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IDENTIFYING THE "SLOW LEARNER" IN BSCS HIGH SCHOOL BIOLOGY.

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THE SUITABILITY OF THE BLUE, GREEN, AND YELLOW VERSION BIOLOGICAL SCIENCES CURRICULUM STUDY (BSCS) FOR THE UPPER 75 PERCENT OF THE STUDENTS TAKING TENTH GRADE BIOLOGY IN THE UNITED STATES IS EXAMINED AND PROCEDURES USED IN ASSIGNING SLOW LEARNERS TO CLASSES USING BSCS SPECIAL MATERIALS ARE SURVEYED. THE SUITABILITY STUDY INVOLVED 12,602 STUDENTS AND THE SPECIAL MATERIALS PHASE INCLUDED 38 CLASSES IN DESIGNATED TEST SCHOOLS. STUDENTS IN THE SUITABILITY STUDY WERE PRETESTED AT THE BEGINNING OF THE YEAR FOR ABILITY TO USE THE PROCESSES OF SCIENCE AND FOR NUMERICAL AND VERBAL REASONING ABILITY. THEY WERE POST-TESTED AT THE END OF THE YEAR FOR UNDERSTANDING OF SCIENCE CONCEPTS AND FOR THEIR ABILITY TO USE BIOLOGICAL INFORMATION. MULTIPLE CORRELATIONS WERE USED TO ANALYZE FINDINGS. THE BLUE, YELLOW, AND GREEEN VERSIONS OF BSCS BIOLOGY APPEARED TO BE SUITABLE FOR USE WITH MOST STUDENTS AT OR ABOVE THE 50TH PERCENTILE AND A MAJORITY OF THE STUDENTS IN THE 40TH TO THE 50TH PERCENTILE IN GENERAL ABILITY AS DETERMINED BY THE DIFFERENTIAL APTITUDE TEST. BSCS BIOLOGY SPECIAL MATERIALS WERE PREPARED FOR STUDENTS OF LOWER ABILITY. DATA OBTAINED INDICATED AT LEAST 50 PER CENT OF THE SCHOOLS WERE NOT SYSTEMATICALLY USING SCORES FROM GENERAL ABILITY AND/OR READING ABILITY TESTS DETERMINING ASSIGNMENT OF STUDENTS TO SPECIAL MATERIALS CLASSES. THIS ARTICLE IS PUBLISHED IN THE "JOURNAL OF RESEARCH IN SCIENCE TEACHING," VOLUME 3, ISSUE 1, 1965. (AG)

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The author discusses success in BSCS as a function of mental ability. Data indicating that many high and average ability students are being improperly assigned to classes using materials for slow learners are presented and the possible consequences are explored.

Identifying the "Slow Learner" in BSCS High School Biology

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Background

In preparing the Biological Sciences Curriculum Study (BSCS) Biology Blue, Yellow, and Green Versions,[1] the stated purpose of the authors was to prepare courses suitable for the upper two-thirds or three-quarters of the students now taking biology in American high schools. Thus, it would be well to examine test data to determine, in quantitative terms, whether the materials are suitable for use with the upper 65 to 75 per cent of students taking biology today. This question is of particular importance, because from the sophisticated level of the presentations and the novel approaches used, an observer might conclude, without sufficient evidence, that the three versions were suitable only for the college-bound student.

In selecting experimental schools for 1962–63, the BSCS attempted to obtain a reasonable cross-section of the American high school population. A description of the experimental schools is included in Table 1. The average ability level of the BSCS group as measured by the Differential Aptitude Tests — Verbal Reasoning + Numerical Ability (DAT — VR + NA) was at approximately the 65th percentile as compared with the national population of all tenth grade students in school (Table 2); however, not all tenth grade students take biology. Probably more high-ability than low-ability students elect biology, but no data are available to describe the ability levels of the total tenth grade population which now takes biology. And so it is not possible to determine the representativeness of the BSCS sample. However, there are enough students in the various ability groups of the BSCS tenth grade experimental population to permit an examination of their experience and to generalize as to the suitability of BSCS courses for tenth graders of various ability levels.

As is the case with all BSCS evaluation studies, the present study was under the aegis of the BSCS Evaluation Committee; the author is Staff Consultant coordinating BSCS evaluation activities. The BSCS obtained technical assistance from The Psychological Corporation which also was responsible for statistical processing of the data.

