# Individualized *vs.* Group Teaching of BSCS Biology

By HARRY F. FULTON



Relative success in education in America has been determined by measuring the growth of groups of students in a given course. This approach to educational research has dominated the thinking of educators to the degree that every student in the classroom has been expected to perform and progress at a predetermined pace established by the teacher. Each student is expected to fulfill the predetermined requirements, without regard to his individual capabilities. Such an approach to teaching biology was used in curricula antedating the Biological Sciences Curriculum Study (BSCS) and is still being employed in the current approach to teaching BSCS courses.

One means of alleviating the problem of forced pacing is to individualize the biology class by having the student pace himself as he progresses through the course. This approach allows the student to progress at a rate commensurate with his abilities.

This paper offers an analysis of the effects of two approaches to teaching BSCS biology on certain student outcomes. The analysis was accomplished by comparing student outcomes when students experienced BSCS biology as a group or as individuals. Individualized instruction, as used in this study, did not attempt to employ a wide variety of approaches. The main emphasis was on the self-pacing aspect (Fulton, 1970).

## Objectives and Methods

The major objectives of the study were to determine whether students who had experienced these two different approaches to biology displayed differences in achievement in biology, degree of understanding of science, ability to think critically, attitude toward science, and attitude toward the ability of the teacher to make the material understandable.

The sample consisted of 20 students selected at random each year from the students enrolled in the eighth-grade biology program at University High School, at the University of Iowa. The same instructor was employed during the two-year period.

Both classes used BSCS materials but were taught by two different approaches. During the 1967-68 school year the students were taught by group instruction. This class used the Blue Version (BSCS, 1964) as the basis for instruction. The rate at which the students worked was determined by the teacher and applied to the whole class.

The following school year, 1968–69, the students were taught BSCS biology by an individualized approach. The students worked with an adaptation of the Blue Version, which contained the same content and sequence of materials as the original textbook. Because of individualized use the adaptation followed a format that consisted of reading material interspersed with discussion questions, activities, and laboratory investigations, which were related to similar techniques used when the class was handled as a group. Each chapter was followed by a summary and a series of questions. Space was provided within the reading material for the student to consider any problem presented to him in the reading and laboratory investigations.

The students progressed at individual rates through verbal "contracts" between student and teacher. A student would progress to another contract when he

The author teaches biology at Olivet Nazarene College, Kankakee, Ill. 60901.

**Table 1. Comparison of two groups, prior to the study of BSCS biology, as measured by the Iowa Tests of Basic Skills.**

| *ITBS test* | *Group (G) and individualized (I) approach* | *Mean* | *t* |
|---|---|---|---|
| Composite score | G | 83.95 | |
| | I | 87.65 | 0.87 |
| Vocabulary score | G | 92.58 | |
| | I | 96.71 | 0.72 |
| Reading comprehension composite score | G | 87.05 | |
| | I | 86.65 | 0.08 |
| Work-study skills composite score | G | 86.58 | |
| | I | 87.76 | 0.28 |
| Arithmetic skills composite score | G | 77.00 | |
| | I | 84.00 | 1.54 |

$H_0: \mu_G - \mu_I = 0$ Critical region: $\alpha = 0.05$ $N_G = 20$

$H_1: \mu_G - \mu_I = 0$ $R = |t| \geq 2.03$ $df = 38$ $N_I = 20$

and the teacher agreed that the present contract had been satisfactorily fulfilled. This was determined by periodic checks of student progress—initiated either by the student or the teacher—in individual or small-group discussions, review sessions, laboratory investigations, and examinations. An effort was made to keep the presentation and emphasis of the material similar to that of the previous year. Excursion activities were provided for those students who had finished with the basic materials before the end of the school year. Such options were also available during the school year for interested students in the group approach.

## Tests Administered

To determine the background of the students, information from the Iowa Tests of Basic Skills (ITBS) (Lindquist and Heironymus, 1964) and the Iowa Cardpac System of Educational Accounting Pupil Inventory (Iowa Educational Information Center, 1967, 1968) was obtained. The t-statistic was used to compare the background on the ITBS between the two groups studied.

The results (table 1) indicate there was no statistically significant difference between the two groups as measured by the ITBS. The results of the Iowa Cardpac inventory (table 2) indicate that the two groups had similar backgrounds with respect to matters considered in the inventory. Information provided by the University High School principal and taken from the school records revealed that the students in the two-year study had the same class schedules and teachers.

