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ABSTRACT

The purpose of this study was to describe and exemplify a model to aid schools in introducing and evaluating new instructional programs. Four basic steps are identified: selecting the curriculum goals, identifying a possible program or programs, evaluating the implementation of the program or programs, and developing and obtaining instruments for the evaluation of goals. This model was used to evaluate two biology courses to assist in making a curriculum decision. Twenty-two 10th grade classes in one high school were studied. Twelve of these classes were using Biological Sciences Curriculum Study (BSCS) materials and the other ten were using a traditional text. Achievement of the students was measured using the Test on Understanding Science, the Cooperative Biology Test, and the Problem Solving Ability Test. Classroom transactions were measured using the Biology Classroom Activity Checklist and three interaction analysis systems. Lesson plans were also collected and examined. It was concluded that, as taught in this high school, the BSCS program more nearly fulfilled the goals that had been set for biology instruction. (EB)

"The bravery with which schools introduce new heresies can be compared to the quavering whistle of a man taking a shortcut through a cemetery at midnight in the dark of the moon. We must take care that promising new heresies do not become dull new orthodoxies."

-F. F. Brown

I. INTRODUCTION

A. Background and Model Development

Most educators are aware of the impact Sputnik had on our educational system. They have speculated that this event may have changed the American school system more than any other event in the history of our nation. Since 1957, entire school systems have reviewed their goals, philosophies, techniques and results. These reviews have revealed, all too often, glaring deficiencies within the various systems. One concrete result of these reviews has been a revolution in curriculum. Curriculum makers working within this revolution have designed and implemented innovations which will alter the total learning experiences of students--now and in the future. Dressel[1] conveniently categorized these curriculum makers into four groups of people: professional educators, the public, the government, and industry. Soon after Sputnik, Curriculum Revision

[1]Fred B. Dressel, "Curriculum Makers," School and Society, (October 12, 1968), p. 336.

Committees were set up on a national level by concerned educators to up-grade high school science. These national committees, funded by the federal government and/or professional associations, contained all four groups who collaborated to produce a series of new science curricula. The results of this collaboration are (1) the Physical Science Study Committee, for physics; (2) the Chemical Bond Approach and the Chem Study Group, for chemistry; and (3) the Biological Sciences Committee, for biology. These packaged programs, produced and distributed nationally, contained, in addition to textbooks, all kinds of teaching and learning devices: laboratory manuals, video tapes, slides, laboratory equipment, and other audio-visual materials.

Although the major objective of each program developed was to up-grade the high school science curricula, the committee usually constructed each new program with a particular theme or goal. Tyler states "the new courses being constructed in science included as their goals comprehending the kinds of problems with which the scientist deals in understanding natural phenomena."[1] The status quo was challenged by these new programs which brought curriculum unrest in the high school among administrators and science teachers. Today, twelve years later, nearly all schools met the challenge and

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[1]Ralph W. Tyler, "Purpose, Scope and Organisation of Education," Designing Education for the Future, No. 1, edited by Edgar L. Morphet and Charles O. Ryan, (Citation Press, New York, 1967), p. 41.

have engaged in some kind of curricular change. Conant[1] discovered that all of the 2,023 schools responding to a questionnaire were offering one or more of the new courses in chemistry, physics and biology. The results indicated that about one-half (47.6 per cent) of the schools had adopted the new chemistry, one-half (49.5 per cent) the new physics, and over one-half (64.9 per cent) the new biology.

When a curriculum change is contemplated, the local school system is placed in a decision making position. Most local schools, when cost prohibits local research, rely on the voluminous literature and statistical conclusions recommending adoption of the nationally-oriented curricula. Such easy reliance may have adverse affects since all programs which have been tested nationally are marketed by commercial interests. They provide the school using the new programs with the necessary materials and aids. Curriculum makers have co-operated and co-ordinated with industry to design these packages. However, as commercialism entered into the curriculum revolution, innovation became an expensive venture for most school districts.