Prediction Criteria for BSCS Biology

From the 1962–63 evaluation, there are complete beginning and end-of-year test data available on 12,602 tenth grade students who used one of the versions of BSCS Biology and did not use one of the BSCS Laboratory Blocks.* The tests on which scores are available include a beginning-of-the-year DAT Form A, VR + NA, the beginning-of-year BSCS Impact Test, and an end-of-year BSCS Comprehensive Final examination. The BSCS 40-item Impact

* The present study is limited to nonblock students in order to reduce the sources of variance. Students in the study used the 1961–62 revised experimental edition of BSCS Biology. All experimental teachers had used a version of BSCS Biology for at least one year prior to 1962–63.

TABLE 1

Characteristics of Teachers from which BSCS 1962–63 BSCS Sample of 12,602 Nonblock Students Selected

	Number of teachers[a]		Number of teachers[a]
Sex of Teachers		Year of bachelor degree	
Male	139	1920–1929	7
Female	40	1930–1939	34
Population of community		1940–1949	41
Less than 2,500	4	1950 or later	96
2,500–25,000	52	Advanced degrees	
25,000–500,000	88	Yes	126
Over 500,000	34	No	53
Region		Type of advanced degree	
Urban	90	M.A.	59
Suburban	59	M.Ed.	16
Rural	19	M.S.	46
Other	11	Ph.D.	1
Type of school		Ed.D.	0
Public	164	Other	4
Private	2	Year of advanced degree	
Denominational	10	1930–1939	11
University laboratory	2	1940–1949	20
Other	1	1950–1959	68
Size of 1962 graduating class		1960 or later	27
Less than 100	17	Years biology teaching experience	
100–299	44	0–5	45
300–499	63	6–10	70
500–999	49	11–15	24
1,000 or more	6	16–20	18
Per cent of 1962 class in college		21 or more	22
Less than 10%	8	Number introductory biology classes	
10–24%	7	1	5
25–49%	50	2	17
50–74%	83	3	46
75–89%	23	4	52
90% or more	7	5	55
		6 or more	3

(*continued*)

Test and 50-item Comprehensive Final are multiple choice type tests prepared by the BSCS as part of its evaluation program. The Impact Test was designed to measure the processes of science and is content-free in that it is not tied to the factual knowledge of biology that would be unique to any one biology course. Rather its intent is to measure the student's grasp of how scientific problems are solved, how a scientist works, how data are gathered and evaluated. While the Comprehensive Final is specifically directed to those learnings that would be common to students in any of the versions of BSCS Biology, it is not concerned with detail of biological fact but with the concepts on which the three versions of BSCS Biology are built. It is intended primarily to measure ability to utilize biological information rather than direct recall.* To give criteria for success in the BSCS course for purposes of this

* A description of the method of construction of the Impact Test and Comprehensive Final exam, sample items, and an indication of the skills and areas of biology covered are included in *BSCS Newsletter No. 19*.[2] While the Newsletter treats the 1961–62 editions of both tests, the composition of the 1962–63 editions used in the present study is similar. The name of the Impact Test has been changed to the Processes of Science Test for the 1964 edition published by The Psychological Corporation.

TABLE 1 (*continued*)

	Number of teachers[a]		Number of teachers[a]
Annual per pupil expenditure		Teaching advanced biology	
Less than $300	31	Yes	50
$300–$499	91	No	129
$500–$699	44	BSCS laboratory checklist score[b]	
Over $700	10	149 or less	5
Other subjects taught		150–199	24
0	117	200–249	50
1	40	250–299	42
2	17	300–349	12
3	2	350 or more	4
4	1	Periods a week	
Average number in biology classes		3 or less	0
29 or less	95	4	2
30 or more	84	5	135
Total number students		6	12
74 or less	4	7	21
75–99	21	8	2
100–124	36	9 or more	6
125–149	61	Periods per week with access to laboratory	
150–174	41	0	2
175 or more	13	1	21
Class period minutes		2	52
47 or less	46	3	66
48–53	29	4	30
54–59	88	5	5
60 or more	16	6 or more	3
		Ability grouping	
		Yes	99
		No	80

[a] Discrepancies in section totals indicate failure of one or more teachers to respond to item.