To determine what effect the two approaches to teaching BSCS biology had on the students, seven tests were given—each at the beginning and the end of the school year. The BSCS Comprehensive Final Examination (BSCS, 1963) and the Nelson Biology Test (Nelson, 1965) were used to evaluate achievement in biology. The Test on Understanding Science (Cooley and Klopfer, 1961) and the Facts About Science Test (Stice, 1958) were used to determine student understanding of science. The Watson and Glaser Critical Thinking Appraisal (Watson and Glaser, 1961) tested the ability to think critically, and the Silance Attitude Scale (Silance, 1960) and the Prouse Subject Preference Survey (Prouse, 1964) revealed student attitudes toward science. Another instrument, Question No. 2 of the Performance Scale for High School Biology Teachers (Fowler, 1960) was used at the end of the school year to evaluate student attitude toward the teacher's ability to make the material understandable.

## Analysis of Data and of Results

The data were subjected to analysis of covariance (f-test) on all pre-test and post-test scores, in which the pre-test measure was treated as a covariant. Post-test scores were adjusted on the basis of the pre-test scores, and the adjusted score was used to compare the various scores between the two groups. The effect of this method was to equate the two groups statistically on the pre-test measures. In so doing, differences between the groups on post-test scores could

**Table 2. Comparison of two groups, prior to the study of BSCS biology, as measured by the background information based on the Iowa Cardpac System of Educational Accounting Pupil Inventory.**

| *Information* | *Percentage for group approach, 1967-68* | *Percentage for individualized approach, 1968-69* |
|---|---|---|
| I. Parent background | | |
| married | 75 | 80 |
| divorced | 25 | 20 |
| Father's occupation | | |
| semi-skilled | 15 | 15 |
| semi-professional | 20 | 20 |
| professional | 65 | 65 |
| Mother's occupation | | |
| housewife | 45 | 55 |
| semi-professional | 20 | 15 |
| professional | 35 | 30 |
| Father's education | | |
| high school | 30 | 35 |
| degree beyond college | 70 | 65 |
| Mother's education | | |
| high school | 45 | 45 |
| graduated from college | 25 | 30 |
| degree beyond college | 30 | 25 |
| II. Student background | | |
| Attitude toward studying | | |
| like it | 25 | 20 |
| no like or dislike | 50 | 50 |
| dislike it | 25 | 30 |
| How do your teachers view you? | | |
| good student | 55 | 35 |
| average student | 45 | 65 |
| Education you expect to attain | | |
| high school | 10 | 15 |
| college | 40 | 55 |
| beyond college | 50 | 30 |

be more nearly attributed to the effects of the teaching method (Ferguson, 1966). To compare differences between groups on measures collected at the end of the year, simple t-tests were made.

To determine if the two groups were of equal ability with respect to the standardized tests, the pre-test scores were compared, using the t-statistic. The results (table 3) reveal there was statistically no significant difference between the means of the two groups on all pre-test scores except for the Silance Attitude Scale and the Prouse Subject Preference Survey.

The analysis of covariance results in table 4 reveals consistently greater gains by the students in the individualized class in achievement in BSCS biology, understanding of science, ability to think critically, and attitude toward science. Table 5 reveals that the individualized class thought the teacher's ability to make the material understandable was significantly greater, by comparison with ratings by the students in the group approach.

## General Considerations

The teacher and the students in the individualized course made some interesting observations during the year. In general, the students enjoyed working at their own pace. This pace varied with the degree of difficulty of the subject being studied and with the students' interest in it. They found the contracts to be helpful in establishing goals they believed were fair and within their capabilities. The students also found the option to renegotiate the contract a valuable and sometimes necessary procedure. Because of the way the contracts were handled, the students felt no pressure to move at a specified rate. They believed this made it enjoyable and easier to learn the subject being studied.

The students indicated they had been challenged, and they were satisfied with their successes. This was true even among students who were not getting the higher grades: they still expressed satisfaction with their progress and achievement, because they had done their best and had not felt any compulsion to compare their work with anyone else's. This is not to say that competition did not exist; on the contrary, it was present—but not always just for a grade.

It was interesting to observe how the students employed the option to work alone or with one or more partners. In general, the size of a group was limited to four students. All of the students were flexible in the use of this option: sometimes they worked alone, sometimes with one partner, sometimes with more than one. This, too, depended on the degree of difficulty and the interest. The same flexibility existed in the individual and small-group discussion sessions conducted by the teacher. The selection of partners

(Concluded on p. 291)

**Table 3. Comparison of two groups, prior to the study of BSCS biology, as measured by the pre-test instruments.**

| *Pre-test Instrument* | *Group (G) and individualized (I) approach* | *Mean* | *t* |
|---|---|---|---|
| BSCS Comprehensive Final Examination | G | 18.85 | |
| | I | 18.30 | 0.34 |
| Nelson Biology Test | G | 19.80 | |
| | I | 21.65 | 0.61 |
| Test On Understanding Science | G | 20.80 | |
| | I | 28.00 | 0.98 |
| Facts About Science Test | G | 42.55 | |
| | I | 46.85 | 1.14 |
| Watson and Glaser Critical Thinking Appraisal | G | 56.40 | |
| | I | 55.25 | 0.28 |
| Silance Attitude Scale | G | 7.88 | |
| | I | 6.38 | 2.22* |
| Prouse Subject Preference Survey | G | 3.65 | |
| | I | 2.40 | 2.81* |

*Statistically significant difference.
Statistical criteria as in table 1.