The purpose of this paper is to describe a model that will aid local schools in innovating and subsequently in evaluating instructional programs. This model is based on the establishing of specific goals and include procedures of application and evaluative

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[1] James Bryant Conant, The Comprehensive High School (McGraw-Hill Book Company, Inc., New York, 1967), p. 55.

means, in order to assure the achievement of specific goals. All of these procedures were included in the work done in this study, and constitutes the premises for this model.

Some systematic procedures have been developed that one could categorize as a model. The National Education Association[1] lists six sequential steps in their curriculum-decision model. Alberty[2] in his model incorporated nine steps, emphasizing philosophy and goals.

Simplicity makes possible a clear understanding of any model. Hansen[3] proposes a simple six item model: (1) identification of problems; (2) diagnosis of the problem-situation; (3) classification of the diagnostic findings; (4) search for solution; (5) mobilizing for change; and (6) making the actual change decision. Ronald Doll's[4] diagram (objective--activities--evaluation) suggests that the purpose of evaluation is to determine the extent to which objective of a project or activity have been achieved. The diagram suggests that,

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[1] Schools for the Sixties. A report on the project on instruction, (McGraw-Hill Book Co. Inc., New York, 1963).

[2] Harold B. Alberty, Reorganizing the High School Curriculum (Macmillan Co., New York, 1967), p. 462.

[3] Kenneth H. Hansen, "Planning for Changes in Education," Designing Education for the Future, No. 3, edited by Edgar L. Morphet and Charles O. Ryan (Citation Press, New York, 1967), p. 25.

[4] Ronald C. Doll, Curriculum Improvement (Allyn and Bacon, Inc., Boston, 1964), p. 147.

as soon as the objectives of a project are stated, ways of evaluating the achievement of the objectives should be considered.

B. Concept and Use of the Model

The inherent value of the model lies with the establishment of a method which may aid in curriculum decision, and consequently, the expenditure of funds by any school district. The model in this paper includes: (1) selecting the curriculum goals, (2) identifying possible program or programs to satisfy the goals, (3) evaluation of implementation of program or programs, and (4) evaluation of the goals of such a program. In actuality, since the model is a generalized plan, it could conceivably be used to study and make curriculum decisions concerning any academic discipline. The following outline will serve as a model to make a curriculum-decision:

1. A committee of staff members would be encouraged to establish basic goals and objectives for the specific subject area in terms of desired changes.

2. An identification of a program or programs which achieve these basic goals must be written, or if selected, be analyzed and supplemented by instructional materials and aids, if the established program goals are to be achieved. Each program identified must be specifically related to satisfying some or all of the established basic goals.

3. As the accepted program or programs are implemented, much critical analyses are made of all operational items. These include (1) textbook content, (2) teacher performances, (3) lesson plans, (4) laboratory sessions, (5) classroom activities,

(6) supplementary materials, and (7) testing programs. Evaluation of these items can determine how effectively the program goals were achieved in terms of the intent of the program actually being implemented.

4. Finally, instruments must be procured or devised for assessing the degree of achievement of each of the goals that the specific program or programs are designed to achieve. Data collected from standardized or non-standardized tests are examined statistically to aid in making curriculum-decisions.

C. Four Basic Steps of the Model

Step I. Selecting the Curriculum Goals

Usually, it is the primary responsibility of the principal to initiate curriculum improvement.[1] However, a teacher, having participated in one of the National In-Service Training Institutes, could be its originator. No matter who initiates the plan for change, it is recommended that those most directly affected by the change become actively involved in its development. Instead of the method used in this study to establish goals, it is recommended that a committee be formed to establish priorities and to create educational goals. Identifying goals can be accomplished by reading and reflecting upon educational literature. It would be difficult, if not impossible, to acquire all available information.

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[1] John M. Nagle, The Supervisory Activity of Secondary School Principals in Districts in the Tri-State Area School Study Council, University of Pittsburgh, Pittsburgh, Pa., (March, 1969), p. 10.

However, sufficient literature should be included to insure adequate comprehension of the basic premises.