[b] The BSCS Laboratory Checklist is a measure of adequacy of laboratory facilities; maximum score is 388 points. The Checklist appears in Reference 4.

study, two different cut-off points were set on the 50-item final exam; for students who did not achieve these scores, a study was made of beginning-of-year scores on the Impact Test and DAT. The cut-off points for success on the 50-item Comprehensive Final are arbitrary ones, set by the BSCS staff in consultation with BSCS teachers. These were set at: below 18 correct, and below 20 correct.*

Beginning-of-year scores for these groups are presented in Table 2. (For the experimental group, correlation between the Comprehensive Final and DAT is .66, and with the Impact pre-test, .62. The partial correlation coefficient for the Impact pre-test and Comprehensive Final with DAT held constant is .29.) Both tests appear to be reasonably good predictors of success as measured by the end-of-year final.

Based on data in Table 3, it would appear that BSCS Biology is suited to average and above-average students. In the experimental group, 18 students in 20 at or above the 50th percentile on DAT obtain a score of at least 20 items correct on the end-of-year final; 13 students in 20 in the 40th-50th percentiles score at least 20 correct on the final; and 9 students in 20 below the 40th percentile score at least 20 correct on the final.

* Mean score on the Comprehensive Final for the experimental group is 25.75, with a standard deviation of 7.47.

TABLE 2

Beginning-of-Year DAT Raw Scores and Impact Test Scores for 1962–63 BSCS Nonblock Students by Score on the End-of-Year BSCS Comprehensive Final

Comprehensive Final	No.	DAT − VR + NA		Impact pre-test	
		Mean	S.D.	Mean	S.D.
1–17	1,794	30.39	12.95	16.29	5.00
18–19	936	36.60	13.15	18.17	4.85
20 and over	9,872	52.04	15.05	23.48	5.55
Total groups	12,602	47.82[a]	16.76	22.07	6.12

[a] Approximately the 65th percentile on national norms for all tenth grade students.

TABLE 3

1962 Student Performance on Comprehensive Final by Beginning-of-Year Scores on DAT − VR + NA and Impact Test,[a]

	Pre-test score							
	DAT − VR + NA				Impact test			
	40 and over	34–39	0–33	Total	22 and over	16–21	0–15	Total
Number of students with Comprehensive Final score								
20 and over	7,820	867	1,185	9,872	6,359	2,695	818	9,872
18–19	376	173	387	936	228	441	267	936
0–17	436	293	1,065	1,794	273	728	793	1,794
Total	8,632	1,333	2,637	12,602	6,860	3,864	1,878	12,602
Per cent of students with Comprehensive Final score								
20 and over	91	65	45	78	93	70	44	78
18–19	4	13	15	7	3	11	14	7
0–17	5	22	40	14	4	19	42	14
Total	100	100	100	100	100	100	100	100

[a] On national norms for all tenth grade students on the DAT − VR + NA, the 50th percentile is at a raw score of 40–42 for boys and 38–40 for girls; the 40th percentile is at a raw score of 34–36 for boys and 34–35 for girls.

Certainly there are many reasons for lack of success on the BSCS test other than ability, but it might be concluded that a certain level of ability is a prerequisite. (In order to examine factors other than ability, a specific study of low-scoring biology students with above-average ability would be desirable.) However, below the 40th percentile, a majority of students do not master the materials in the minimum fashion indicated by the cut-off points. This does not mean that all students below the 40th percentile should automatically be assigned to a slow-learner class, but would indicate need for individual consideration of such assignment. The data would also lead one to question assignment of students over the 50th percentile, and even over the 40th percentile, to classes designed for slow learners.

Earlier studies of achievement on conventional biology tests,[3] indicate that the verbal factor of DAT is a better predictor of achievement of students in conventional biology courses than is the numerical factor. In the BSCS study, this was also true, insofar as average and below-average students were concerned (Table 4); no study was made of the verbal and numerical factors individually for above-average students.

TABLE 4

Coefficients of Correlation among DAT Verbal, DAT Numerical, DAT − VR + NA, and Comprehensive Final Tests for Tenth Grade Nonblock Students with DAT − VR + NA Scores of 41% or Less[a] (Males = 2054; Females = 2407)

	DAT-verbal		DAT-numerical		DAT − VR + NA	
Test	Males	Females	Males	Females	Males	Females
Comprehensive Final test	.329	.302	.228	.226	.380	.340
DAT-verbal			.100	.188	.725	.750
DAT-numerical					.758	.791

[a] A raw score of 41 is at approximately the 50th percentile. Correlations are low because of two kinds of restriction on range. For VR and NA scores, approximately half the normal curve is represented; for the VR and Comprehensive Final, chance scores restrict the range.

