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The Readability of BSCS Textbooks

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Since they appeared, the BSCS materials have been widely acclaimed by science educators, and justly so. They represent a contribution toward the movement away from the traditional teaching patterns and toward the modern approach to teaching of science, that is as inquiry.

Since these materials were designed as a basis for a course in the life sciences at the beginning level, it is logical that teachers preparing to teach such a course should choose to use one of the three sets of BSCS materials. The materials, however, were prepared to be used at the traditional time slot in the educational sequence for beginning biology courses. They were prepared with the idea in mind that most general education biology courses were being taught at the tenth-grade level.

Now that changes in junior high school curricula are catching up with other recent changes in science education, some schools are finding time available in the junior high school sequence for a beginning biology course. A junior high teacher or supervisor who wants to use the best textbook available in his course might well be commended for choosing one of the BSCS books. One should be aware of the problems which might arise from using these materials at an

earlier level than that for which they were designed.

One of the problems which might early be encountered when using BSCS materials in the junior high is that the students may not be able to use the textbook in a beneficial manner. It is desirable that a textbook should be a source of factual information for the student as well as a tool which he can use to increase his understanding of the material discussed in class. In order for the textbook to be able to fulfill these functions, the students must be able to read the book with some facility. It is the author's hypothesis that the BSCS textbooks are written in such language as to be difficult reading for junior high students.

In order to test the hypothesis, the investigator has applied the Dale-Chall formula for predicting readability* to the green version and the blue version of the BSCS text materials. This formula was chosen over the others available because it could be applied to materials in the range of reading ability with which we were concerned and because it could be applied with as great a certainty as

*Dale, Edgar, and Chall, Jeanne S. "A Formula for Predicting Readability," *Educational Research Bulletin*, XXVII (January 21, 1948), pp. 11-20, 37-54.

any for the formulas to the type of material contained in the textbooks. This formula can be applied to materials which read at any level fifth grade or above, but it can not be used to distinguish between materials which read at the fourth grade level or below. Further, this formula had been successfully applied to health education materials, which is as close as any of the formulas had come to the type of material with which we were concerned.

As a check on the reliability of the readability formula, a quiz was given to a group of 114 eighth graders after having asked them to read a selection from either the blue version or the green version. These quizzes were designed to test the usefulness of the texts as a source of factual information. They asked the students to recall some facts they had read immediately after having read them.

The selection of passages from which the quiz questions were derived was made at random from that part of the texts which had not been previously covered in the course being taught to the students of the sample group. Each passage was then analyzed using the Dale-Chall formula to be sure that the passage was representative of the difficulty of reading found in the rest of the book. Each passage was about one thousand words long. Two 100-word samples were analyzed from each passage. The two samples from the green version passage gave an average raw score of 8.3685. Similarly, the two samples from the blue version passage gave an average raw score of 8.1068. Comparison of these scores to the Dale-Chall Correction Table

(shown below) indicated that these passages were representative of the readability of the books.

Correction Table*

<i>Formula</i>	<i>Corrected</i>
<i>Raw Score</i>	<i>Grade-level</i>
4.9 and below	4th grade and below
5.0 to 5.9	5th to 6th grade
6.0 to 6.9	7th to 8th grade
7.0 to 7.9	9th to 10th grade
8.0 to 8.9	11th to 12th grade
9.0 to 9.9	13th to 15th grade (college)
10.0 and above	16th + (college grad.)

An effort was made to keep the readability of the quizzes within the range of ability of the students. This was done so that the performance on the quizzes would be more a test of how well the students could read the textbook, and not how well they could read the quiz questions. The green version quiz had a raw score of 5.8694 which is high in the 5th to 6th grade reading level. The blue version quiz had a raw score of 6.4605 which puts it in the 7th to 8th grade reading category.

Copies of the quizzes appear at the end of the article. The students taking the green version quiz were first asked to read a passage on "Creatures of the Deep," pages 280 and 281. The students taking the blue version quiz were asked to read a passage on "Group Structure Based on Body Adaptations of Individuals," on pages 621 and 622.

GREEN

1. Which of the following groups of animals contain *no* known examples of bioluminescence?
 - a. land animals
 - b. sea animals
 - c. fresh water animals
 - d. Each of the above groups contain

**Op. cit.*, p. 44.

- at least one known example of bioluminescence.
2. The number of living things is related to depth of the sea in which of the following ways?
 - a. The number of living things found increases as one goes deeper into the sea.
 - b. The number of living things found decreases as one goes deeper into the sea.
 - c. The number of living things found stays the same as one goes deeper into the sea.
 3. The number of *different kinds* of living things is related to depth of the sea in which of the following ways?
 - a. The number of kinds of living things found increases as one goes deeper into the sea.
 - b. The number of kinds of living things found decreases as one goes deeper into the sea.
 - c. The number of kinds of living things found stays the same as one goes deeper into the sea.
 4. The movement of deep-sea animals toward or away from the surface of the water is not affected by which of the following?
 - a. water pressure
 - b. temperature
 - c. light
 - d. All of the above affect such movement in deep-sea animals.
 5. Which of the following is the best definition of bioluminescence?
 - a. The ability of a living thing to produce light.
 - b. The ability of deep-sea animals to see one another in the near dark conditions in which they live.
 - c. The tendency of cave dwelling animals to be white.
 - d. A mechanism of some deep-sea animals for lighting their field of view.
 6. Which of the following is a use of bioluminescence?
 - a. an aid to escape
 - b. a mark of recognition
 - c. a lure for prey
 - d. All of the above are uses of bioluminescence.
- BLUE**
1. Which of the following best characterizes a society with a "caste" system?
 - a. Groups which are distinguished from one another by special body structures.
 - b. Groups which are distinguished from one another by different behavioral patterns.
 - c. Groups which are distinguished from one another by the tasks which they perform for the society.
 - d. Groups which are indistinguishable from one another.
 2. Which of the following may be a basis for determining the division of labor among the workers of an insect society?
 - a. length of antennae
 - b. body size
 - c. wing size
 - d. abdominal size
 3. Which of the following is *not* a social insect?
 - a. termites
 - b. ants
 - c. grasshoppers
 - d. wasps
 4. Which of the following best characterizes a drone bee?
 - a. weak wings and large body
 - b. strong wings and short antennae
 - c. weak wings and long antennae
 - d. strong wings and big eyes
 5. Which of the following is a characteristic shared by both drone and queen bees?
 - a. strong jaws
 - b. short antennae
 - c. reduced digestive system
 - d. big eyes
 6. Which of the following would *not* be a likely characteristic of a soldier in an insect society?
 - a. strong jaws
 - b. poison glands
 - c. heavy armor
 - d. All of the above are likely characteristics of a soldier in an insect society.
- The Dale-Chall formula was applied to fifteen samples of 100 words each from both the blue and the