Step II. Identifying Possible Program or Programs

Once goals have been established, it is imperative that the committee review and select the innovative programs to be adopted. Capitalizing on a nationally packaged program may save time and money. Many such programs are listed in bulletins, newsletters, periodicals, magazines and promotional literature. Encouragement is voiced by McNally and Passow, who maintain that "the traditional idea that the educational planning had to be done by experts was discarded in favor of the philosophy of involving local citizens in a team with professional educators of the community."[1]

To help guarantee success of the innovation, a school system must also procure suitable and necessary facilities. In most instances, preferential treatment must be given to the new program. Additional teachers may have to be employed, schedules may be altered, and additional instructional aids and materials must be purchased.

No matter what decision is made concerning a program, preliminary planning must provide an ample opportunity for participants to express their apprehension and to suggest ways to overcome these

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[1] Harold J. McNally and A. Harry Passow, Improving the Quality of Public School Programs (Teachers College, Columbia University, New York, 1960), p. 100.

apprehensions. In order to eliminate feelings of insecurity and inadequacy, an in-service training period is desirable. All of these items will cost money, but must be considered in taking advantage of a program.

Step III. Evaluation of Implementation of Program or Programs

Implementation of one or more programs need to be evaluated to determine optimal success. For example, are the teachers instructing within the context of the textbook? Are the instructional materials and devices prepared for the curriculum program being used effectively? Are facilities available or provided to insure proper implementation of the program? Does the inspection of lesson plans indicate that the intended program is being followed? All of these questions must be answered in order to assure that the program, and only the program, is making a significant contribution of the established goals described in item one.

If a particular method of instruction is necessary to make the program successful, re-training of teachers may be required. Most curriculum innovations include some of the new methodologies such as problem-solving, inquiry, discovery, individualized instruction, and verbal interaction. However, an in-service program does not negate an evaluation of the implementation for these new programs. Dr. Grobman lends some support to this opinion. He states:

> It must be recognized, of course, that there are limitations to the impact of the inquiry orientation of the new science courses...and many teachers are

teaching in a traditional fashion, even though they had inquiry oriented books in their hands.[1]

Step IV. Developing and Obtaining Instruments For Evaluation of Goals

The nature of the criteria can be decided by any qualified person or persons. Generally, the criteria for evaluation purposes are classified into standardized and non-standardized tests. The immense diversity of subject areas, the reliability and validity of tests, and the economy of time have encouraged educational researchers to use the standardized test for evaluation.

But, the hypothesis that "any subject can be taught effectively in some intellectually honest form to any child at any stage of development"[2] may imply that to gather empirical evidence, educators must construct non-standardized instruments to appraise these intangibles. Therefore, one of the principal functions of the committee is to pass judgment on the tests which are available commercially, and those which must be developed.

The criteria assembled do not automatically produce a better educational system. Improvement will result when: (1) the data significantly supports the educational goals; (2) when the weaknesses of the curriculum are eliminated; (3) the entire educational system

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[1]Arnold B. Grotman, "School Biology of the Future: Some Consideration," The American Biology Teacher, Vol. 29, (May, 1967), p. 353.

[2]Jerome S. Bruner, The Process of Education (Harvard University Press, Cambridge, 1960), p. 33.

is enhanced by the addition of innovating programs; and (4) curriculum-decisions are based upon supportive and validated criteria obtained through using the model.

II. ESTABLISHED GOALS AND THEIR EVALUATION

A. Selecting the Curriculum Goals

The established goals of an educational program are statements that describe the types of learning pupils should experience through instruction. A review of the literature revealed that new instructional programs are produced with specific goals in mind. With this in mind, the local curriculum committee is to establish policies and procedures for selecting educational goals. There are, however, some materials readily available which make a good beginning, and local committees should become acquainted with them. In science, two associations which assist this general effort are the Association for Supervision and Curriculum Development (ASCD) and the National Science Teachers Association (NSTA). In 1966, the ASCD published a book, titled _The Changing Curriculum: Science_, containing the general objectives of science instruction. This book was prepared for ASCD by Richard E. Haney.[1] In 1964, the NSTA[2], sharing in its responsibility to keep

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[1] Richard E. Haney, _The Changing Curriculum: Science_, Washington: National Education Association, (1966).