TABLE 5

Multiple Correlation of Comprehensive Final with DAT − VR + NA Scores for Tenth Grade Nonblock Students with DAT − VR + NA Scores of 40% or Less (Males = 2051, Females = 2407)

	Males	Females
R of Comprehensive Final vs. DAT − VR + NA scores	.388	.347
Beta weight of DAT − VR	.308	.269
Beta weight of DAT − NA	.208	.175

Given the content of the BSCS course and the relatively sophisticated reading level of the exam, one might expect VR to provide a better prediction criterion than VR + NA. However, for students at or below the 50th percentile on the total DAT score, the verbal plus numerical is a better predictor than verbal alone. And in multiple correlation, the prediction of Comprehensive Final scores from the optimum combination of verbal and numerical was insignificantly better than that from the simple summing of VR + NA scores (Table 5). Thus, it would appear that the VR + NA scores are the appropriately weighted combination of the two for prediction of the criteria for this group. Examination of the test data indicates that, for the below-average students who made satisfactory final exam scores, only 13 per cent had an above-average verbal ability. Of the above-average students with unsatisfactory final exam scores, 68 per cent had an above-average verbal ability. Thus, it would appear that higher verbal ability was not a reason for success of the average and below-average students, nor was limitation on verbal ability generally the reason for failure of above-average students.

School Identification of the Slow Learner

These BSCS findings concerning which students are able to handle the regular materials for BSCS Biology apparently do not agree with the practice in the schools of assigning students to regular and special slow-learner sections for biology. During the 1963–64 school year, the BSCS tested several experimental units of BSCS Biology Special (slow learner) Materials prepared for students who do not have the academic ability to handle the regular BSCS Biology versions. The materials are not intended for all unsuccessful learners. They are not intended for the able "under-achiever," but are for the low-ability student. Participating schools all expressed considerable concern over the problems of the slow learner and volunteered to participate. Thus, one might expect at least an average concern with identification of this type of student.

Each experimental school made class assignments to the Special Materials sections based on its own criteria, as reported in Table 6. Table 7 indicates the DAT profiles of the students selected. Twenty-five per cent of the students in the 1963–64 Special Materials program for slow learners are at or above the 50th percentile on the DAT; and 40 per cent are at or above the 40th percentile. These students appear to be improperly assigned to the slow-

TABLE 6
Teacher Report on Criteria for Selection of Students for the 1963–64 BSCS Special Materials (Slow-Learner) Classes

Teacher identification no.	General record	Teacher record	Ability and intell. tests	Comments
1				SA Test, Otis
2	X		X	
3			X	75–90 IQ, below reading level, lowest 40% sch. apt.
4	X		X	Lowest rank on DAT and previous grades
5				Reading comprehension—with retardation of 1 1/4 year or more
6	X	X	X	
7	X			
8		X	X	STEP reading and writing tests
9				Students not taking Sp., Latin, or new math or new biology scheduled for this period
10			X	IQ and performance
11		X	X	
12		X		IQ, achievement test
13	X			Selected by counselor
14		X		Rec. of general math instructor or in lowest 1/3 on DAT numerical
15			X	IQ and reading test
16	X		X	IQ, taken from general math class last year
17				Selected at random
18	X		X	DAT, IQ
19	X	X	X	IQ
20	X		X	IQ and achievement tests
21		X	X	
22	X			Low IQ, retarded in reading, student request
23			X	Counselor's records
24	X			MAT, SCAT, IQ
25				Reading level-SCAT-DAT 0–15 percentile
26	X		X	IQ and reading ability
27	X		X	Verbal scores on DAT
28	X		X	Below 1.8 grade pt. average, below 40 percentile on scholastic aptitude section of DAT
29			X	80–90 IQ, reading 2 yrs. below grade level
30	X	X	X	
31				Lowest 25% on 9th grade achievement test (80% reading ability, 20% numerical)
32	X	X	X	Tests in reading and natural science
33		X	X	Student request
34			X	Iowa Test—reading
35	X		X	School placement test
36	X	X	X	
37	X		X	
38			X	IQ and science achievement scores

learner sections. There are even students in the 90–99th percentiles on general ability assigned to slow-learner sections. In some special cases (such as those concerning students with high NA and low VR), assignment of an above-average student on general ability to a slow-learner section might be warranted; however, scanning the VR and NA scores for students in the Special Materials sections indicates few such cases.

