

Type of High School Biology Program and Its Effect on Student Attitude and Achievement in College Life Science

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Synopsis

A specially designed questionnaire and a modification of the "Science Classroom Activity Checklist" by L. H. Krockendorfer were used to categorize 299 life science students at the University of Iowa into two groups; those with high school biology backgrounds founded in the BSCS philosophy and those with traditionally oriented backgrounds. These groups were compared with respect to grade achievement in a college life science course, ratings of their background for the college course, and their attitude toward biology as established by their high school experience. With respect to inquiry and student-centered methods, texts were revealed as poor indicators of types of programs offered.

Introduction

Since the work of the Biological Sciences Curriculum Study at Colorado University, 1959-61, and the subsequent release of materials, biology teachers at every level have been trying to determine if BSCS biology is better for their students and their situation than the more traditional non-BSCS approaches. The non-BSCS or traditional programs are defined as those presented with little or no emphasis on the objectives of the BSCS programs as stated in *BSCS Newsletter*¹ and by Schwab.²

Many investigators with a knowledge of the BSCS objectives have given up the task of controlled group comparisons, stating that it is as impossible as trying to determine if the lecture method is as effective in teaching human reproduction as non-directed laboratory is in teaching the germination of seeds. Nevertheless, investigations have been conducted comparing BSCS with non-BSCS materials. The results

usually reveal no significant differences,^{3, 4} or worse, conflicting findings with respect to the effectiveness of the separate BSCS versions and their respective comparisons to conventional texts.^{5, 6} The objectives of the two types of programs are obviously quite different. There are, however, several common objectives desired by all teachers, even by those who are highly subject matter oriented.

As a teacher, one would like to see the student benefit from a class experience to the highest degree no matter what his future plans may be. Also, one would be pleased if the student would develop a favorable attitude toward the science of biology—its content and its processes.

The Problem

The main objectives of this study were to determine if the BSCS and the non-BSCS high school programs prepared the general liberal arts student equally well for a typi-

cal introductory biology course at the college level and to compare the attitudes of students toward the biological sciences with regard to their type of high school background.

It is quite easy to group students according to the textbook they used: BSCS (blue, yellow, or green) or various non-BSCS textbooks. However, it is quite evident that a textbook in name alone does not indicate the degree of adherence to the BSCS philosophy. It has been previously shown by Granger⁷ that in schools using BSCS textbooks, only 30% presented inquiry laboratories while 16% experienced no laboratory at all. Accordingly, the students in this study were categorized into two populations irrespective of high school textbooks used; those experiencing programs guided under the BSCS philosophy (BSCSP) and those not experiencing these activities (non-BSCSP).

Population

Out of 365 University of Iowa students completing the first semester of an introductory biology course entitled Life Science, 299 or 82% of the students completed the questionnaire. Approximately 70% of those responding were freshmen, 21% sophomores, 6% juniors and 3% were seniors. Four students did not have high school biology and therefore their responses were not included in this study.

The life science course is offered to non-majors in the liberal arts college as an elective to satisfy the requirement for a science course which includes laboratory work. The course consists of two fifty minute lectures, a one hour discussion period, and a two hour laboratory each week. The course outline is typical with respect to its general biology content. *Biology* by Curtis⁸ is used as a basic textbook.

Procedure

A pre-test, regular course grades, and a questionnaire were used as sources for data.

The questionnaire contained seventy items prepared to provide information about: (1) the personal background of the students; (2) textbook and other materials used by students in their high schools; (3) attitudes of the students toward biology; (4) student opinion concerning the benefits derived from courses in high school biology; (5) the degree to which the high school biology experience of the students coincided with the BSCS philosophy and objectives.

A modified form of the Science Classroom Activity Checklist,⁹ initially developed by L. H. Kockendorfer, was used to produce a rating scale for student exposure to the objectives emphasized by the BSCSP. Ratings were allowed to range from 0, a highly traditional background, to 29, a program closely paralleling the BSCS ideal.

The responses on the questionnaires were compiled and then analyzed, utilizing the Chi Square statistic to compare different group responses to various items; 0.01 was set as the level of significance. The t-test was used in resolution of populations of various background of BSCSP exposure.

Results and Discussion

From the questionnaire a distribution of ratings of student background with respect to their degree of exposure to the BSCS philosophy was obtained and plotted (Fig. 1.) The Life Science students responding to the questionnaire had an average of 11.94 points on the rating scale with a standard deviation of 6.08 and a range of 26 points. Neither extreme; 0, highly traditional, or 29, completely matching the BSCS objectives, was achieved by any high school program offered to the students.