[2] National Science Teachers Association, _Theory Into Action... in Science Curriculum Development_, Washington: National Education Association, (1964).

the science profession informed, published a book, Theory Into Action... in Science Curriculum Development. These two books can serve as guides to better goal development. It is also noted that teachers are better able to accept new educational goals when there is a more even distribution of involvement. It follows that these new goals are most relevant when developed at the local level.

In applying the model to compare the two types of biological science instruction, the following goals were established for appraisal.

1. To acquire adequate facts and information necessary for academic achievement.
2. To understand scientific enterprise and the role of scientists.
3. To understand the method and aims of science.
4. To develop problem-solving abilities.
5. To develop the process of inquiry.
6. To develop laboratory activities.

B. Evaluation of Established Program Goals

The devised model was used to develop and evaluate the goals of biology for two biology courses to assist in making a curriculum-decision. The study was delimited to twenty-two groups of approximately thirty students each, in the tenth grade at Baldwin High School. The twenty-two biology classes consisted of twelve BSCS biology classes and ten non-BSCS biology classes. BSCS biology is a program which was developed by the Biological Science Curriculum Study, and was conceived in terms of the inquiry method of learning, in an attempt to meet the demands for a new biology during the 1960's. The teachers who taught the non-BSCS biology used the 1960 edition of Modern Biology, considered, in this study, to be traditional.

In evaluating program goals, nine measurement devices were used. Five of these nine are student examinations or checklists: (1) the Test on Understanding Science, Form W, (2) the Co-operative Biology Test, Form B, (3) the Otis Quick-Scoring Mental Ability Test, Gamma, (4) the Biology Classroom Activity Checklist, and (5) the Problem-Solving Ability Test. In addition to these formalized instruments, the study included the collection of data for classroom analysis, for lesson plan analysis, for inquiry analysis, for teacher observation, and for laboratory analysis. It is necessary that a close relationship exists between establishing goals and evaluating these goals. Understanding this relationship does give some assurance that staff members would become involved in researching what they are teaching. Educational objectives as well as overall goals of a program require careful study. The educational system has grown substantially through experience, and as a result of pressures to meet growing needs, did not become involved in careful analysis and planning. This study was undertaken with the primary purpose being to answer the unsolved question, How does a school district make a curriculum-decision? The following summaries assisted the researcher in answering that question:

(1) A study of the findings made possible by use of the model verifies the rejection of the hypothesis that there is no significant difference in the ability of the tenth grade students to acquire biological facts and information necessary for academic achievement.

TABLE 1

COMPARISON OF CO-OP MEAN SCORES FOR BSCS AND NON-BSCS STUDENTS, AFTER BIOLOGY INSTRUCTION

Group	Total
BSCS	* 72.36
Non-BSCS	* 66.35

* A "t" of 4.623 is significant beyond the 0.01 level.

The results of the data from Table 1 concerning achievement of skills determined that the BSCS students illustrated greater proficiency in achievement than the non-BSCS students. In comparing mean scores on the Co-op Test, the BSCS student with a mean score of 72.36 and a mean score of 66.35 for the non-BSCS student was significant beyond 0.01, the level of confidence for rejection. Hence, there is a reaffirmation of the possible attainment of the first goal of biology as summarized in Table 6.

(2) The hypothesis that there is no significant difference in the understanding of scientific enterprise and the role of scientists between tenth grade biology students using non-BSCS program and those using BSCS program, and the hypothesis that there will be no significant difference in their understanding of the methods and aims of science can also be rejected. Support for rejecting these two hypotheses of the second element of the problem is evident in Table 2.

TABLE 2

COMPARISONS OF MEAN PRE-TOUS AND POST-TOUS SCORES OF BSCS AND NON-BSCS STUDENTS

Student Groups	Pre-TOUS Total	Post-TOUS Total
BSCS	28.70	* 30.59
Non-BSCS	28.42	* 29.06

"t" = 2.78

* P > 0.01

In Table 2, it is indicated that the BSCS students did significantly better on the Test on Understanding Science when the mean score of 30.59 for BSCS students was compared to a mean of 29.06 for the non-BSCS students.

