A Criterion for Biology Textbook Selection

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Since most high school biology programs still utilize a single textbook, the selection of a text is an important decision. There are few guidelines, if any, for selecting a biology textbook, let alone established criteria for textbook selection in general. The selection of most textbooks has been based on how the teacher feels about one text or another.

One criterion worthy of consideration is the style of questions asked in textual reading. There is increasing evidence to indicate that questions in reading materials have considerable effect upon comprehension, understanding, and affective development (Rothkopf and Bisbicos 1967; Frase et al. 1968; Allen 1969; Morasky and Wilcox 1970; Frase 1970).

Research has been done on questioning strategies in classroom dialogue, especially since the work on inquiry by Schwab (1962) and Suchman (1965, 1966). Specific procedures have been developed to train teachers to utilize questioning strategies (Parsons 1970; Lowery 1974). Some reports show that student performances are related to the kinds of questions asked by the teacher (Watts 1971; Allen 1969). Schemes have been created to classify teacher-asked questions (Sanders 1966, Ladd and Anderson 1970, Schmalz 1973). It has been suggested that verbal questions may serve as "advanced organizers" of what is to come in the reading (Allen 1970).

Up to this time, little attention has been given to questions asked in textual reading. Based on preliminary research by Lowery (1970), an instrument was designed and used by Fibish (1971) to categorize elementary science textbook questions by type and science processes. More recent research refined and extended the instrument to assess biology textbook questioning styles, resulting in the comparison of four widely used high school biology textbooks (fig. 1) (Lowery 1974; Lowery and Leonard 1975).

The instrument, Textbook Questioning Strategies Assessment Instrument (TQSAI), categorizes textual reading questions on the following dimensions:

1. Frequency: the ratio of questions to sentences.
2. Experientiality: an indication of whether or not the questions are related to the direct experiences

Fig. 1 The Textbook Questioning Strategies Assessment Instrument (TQSAI).

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Lawrence F. Lowery, associate professor of science education at the University of California, Berkeley, received his Ed. D. degree from that university in 1965. He has written more than forty books, the most recent of which is Science Thesaurus, a science activities resource book for teachers. Lowery was voted Outstanding Teacher at the Berkeley campus in 1975.
of the student.

3. **Type**: the identification of types of questions—rhetorical, direct information, focusing, open-ended, or valuing.

4. **Science process**: the identification of the kind of scientific process the student is asked to do—observing, communicating, comparing, organizing, experimenting, inferring, applying.

The TQSAI is easy to use. The number of questions encountered in the reading are tallied in appropriate spaces and the total number of sentences is counted. The process can be shortened by randomly selecting one-tenth to one-fifth of the pages in a text and computing the questions per sentence per page. (Precise directions for use of TQSAI and definitions of various categories will not be presented here but are available from the authors upon request.)

To indicate the kind of information that can be obtained from this instrument, a summary of results from an analysis of four widely used high school biology textbooks is presented in Table 1.

<table>
<thead>
<tr>
<th>Questions/sentences (%)</th>
<th>Modern Biology</th>
<th>BSCS Green</th>
<th>BSCS Yellow</th>
<th>BSCS Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>8.5</td>
<td>5.4</td>
<td>3.5</td>
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</table>

<table>
<thead>
<tr>
<th>Experiential questions (%)</th>
<th>Modern Biology</th>
<th>BSCS Green</th>
<th>BSCS Yellow</th>
<th>BSCS Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.1</td>
<td>71.1</td>
<td>52.0</td>
<td>57.5</td>
<td></td>
</tr>
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</table>

The texts used were 1973 editions of *Modern Biology* (Otto and Towle), *Biological Science: An Ecological Approach* (BSCS Green Version), *Biological Science: An Inquiry into Life* (BSCS Yellow Version) and *Biological Science: Molecules to Man* (BSCS Blue Version).

*Modern Biology* is the most widely used and still the most commonly sold high school biology textbook today, representing nearly one-half of the nation’s biology textbook market. The other three texts in this study collectively represent about one-half of the high school biology text market and account for second, third, and fourth places in national biology textbook sales. The fifth most widely sold biology textbook (*Biological Science: Patterns and Processes*) was designed for a much different purpose and ability level, so was not included in this study. All other high school biology textbooks are sold in much smaller proportions than these five.

Analysis of variance indicates significant differences between frequency of questions asked among the four texts and between the degree to which questions among the texts related to the experiences of the reader. Further analysis shows all paired comparisons of texts to be significant for frequency and experientiality.

One dimension assessed by TQSAI is the general type of question. For each of the four textbooks figure 2 shows the proportion of questions that: (1) Do not require a response (rhetorical), (2) Require a yes or no or a brief factual statement (direct information), (3) Require convergence of concepts (focusing), (4) Require divergence of concepts with many possible correct responses (open-ended), or (5) Require some opinion from the reader (valuing). One noticeable comparison that can be made is that *Modern Biology* asks the largest proportion of rhetorical questions and the smallest proportion of focusing, open-ended, and valuing questions. Another is that BSCS Blue Version asks the largest proportion of focusing, open-ended, and valuing questions. These comparisons are based upon the proportion of types of questions asked by each textbook, not the total number of each type of question asked, and thus are an indication of emphasis for question type within a given text.

**Table 1. Percent of questions per sentences and percent of questions within textual reading based upon the student's experiences among 1973 editions of four widely used high school biology textbooks.**

**Fig. 2. Comparison of types of questions asked.**
Figure 3 shows the proportion of questions that deal with each process of science. One interesting observation from these data is that *Modern Biology* does not appear to place a great emphasis upon questions that require processes of science compared with the BSCS texts collectively, particularly when communicating, comparing, and inferring are considered. Also it becomes apparent that none of the four texts place an emphasis within the textual reading upon questions that require observing, organizing, or experimenting. The laboratory investigations in all texts do make some use of these three processes.

![Percentage Comparison Between Four High School Biology Textbooks as to the Amount of Learning Processes Asked in Experimental Questions Within Reading Matter](image)

Fig. 3. Comparison of learning processes covered.

The placement of the question within a text can give some excellent clues about questioning style. Although no direct provisions for this are made in TQSAI, it is very easy to keep a running total of questions asked: (1) at the beginning of a paragraph, (2) within a paragraph, (3) at the end of a paragraph, or (4) as a caption to a picture, chart, drawing, or other illustration. For example, it was noticed that more than half of the questions asked in BSCS Green Version are associated with illustrations. The other three biology texts ask about half their questions at the beginning of a paragraph.

Analysis of biology textbook questioning style by TQSAI can be made with the assumption that desirable features of a biology text are: (1) a higher number of questions per sentences; (2) a high proportion of questions per sentences that relate to the student's experiences; (3) a balance of valuing, open-ended, focusing, direct information, and rhetorical questions (perhaps more of the former than of the latter); and (4) a high proportion of sentences that require engagement in one or more processes of science. The TQSAI can also reveal textbook questioning style with respect to other viewpoints. An important feature of TQSAI is that it can be used to reveal general questioning style of any biology textbook and perhaps other textbooks. Given that questions are essential components of textual reading in biology and given a certain viewpoint with respect to questioning strategy, TQSAI can be a definite aid in the evaluation and selection of a biology textbook.

**REFERENCES**


——. 1972. Some effects of advance organizers and level of question on the learning and retention of written social studies material. *Journal of Educational Psychology* 61:333.


When an ecologist says "there goes a badger," he should include in his thoughts some definite idea of the animal's place in the community to which it belongs, just as if he had said, "there goes the vicar."

—Charles Elton