**Table 4. Analysis of covariance results for pre-test and post-test instruments used in the study.**

| *Instrument* | *Group (G) and individualized (I) approach* | *Adjusted post-test mean* | *F* |
|---|---|---|---|
| BSCS Comprehensive Final Examination | G | 24.67 | |
| | I | 30.48 | 10.00* |
| Nelson Biology Test | G | 29.89 | |
| | I | 35.11 | 3.78 |
| Test On Understanding Science | G | 26.89 | |
| | I | 34.61 | 30.19* |
| Facts About Science Test | G | 47.08 | |
| | I | 52.57 | 5.35* |
| Watson and Glaser Critical Thinking Appraisal | G | 58.14 | |
| | I | 65.11 | 7.85* |
| Silance Attitude Scale | G | 7.79 | |
| | I | 8.11 | 0.40 |
| Prouse Subject Preference Survey | G | 3.07 | |
| | I | 4.08 | 6.81* |

*Statistically significant difference.
Statistical criteria as in table 1, except critical region is $F = 4.105$ and $df = 1, 37$.

**Table 5. Comparison of results for Question No. 2, Performance Scale for High School Biology Teachers.**

| *Instrument* | *Group (G) and individualized (I) approach* | *Mean* | *t* |
|---|---|---|---|
| Performance Scale for High School Biology Teachers | G | 5.95 | |
| | I | 8.05 | 5.12* |

*Statistically significant difference.
Statistical criteria as in table 1.

## *NSF . . .* from p. 272

college teachers in 1956. This action and subsequent institutes and related training activities led to a transition from multiple or general-science teachers in the secondary schools to the professionally recognized, single-discipline teacher of today. Commensurate with this emergence of the professional biology teacher, the high school curriculum underwent a similar transition from a teacher-directed presentation of conventional and often dated subject matter with limited student response to a presentation of basic principles and current topics in biology with considerable student involvement. During this period of transformation, NSF provided financial support and direction in an advisory capacity without resorting to predetermined standards or otherwise unduly restricting the course of action once initiated.

The reforms brought about by these changes at the pre-college level have focused attention on the crux of the problem: adequate preparation of preservice teachers. It is at this level that a catalyst for change similar to the one just described must be applied—and applied now. This must be done in order to move from the previous policy of remedial training for experienced but inadequately trained teachers to one of updating and strengthening expertise in subdisciplines for the professionally trained teacher of biology on a continuing basis.

### MATH MATERIALS READY

A new set of instructional materials to help low-achieving fifth through eighth graders learn mathematics has been developed by the National Council of Teachers of Mathematics (NCTM). Called *Experiences in Mathematical Ideas,* the two-volume textbook for teachers includes 13 prototype units, ranging from "Experiences with Base and Place Value" to "Experiences with Geometry." A teaching package accompanying each volume contains materials needed for classroom use, printed on 8½-by-11-inch sheets, which can be easily reproduced for overhead-projector transparencies, game materials, and copies of worksheets for students.

"EMI does not comprise a complete mathematics program for low achievers in grades five through eight," the National Council explains. "Neither is it intended to be used solely for supplementary or enrichment purposes. Rather, the units offer a model for teaching the representative segments of mathematics that are usually taught to and needed by all students. Most of the units are independent of the others and need not be taught in any specified order nor at certain grade levels."

The cost is $20 a volume, which includes text and teaching package. For further information contact National Council of Teachers of Mathematics, 1201 Sixteenth Street, N.W., Washington, D.C. 20036.

### CHARACTER POLLUTION?

Pollution may have unsuspected, subtle effects responsible for some of the uglier traits of character in modern man, an Indiana University physiologist believes.

"Chronic high irritability, possibly affecting our whole society, is an example of what I'm talking about," says Alfred Strickholm, whose research is on the hard-to-detect but real effects of chemicals on individual nerve cells. "Society may be suffering from subtle sicknesses to which pesticides and other pollutants are contributing.

"People can be sick all the time and not know it. They can feel rundown, chronically bad, and think it's normal."

More research is needed on such problems, Strickholm feels, and he deplores the fact that one of the reasons it's not being done is the recent cutback in government support of research.

"There should be more, not less, public support of basic research. Putting tax money into research is sound investment," he says.

## *Individualized . . .* from p. 279

by the students for these laboratory and discussion groups appeared to be independent of ability.

The overall result was that the class was conducted without too many problems. There was a period of adjustment for the students and teacher, but it was achieved with relative ease. The teacher and the students became more of an integral part of the learning process.

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