Because the established 0.01 level of confidence was reached, the rejection is valid. These conclusions are based on the results obtained from the Test on Understanding Science, which, as described by the authors, encompasses these categories.

(3) The informational data relevant to the per cent of BSCS and non-BSCS students passing each of the six problems on the Problem-Solving Test is listed in Table 3.

TABLE 3

PER CENT OF BSCS AND NON-BSCS STUDENTS IN EACH SCORE GROUP PASSING EACH OF THE SIX PROBLEMS ON THE PROBLEM-SOLVING TEST

Problems Correct	(Per Cent Passing Problems) 0	1	2	3	4	5	6
BSCS	20.0	37.1	28.2	11.6	2.8	.2	.0
Non-BSCS	24.6	41.2	25.4	7.4	1.4	.0	.0

This data substantiates the conclusion that the goal of problem-solving techniques is better accomplished by the BSCS program. The Chi Square Analysis of the data was significant at the acceptable level of confidence. The reported findings reject the hypothesis that there is no significant difference in the problem-solving ability of BSCS and non-BSCS students. Based upon this conclusion, a clearly discernible strength is evident in the BSCS program.

Apparently, the BSCS program is developing problem-solving abilities.

(4) Inasmuch as the model includes implementation, attention is directed to a question frequently asked by many researchers: Were there, in reality, differences in the classroom activities as presented by the BSCS and non-BSCS teachers?

TABLE 4

SUMMARY OF BCAC FOR NON-BSCS AND BSCS GROUPS

Groups	Student Raw Mean Score	Teacher Raw Mean Score	S. D.
BSCS	31.1 *	39.3	4.3
Non-BSCS	24.6 *	33.0	5.5

* "t" = 181

P > 0.001

It is noted in Table 4 that a BSCS student's mean score of 31.1, when compared to a non-BSCS student's mean score of 24.6, on the Biology Classroom Activity Checklist, was significant at the acceptable level of confidence. One can now characterize the typical BSCS classroom. Characteristics referred to in the Biology Activity Checklist include the following: (a) role of the teacher in the classroom, (b) student classroom participation, (c) use of textbook and reference materials, (d) design and use of tests, (e) laboratory preparation, (f) type of laboratory activities, and (g) laboratory follow-up activities. These seven areas describe classroom practices that contribute positively toward the attainment of BSCS objectives, and which analyze the role of the teacher and student in each of the seven activities. In sum, therefore, the BSCS students maintained that their classroom activities were different than those of their classmates. This established fact rejects the hypothesis that there is no significant difference in the classroom activities between those tenth grade students studying non-BSCS and those studying BSCS biology.

(5) Further evaluation of program implementation indicates that differences in teacher presentation are significant. The audio tapes of classroom verbal interaction, however, revealed that the teachers resembled the prototype of a typical teacher in the area of verbal responses. Further evidence of this relative confidence was that the objective data recorded was 76.76 per cent for teacher output and 23.24 per cent for pupil output (excluding other categories, such as management). In spite of the fact that the teachers

dominated the classroom interaction, in most cases, the nature of the pupil responses was different. When the non-BSCS teacher called upon the non-BSCS student to respond to a direct question asked by the teacher, those questions were short, direct, and factual; whereas, the BSCS teachers questions were in the form of a problem. Further distinctions were noted in the matrix in that the BSCS teachers developed in their students a distinct confidence to question facts and to seek explanations. In order to assimilate the various data by contrasting the BSCS and non-BSCS pupil responses, one can now determine that in the lecture-recitation classroom, the BSCS material is developing an inquiring student, one who questions concepts that were not clearly understood. Data obtained from the randomized ten minute tapes provided by this method can be analyzed in two ways: in terms of the distribution of teacher and pupil responses for each of the tapes; and in terms of each type of pupil responses. Employing either means, it would seem that, for the most part, BSCS and non-BSCS teachers dominate the verbal interaction of the classroom, and Baldwin High School teachers are not completely developing the "inquiry approach," as defined in this study.