Thus, despite school reports to the

TABLE 7

Frequency Distribution of Students in the 1963–64 BSCS-SM Program on the DAT — VR + NA by Percentile Rank and by Teacher as of September 1963[a]

	SMS Teachers																																		
Percentile	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
99																	1									1											
97																	2									1	1								1		
95			1								2						1									1		1				1					1
90	1					1	1		1		1	1	1				2	1		1				1			1			2					2	
85							2					1					2			1			1	2			1		1		1				3	
80				2							2						4			1			1			1	2	1			1	1				
75	1			2			2			1	1	1					2			1						1										1
70	2			2			3			1	3	2					1				1		2	3		1									1	
65	1		1	2		2	2		1		2	2				2	1	1	1				2	2		1			1		2			1	5	
60	1			3			1	1				1	1				3	2		1	1		1	1			1		2	1	2				2	1	2
55	2			4		1	3	2		2		1	1					4		1	1		2	2	1	1	4					1			2	3	
50	*1*		*2*	*5*		*1*	*2*	*1*	*2*	*1*		*2*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*4*			*1*		*1*	*3*	*1*			*1*	*2*		*2*		*1*	*5*	*3*
45	1		1	1	1	2	2		3			3		1		3	3	3	3	1	2		3	5	1	1	2		2		3	1				3	3
40			1	5	1	1	4	1	1	2	1	3	4			3	3	2	2	2	3	1	3	3	2	4	2	1	2	3	3	1	3		1	3	1
35	2		2	3		3	1	1	1	5	1	2	2	5	2	3	1	2	3	2	5	1		3	1	1		2	2	1	1	2	1		7	8	2
30	2		1	3		1	2	2	2	2	1	3	1	1		3	1	3		3	5	2	4	2	5	1			2	4	4	1	3		2	2	6
25			1	1	2	1	1	3	1	2		2	3		1	1	3	1	3	2	1	1	4	1	2		1		3	2	5	1	1			4	2
20			2		1		1	1	4		3	1	1	2	3	3			1	1	2	1	1	1	3	1	1	3	1		4			1	1	1
15			4		4			3	1	1		3	4	1	2	5	2	1	3	1	3	2		1	2		1		4	5		3	3		1	5	2
10			3		4	1	1	4	3	3	3	3	1	6	5	5		5	2	2	3	7	2		4	2	1	5	1	3	2	3	2	1	2	3	4
5			3		3	2	1	2	3	5			3	5	4	2		1	6		1	5	1	3	4	2	1	5	3	3	3	3	4	2	1	2	1
3				1	5	1				1			2	8	3	2			1			5	1	1	3	3		1	1		3		7	3		2	1
1				1	4	1						2		5	8	3				1	1	1	1		3			1	3		1		3	4		1	
N	14		22	35	25	18	29	21	23	26	20	33	26	35	29	36	33	27	26	25	29	26	30	31	32	25	21	20	28	23	32	23	31	10	22	54	30
Median	55		20	50	10	35	50	25	25	30	65	40	25	5	5	20	60	40	25	40	30	10	40	45	20	40	55	10	25	25	30	20	10	3	35	35	30
To. range	60		90	80	45	90	85	55	85	70	85	90	85	50	50	65	85	85	65	90	70	40	85	85	55	95	90	95	85	55	90	90	80	10	90	90	90

[a] In computing percentile rank for the DAT on the 1963–64 SM students, the actual grade level of the student was used. Thus, an 11th grade student with a raw score of 67 would be at the 85th percentile, whereas the same score for his SM classmates who were tenth graders would be the 95th percentile. (This example represents an actual case.) Similarly, a ninth grader with a raw score of 17 would be in the 25th percentile, whereas others in the class who are 10th graders would be in the 10th percentile.