The rating distributions were then plotted according to the text used—BSCS or non-BSCS. Those students that used a BSCS text had a mean rating of 14.34 with a standard deviation of 5.76 and those students using a non-BSCS text had a mean of 10.12 with a 5.67 standard deviation. The t-test shows that the two means are

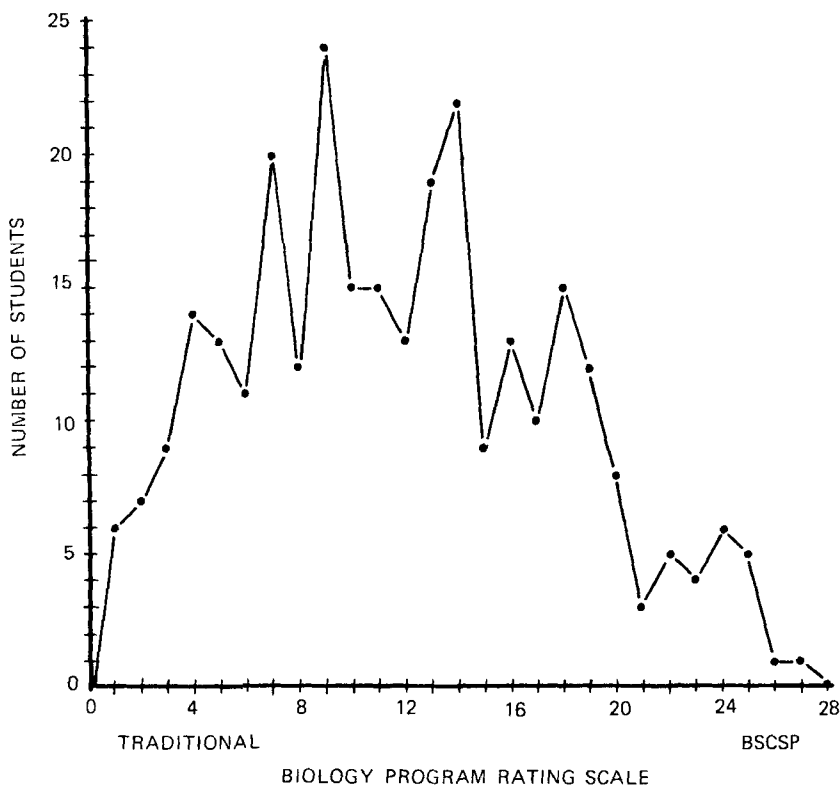


Figure 1. Distribution of college life science students experiencing various degrees of BSCSP-type high school programs

significantly different at the 0.01 level. However, as can be seen in Figure 2, the ranges are nearly the same and the means are less than three quarters of a standard deviation apart.

The curve representing the total sample of students as presented in Figure 1 was subjected to the Chi Square test for normality. It was found that the multi-mode configuration was a true representation of the sample and that indeed the curve was significantly different from a normal curve at the 0.05 level. This indicated that the questionnaire was able to resolve two different background types with respect to BSCS objectives and philosophy. The Chi Square test for normality was also applied to the samples of students utilizing BSCS and non-BSCS textbooks. Here it was found that the non-BSCS sample is multimodal; not a statistically normal distribu-

tion at the 0.05 level of significance. This indicates that the textbook material *per se* does not dictate the philosophy that prevails in the classroom. Lack of normality could not be demonstrated for the portion of the sample utilizing BSCS textbooks. This indicated, along with the range of ratings, that the BSCS textbooks are used on a continuum from highly traditional approaches to those aligned with the philosophy for which they were intended. Even though there is a difference in means on the rating scale between users of the BSCS and non-BSCS textbooks, it can be easily seen that studies based only on the utilization of a certain textbook as criteria for representing a particular approach are on a questionable base.

For comparison the total sample was divided into four groups, approximately -2 , -1 , $+1$, and $+2$ standard deviations from