Hence, since the primary responsibility for developing the "inquiry method" lies with the teachers and is determined by employing formal observation schedules such as Parakh's, Moser's, and Foldgoise's[1], the hypothesis that there are no differences in developing the process of inquiry between those classes taught by non-BSCS teachers and those taught by BSCS teachers cannot be rejected. Table 6, of the model, gives evidence to support this conclusion.

(6) In reviewing the lesson plans submitted by the BSCS and non-BSCS teachers, it was revealed (1) that the six biology teachers in this study, regardless of the program, taught directly from the prepared textbook and (2) that the BSCS students were exposed to laboratory work more frequently than the non-BSCS students. To have students participate in laboratory activities is one of the objectives of BSCS biology, and is a stated goal in the model of this study.

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[1]Additional material included in Appendix A of this paper.

TABLE 5

PERCENTAGE FREQUENCY OF LABORATORY EXPERIENCES AS REPORTED ON TEACHERS' LESSON PLANS

Teacher	BSCS Per Cent	Non-BSCS Per Cent
1	22.0	
2	13.0	
3*		14.0
4*		9.2
5	22.0	
6	21.0	
Average per cent	19.5	11.6

* Taught non-BSCS biology

Table 5 presents data relevant to the number of times each teacher held formal laboratory sessions during the school year. Table 5 shows that the BSCS student spent about twice the time in laboratory activities as did the non-BSCS student. More specifically, the BSCS student spent 19.5 per cent of his time in laboratory activities, whereas, the non-BSCS student sp[illegible] 11.6 per cent of his time in laboratory oriented activities. Hence, if laboratory activities increase the breadth and depth of a student's knowledge of science, and if this is a stated goal of biology, it would seem that one can reject the hypothesis that there is no difference between those tenth grade students studying non-BSCS and BSCS biology in their laboratory activities.

A concluding statement by Yager, Engen, and Snider[1], suggesting that the laboratory approach has no measurable advantage over other modes of instruction other than in the development of laboratory skills has prompted this researcher not to make any other specific conclusions from the data.

C. Fulfillment of Goals

Table 6 places special emphasis on comparing the BSCS and non-BSCS approaches to teaching biology in terms of goal satisfaction. It reveals that the BSCS biology comes closer to fulfilling these goals than the non-BSCS biology. Neither of the programs as taught in Baldwin High School qualifies for a positive reaction on the development of the process of inquiry. However, the facts from Table 6 of the model favor the BSCS curriculum materials. Inasmuch as the detailed study of this model indicated the better curriculum choice to be the BSCS program (in terms of total goals), the researcher recommends that district monies be spent on this program.

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[1]Robert E. Yager, Harold B. Engen, and Bill C. F. Snider, "Effects of the Laboratory and Demonstration Methods upon the Outcomes of Instruction in Secondary Biology," Journal of Research in Science Teaching, Vol. 6, (1969), p. 85.

TABLE 6

SUMMARY OF EVALUATIVE ASPECTS OF THE BSCS AND NON-BSCS PROGRAM, IN TERMS OF GOALS FOR BIOLOGY

Goals of Biology	BSCS Program	Non-BSCS Program
Biological Facts and Information	+	-
Understanding Scientific Enterprises and Scientists	+	-
Understanding the Method and Aims of Science	+	-
Problem-Solving Techniques	+	-
Developing the Process of Inquiry	-	-
Laboratory Activities	+	-

(+) Favorable aspects (-) Unfavorable aspects

APPENDIX A

In evaluating classroom learning environment, the researcher used the Parakh[1] system, the Feldgoise[2] system, and the Mosor[3] Six Set System of verbal interaction analysis.