To compute the median for classes with an even-numbered total enrollment, a count down of half the cases was made starting from the top of the distribution. In computing total range, figures were rounded to the nearest multiple of 5. Total range was used as the indicator of distribution spread, since, for the purposes of this study, the cases at the extremes are of interest; the total range takes on particular significance in view of the fact that these are intended by schools to be homogeneous classes.

contrary, schools are obviously not assigning students to slow-learner classes based on student ability as measured by reading or general ability tests, but rather on other criteria. Feedback from some schools indicates assignment to slow-learner classes for many other reasons not stated on official reports. These include: late registration of student and therefore assignment to the smallest section of biology, which happens to be the slow-learner section; availability of only one biology section at that hour; previous teacher reports that the student is a troublemaker (This may be a creative, questioning individual or a very bright student who is bored.); lack of student motivation; unacceptable social or economic background of the student, which means that he does not "fit in" to regular sections; previous grades in other related or unrelated subjects.

Such improper assignment of academically able students to slow-learner classes has several unfortunate results. It may mask the real problem of the student, such as the under-achiever. It may create an unfavorable or false image of biology in the minds of the brighter students who are bored with the slow-learner materials. And the presence of the brighter student in the slow-learner classroom defeats the major purposes of homogeneous grouping for ability in BSCS Biology-SM Materials, that is, to permit the academically less able student to go at his own pace, to discover new ideas and relationships through discussion that is slow enough for him to keep up and participate in actively, and to compete at his own level.

Conclusions

Based on testing of the experimental editions, the DAT − VR + NA and Impact Test are good predictors of success in BSCS Biology. The Blue, Yellow, and Green Versions of BSCS Biology appear to be suited for use with most students at or above the 50th percentile on general ability as measured by the DAT − VR + NA. A majority of students in the 40th to 50th percentiles are also able to handle the materials in a satisfactory manner, as measured by the Comprehensive Final. However, the materials appear to be too difficult for a majority of students below the 40th percentile in general ability.

It was the intent of the BSCS to prepare materials suitable for use by the upper two-thirds to three-quarters of the students who now take biology. While most tenth graders elect biology, no data are available on the characteristics of students who do not take biology; although some brighter students take biology in ninth-grade, it seems likely that for the most part the students not taking biology in tenth-grade are the slower students who either take a tenth-grade special general science course for slow learners or satisfy the high school science requirement with their ninth-grade science course. Thus, if BSCS Biology can be used successfully with students at or above the 40th percentile of all tenth graders, it would appear that the BSCS has achieved its original aim, that is, the versions are suitable for use by two-thirds to three-quarters of the tenth graders who now take biology.

Although schools in the BSCS slow-learner study report using tests of general ability and/or reading ability, at least half of the schools participating in the BSCS Special Materials program in 1963–64 have not actually done this systematically in sectioning students for slow-learner classes. In view of the BSCS experience with its slow-learner program, it might be well for others to investigate the extent of improper assignments to slow-learner sections in other disciplines. Also, other investigators studying slow learners should be wary of accepting a school's designation of that population.

Several phases of this study are being replicated with data collected in 1963–64 for students in regular BSCS Biology classes and 1964–65 data on students in BSCS Special Materials classes.

Synopsis

BSCS Biology was written for the upper 65–75 per cent of the high school students now taking biology. To determine whether the materials are suitable for use by these students, performance on the BSCS Comprehensive Final for 1962–63 students was examined in terms of beginning-of-year scores on a general ability measure (DAT — VR + NA) and the BSCS Impact Test. Data indicate that both tests were good predictors of student performance, and a majority of students at or above the 40th percentile obtained a minimum acceptable score on the Comprehensive Final. BSCS Biology Special Materials have been prepared for the low-ability students not able to use the regular BSCS Biology. However, data from test schools in 1963–64 indicate that many schools are improperly assigning students to slow-learner sections based on subjective criteria rather than on student ability.

References and Note

1. The 1963 editions are: *Biological Science: Molecules to Man*, Houghton Mifflin, Boston; *Biological Science: An Inquiry Into Life*, Harcourt, Brace and World, New York; and *High School Biology, BSCS Green Version*, Rand McNally, Chicago.

2. *BSCS Newsletter No. 19*, Biological Sciences Curriculum Study, Boulder, Colorado, September 1963.

3. Bennett, George K., Harold G. Seashore, and Alexander G. Wesman, *Manual for the Differential Aptitude Tests*, Third Edition, The Psychological Corporation, New York, 1959.

4. *BSCS Newsletter No. 9*, Biological Sciences Curriculum Study, Boulder, Colorado, September 1961.