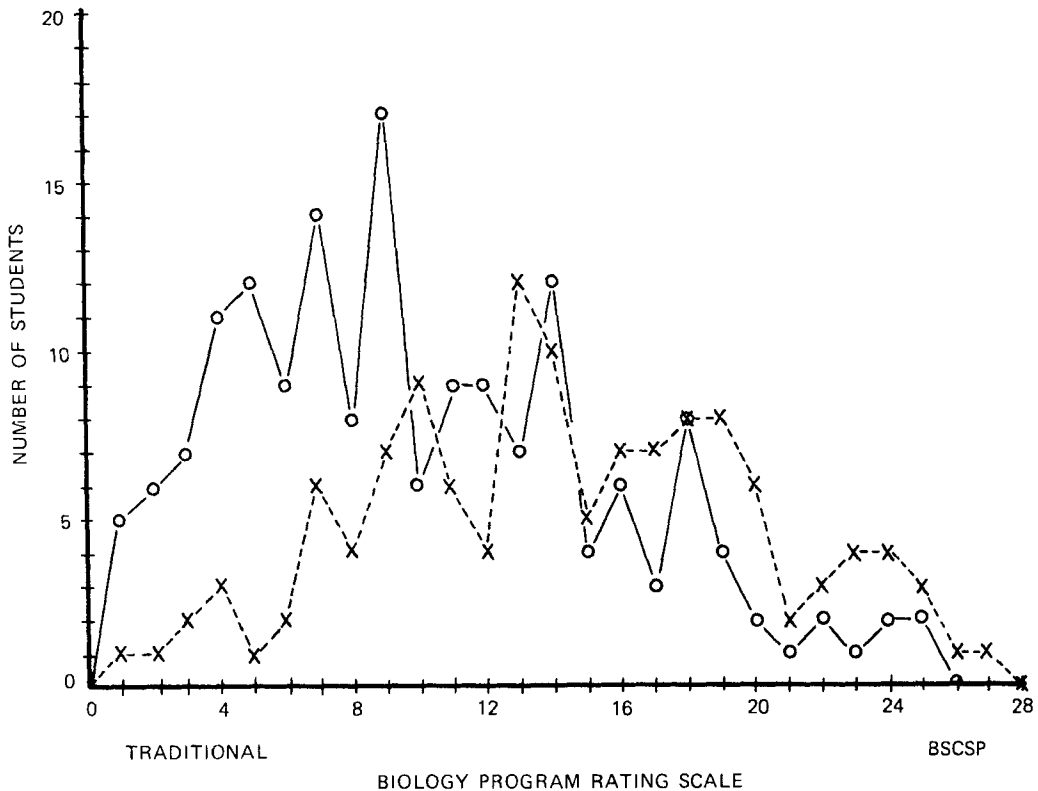


Figure 2. The number of students in college life science experiencing various degrees of BSCSP-type high school programs. 0—0—0—0 represents students using non-BSCS texts. X—X—X—X represents students using BSCS texts.

the mean of the total sample. The -2 group represents the lowest rating on the BSCS scale and the +2 represents those most closely approaching the ideal BSCS background.

Table I shows that there was no significant difference among the four groups of students with respect to achievement in

their high school biology course. This helps eliminate any student bias in evaluation caused by success in class and indicates uniformity in evaluation in the various types of programs.

Table II shows the results of a pre-test given to the life science students on the first day of class. It is based on items from

TABLE I

High School Grades Obtained by College Life Science Students with Differing BSCSP Oriented Backgrounds

BSCSP Oriented Background	High School Grade			
	A	B	C	D
-2	31.2%	47.5%	18.3%	3.3%
-1	31.9	53.9	13.4	1.1
+1	38.2	48.7	11.8	1.3
+2	31.0	53.5	15.5	0.0

TABLE II

Pre-Test Rank Obtained by College Life Science Students with Differing BSCSP Oriented Backgrounds

BSCSP Oriented Background	Lowest 25%	Quartile Rank		
		25%-50%	50%-75%	Highest 75%
-2	21.3%	13.1%	26.2%	32.8%
-1	25.3	21.3	24.2	27.4
+1	28.6	14.3	24.7	26.0
+2	16.7	20.0	35.0	26.7

past examinations in the course. All test items required factual recall of knowledge and were not of a problem solving nature. Here again the Chi Square test shows no significant difference in scores. This would seem to indicate that both traditional and BSCS programs prepare the student equally well for college level biology.

Similarly, Table III indicates no difference in achievement among students of various backgrounds as far as final course grades are concerned. A slight trend in favor of the BSCS Program can be noted but cannot be substantiated statistically.

When students were asked if they would have liked to change their high school biology experience to meet better their total need as individuals, approximately 87% of the students who experienced the highly traditional approach stated that they would have. On the other hand, 70% of the students in the various BSCS programs felt the program satisfied their needs. Similarly, when asked if they would have had their high school biology course changed to aid or prepare them more specifically for the college life science course, 83% of the -2 group said they would while only 30% of the +2 group felt their high school program could have been more adequate.

When students were asked to rate directly the background for the life science course provided them by their high school experience, a large difference, greatly exceeding the 0.01 level of significance, was shown among the four groups (see Table V). The

TABLE IV

Adequacy of High School Preparation

If you were allowed to, would you have changed your high school biology course to more specifically aid or prepare you for this college science course?

BSCSP Oriented Background	Response	
	Yes	No
-2	83.3%	16.7%
-1	59.6	40.4
+1	35.1	64.9
+2	30.0	70.0

+2 group rated the high school experience as good or excellent 75% of the time while the -2 group did so in only 12% of the time. These data clearly show that in the student's opinion BSCSP-type programs provide him with the type of background he wants for both general knowledge and for preparation for college level courses.