green versions. These samples were chosen at random from evenly spaced sections of the books. The raw scores obtained are shown below.

BLUE VERSION		GREEN VERSION	
Sample No.	Raw Score	Sample No.	Raw Score
1	8.3098	1	7.3037
2	8.9596	2	7.1053
3	8.9100	3	8.4272
4	8.9505	4	10.4526
5	8.7835	5	6.2571
6	8.0031	6	8.5264
7	6.7986	7	8.5264
8	9.9293	8	10.5791
9	9.4647	9	9.0092
10	8.3280	10	9.1549
11	6.5911	11	9.1475
12	7.2723	12	7.6286
13	8.4677	13	7.7774
14	9.0993	14	7.1640
15	7.6873	15	8.0750

The average raw score of fifteen samples from the blue version was 8.37. This corresponds to a reading level of an average junior or senior in high school (see the Dale-Chall Correction Table on page 9). The average raw score of fifteen samples from the green version was 8.34, which corresponds to the same reading level.

Below is the distribution of scores from the quizzes given over the selected passages from the two text versions. The score of the quizzes is the number each student marked correctly on his quiz.

BLUE VERSION QUIZ		GREEN VERSION QUIZ	
Score	Frequency	Score	Frequency
6	3	6	6
5	14	5	16
4	22	4	14
3	14	3	11
2	2	2	8
1	1	1	2
0	0	0	1

version gave raw scores from the Dale-Chall formula which would indicate that a reader must have a reading level of eleventh to twelfth grade to fully appreciate what he reads in them. This number may be slightly higher than the true reading level of the material due to the technical nature of the subject matter. It is more than likely that the material could be read at the tenth grade level, the level at which the authors intended it to be used.

We can arbitrarily interpret the results of the quizzes by assuming that any student who missed half of the factual items with which he was confronted was not able to make full use of the textbook as a source of factual information. Of the fifty-six students who took the quiz of the blue version, thirty-nine or 70 per cent missed fewer than half of the items. Of the fifty-eight students who took the quiz over the green version, only twenty-five or 52 per cent missed fewer than half of the items. Thus a total of sixty-four or 56 per cent of the 114 students who took part in this experiment seemed to demonstrate ability to use a text of this type as a source of factual information. For the 44 per cent of the students who did not demonstrate an ability to use the textbook in this manner, the junior high teacher using these books must be aware that the factual information basic to an understanding of the content of the course is not available to a great many of his students. Other means must be found to convey this information.

In the Cedar Rapids Public Schools, where the fifty-six students who took the quiz over the green version are

Both the green version and the blue

in attendance, ability grouping is practiced. The students are grouped for eighth grade science on the basis of their performance on the Iowa Test of Basic Skills which is administered in the seventh grade. Particular emphasis is placed on the section of the test designed to test for reading comprehension. Thus the teachers in this situation can meet with the students who are low in ability to

comprehend what they read as a group, and plan different types of fact-presenting activities and sources for them. That such planning is extremely necessary for the average and below-average students is indicated by the chart below which separates the fifty-eight students who took the green version quiz along the same line as the counseling staff of their school divided them.

<i>Ability Group</i>	<i>Grade-level of Reading Comp.</i>	<i>No. of Students</i>	<i>No. missing fewer than ½</i>	<i>No. missing ½ or more</i>
Superior	8.5 or above	23	20	3
Average	6.5 to 8.4	17	9	8
Below Average	6.4 or lower	18	7	11

The chart above also shows the nature of the sample which is overly heavy with high-ability students. The same may well be true of the student sample which took the blue version quiz at University Schools at Iowa City.

Despite the difficulties encountered in interpreting the results of a readability formula and the sparkling performance of our student sample on the quizzes, we feel the evidence warrants acceptance of the hypothesis. The Dale-Chall formula gave a high enough raw score to account for the technical nature of the material and still be well above the reading level of a majority of junior high students. The quiz results were undoubtedly af-

fectured by the nature of our student sample, which had a high number of very able students, and still showed a large proportion of the sample could not use the book to full effectiveness. Therefore, we must conclude that these two versions of the BSCS text are written in such language as to be difficult reading for junior high students.

This is not to say that these materials can not be of any use in the junior high classroom. But the teacher using them should be aware of the problems the students face when he picks up such a book and be prepared to offer an alternative course of action for the students who are troubled.