose experiments to be done, interest is heightened for most young readers. Children get a lot of pleasure and excitement from what they believe to be "a real science experiment." Because of this the word has often been used in less than appropriate ways, and care should be exercised in the use of the word "experiment."

An experiment should be more than an interesting activity. To be acceptable, an experiment should have a question to be answered,

done with techniques or procedures clearly understood, and have a testable conclusion. Other characteristics of an experiment, such as control of variables and making predictions, may not be evident in all experiments, but they should be clearly pointed up if it is possible without detracting from the interest. Children should be left with the feeling that the activity or the experiment is something they want very much to do for themselves.

This author does not imply that experimentation should be given a lesser place in the development of manuscripts for children's books, but that it should be given greater and more accurate scientific development. Vocabulary which deals with the scientific method should be used accurately and as often as it adds to the skill of carrying on scientific investigation without detracting from the reader's interest.

Mention has been made of the use of terms and vocabulary related to scientific method. There are other specialized or so-called "big words" which may prove difficult for the young reader. This author has followed the practice of using the needed vacabulary if it and it alone carries the message. If the word can be used more than once and in a context that makes the meaning clear for the young child, then it is the view of this author that it should be used. It follows, of course, that the number of such words in any one section of a book should be kept at a minimum. If the so-called "big words" are necessary but are feared to be troublesome, then the art of illustrating may add meaning and provide help for the reader.

Vocabulary should also be considered carefully for the older, even high school, readers. Older readers can handle more difficult vocabulary, including sophisticated scientific terms and constructions, and take great pride in so doing. However, they are able to read and participate more actively if they find the reading intriguing, challenging, and, at the same time, not difficult.

A criticism often made of material written for children is that it is anthropomorphic. Any material that treats animals as though they have human characteristics can be said to be anthropomorphic. There is at this time considerable research going on in an effort to determine how and why animals behave as they do. Some of their behaviors are remarkably human-like, but in no way should they be explained with phrases as though they were human behavior. "Little butterflies love flying about in the sunshine," and "The geese came swimming down the pond in a straight row. They like to play follow the leader," are examples of anthropomorphism.

When purpose is ascribed to anything in the natural environment the materials are said to be teleological. "The leaves of the plant curl up in the hot sun to prevent loss of water" and "Squirrels bury acorns in the ground so they will have food in winter" are well-known examples of teleological material. Many of the earlier science books which were very popular with children can be criticized because anthropomorphic and teleological phrases were common in them. It is an easy trap to fall into in an effort to make the material interesting and exciting. Aside from being anthropomorphic or teleological, such material, however interesting to children, may lead to wrong ideas and overly simplified ways of thinking.

Pictures, photographs, drawings, or diagrams add much to any material developed for children. These should be as carefully selected, prepared, or considered as the written word. They should be simple without being inaccurate if at all possible. They should be fitted carefully to the script, and as far as possible do what the written word cannot do. The location of the pictures, illustrations, or diagrams is also important. It should be easy for the reader to find the picture and then refocus on the text without loss of time or delay in thought development.

Any pictures that present several ideas may be confusing to the reader. They may be attractive and add interest to the book at a glance, but on closer examination prove to be less functional and may even provide distraction in trying to fit text to the diagram. The question: "Is this bit of art worth the space it occupies?" should be answered in the positive for each diagram, photograph, or illustration proposed for the manuscript. Nonverbal representations are useful in prepared directions for activities. Symbols, arrows, and outline drawings of pieces of equipment can be substituted for words. This adds to the interest of a page and at the same time may reduce the vocabulary load.

A real plus in evaluation for any book for children is the knowledge that it will continue to be functional for them after they have "put the book down." After they have finished reading the book they may spend considerable time thinking about what they have read, asking questions based upon what they have read, duplicating some of the activities or experiments described, or developing related activities or experiments in a creative way.

More and more trade books are coming on the market, and it is becoming less difficult to acquire a collection of enrichment reading materials to accompany a science curriculum suitably. To produce such materials has been a special challenge to authors. This challenge is still

very much in evidence and many authors are making a sincere effort to meet the challenge in a way it has not been met before.

There is another special challenge for teachers—to find new and better ways of interesting young readers in quality reading materials beyond the textbook. Many science curricula for young children are not accompanied by a so-called textbook. Curricula for older children may be accompanied by a recommended book but may also depend heavily upon enrichment reading materials. Teachers then need to find, select, and decide more specifically upon the reading references as well as to guide the students in their free reading choices. Many teachers find a need to change their teaching techniques or methods and to be less dependent upon the course outline as prescribed through the textbook, if there is one. They need to become more involved with the trade books and other enrichment reading materials. Teachers and librarians need to work together to interest children in a quality reading program to accompany their subject matter areas of which science is a very important one.

This article does not intend to convey the idea that all science books for children should be factual and curriculum-oriented. Quite the contrary, it is the intention of the author to support a great variety of books being published and a part of the available literature. All books should be described, and the identity of the contents should be portrayed as honestly as possible, which would be helpful to librarians, teachers and children as they make their selections for free reading or for course work. If there is fiction included it should be so indicated. Children should not be expected to separate fact from fiction as they read, especially in new and unfamiliar areas. With the concerted effort of authors and the guidance of librarians, teachers and parents, children should have available a wide range of scientific literature and be able to make appropriate selections in line with their personal needs and interests.

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