When the students were asked to compare their high school and college courses with respect to difficulty, a significantly larger percentage of the BSCSP oriented students thought their high school course was as difficult or more difficult than the college life science course. The values in Table VI were obtained when the students were asked to disregard interest or motivation and only evaluate the degree of difficulty.

The difference in difficulty, however, was not derived from an increased amount of rote learning. As pointed out in Table VII, 88% of the -2 group as opposed to 67%

TABLE III

First Semester College Life Science Grades Obtained By Students With Differing BSCSP Oriented Backgrounds

BSCSP Oriented Background	College Grade					
	A	B	C	D	E	I
-2	13.1%	27.9%	42.6%	11.5%	4.9%	0.0%
-1	8.5	26.6	46.8	13.8	4.3	0.0
+1	14.3	27.2	41.5	11.7	3.9	1.3
+2	15.0	31.7	40.0	10.0	3.3	0.0

TABLE V

Rating of High School Biology Program With Respect to Background Provided for a College Level Course

My high school biology course provided background for this college science course that was:

BSCSP Oriented Background	Responses				
	Very Poor	Poor	Fair	Good	Excellent
-2	11.7%	33.3%	43.3%	10.0%	1.7%
-1	4.2	21.1	38.9	30.5	5.3
+1	5.2	5.2	27.3	48.0	14.3
+2	0.0	1.7	23.3	41.7	33.3

TABLE VI

Relative Difficulty of Types of Biology Programs Disregarding interest or motivation, compared to this college life science course, my high school biology, for my age at the time each was taken, was:

BSCSP Oriented Background	Responses		
	More Difficult	Same	Easier
-2	13.1%	9.8%	77.1%
-1	14.6	15.6	69.8
+1	25.9	24.7	49.4
+2	29.3	25.2	47.4

of the +2 group felt that their high school experience when compared to their college course required more memorization without the need for complete understanding.

Even though BSCSP-type programs are more difficult for students, 90% of the students in the +2 group consider their high school biology course in the top 50% of all courses taken in high school. Table VIII

TABLE VII

Relative Amount of Memorization in the BSCSP and Non-BSCSP Programs

Which science course experience, high school biology or this college science course required more rote learning (memorization without the need for complete understanding)?

BSCSP Oriented Background	Response		
	High School	Same	College
-2	88.5%	6.6%	4.9%
-1	80.5	3.0	16.5
+1	75.7	12.8	11.5
+2	67.5	17.3	15.2

also indicates that only 37% of the students in the -2 group value their biology experience as highly. This certainly is a strong recommendation for BSCSP-type programs considering the students in the sample were not biology majors or even students who were science oriented.

TABLE VIII

Comparison of High School Biology With Other High School Courses

Compared to all my high school courses I would rate my high school biology class:

BSCSP Oriented Background	Responses							
	Worst	Lowest			Highest			Best
		10%	25%	50%	50%	25%	10%	
-2	6.7%	16.7%	23.3%	16.7%	28.4%	6.7%	1.7%	0.0%
-1	3.5	4.2	11.6	17.9	37.8	16.8	3.2	5.3
+1	1.3	1.3	6.5	14.5	33.8	22.1	15.6	5.2
+2	0.0	0.0	3.4	6.8	44.1	15.2	20.2	10.2

Conclusions

It appears that there is no foundation in the statement by highly subject matter oriented teachers that students need to cover a definite amount of material to be prepared for future experiences. It has been shown that students with backgrounds from both the traditional (subject matter oriented) and the BSCSP (process oriented) biology programs achieve equally well in college level biology courses. But even more significant is the favorable attitudes generated by the BSCSP-type approach toward biology and the total high school biology experience of the students.

BSCSP students are more satisfied with their high school experience as far as their total needs are concerned as well as with their backgrounds for a college level course. The degree of difficulty appears to have no effect on student attitudes as long as the work is meaningful and provides the student with relevant experiences.

The findings of this study can be enumerated as follows:

1. BSCS textbooks are used on a continuum of program types from the highly traditional to those incorporating the philosophy for which they were intended.

2. Two types of high school programs can be resolved in a sample of college life science students by comparing their backgrounds as indicated by classroom activities.

3. There is no significant difference between students experiencing BSCSP and non-BSCSP backgrounds with respect to achievement in either high school biology or college level biology.

4. A significantly larger percentage of BSCSP oriented students felt their background was better in meeting their indi-

vidual needs as well as in preparing them for college level biology.

5. BSCSP oriented students felt their high school experience was more difficult than did the non-BSCSP students but they rated it significantly higher with respect to all other high school course work.

6. Non-BSCSP oriented students felt that their high school experience was composed of more rote memorization without the need for complete understanding than did the BSCSP oriented students.

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