The first technique used was devised by Jal S. Parakh. Briefly, this system includes a coding procedure which yields a number of interaction matrices for each teacher. Figure 1 explains how the modified Parakh's matrix was set up by Feldgoise. She divided the matrix into quadrants in order to study the classroom verbal interaction of recorded events. Quadrant A represents all the teacher to teacher interaction (T--T). Quadrant B represents all the pupil to teacher sequential events (P--T). The area labelled C represents all the teacher to pupil chain of events (T--P). Quadrant D represents all pupil to pupil events (P--P). Any other events not readily classified under the modified chart were not recorded. The quadrant labelled D was categorized by Feldgoise as the area describing inquiry.

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[1]Jal S. Parakh, <u>Teacher-Pupil Interaction in Biology Classes</u> (Chicago, Illinois, 1967).

[2]Roberta L. Feldgoise, "Using Interaction to Describe Pupil and Teacher Behavior in the Science Classroom," (unpublished paper, University of Pittsburgh, 1968).

[3]Gene W. Moser and Roberta Feldgoise, "Use of Interaction Analysis to Increase the Use of the Inquiry Approach in the Teaching of Science," Science Project Center, Baldwin-Whitehall School District, ESEA Title III, (April, 1968).

FIGURE 1

INTERACTION MATRIX FOR TEACHER_____

	TD	TS	TQ	PR	PV	PQ	PS
TD							
TS		A				B	
TQ							
PR							
PV		C				D	
PQ							
PS							

The third technique, which was developed by Moser, was called the Six Set System of Interaction Analysis. Although it utilises the Parakh's categories, the difference is that Moser offers a simpler system which measures the generation of information found in the classroom, the teacher, and the pupils. A description of the system follows:

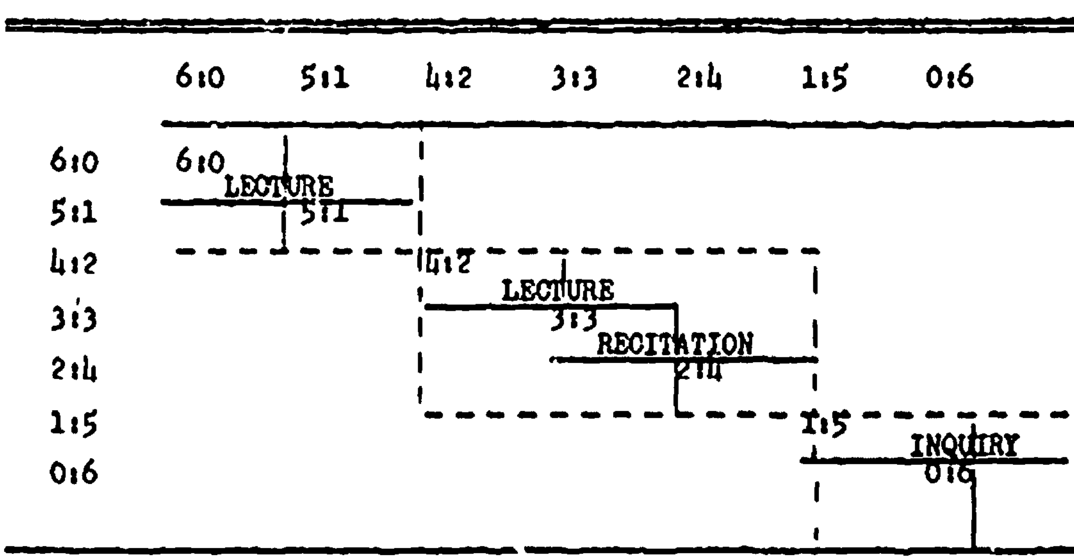
> The Six Set System of Interaction Analysis is a system that differentiates only in two forms, the type of input or output is either the teacher or the students. The techniques involve the labelling of each of the output sources as they sequentially occur in a classroom lesson. The labels are then arranged in arrays or sets of six outputs. For example, a set could read: T, T, T, P, T, P. This means that the teacher was an output generator two-thirds of the time and one-third of the time was a pupil output mode.

There are seven ratio sets which can be identified in the Six Set System. The seven sets are 6:0 5:1, 4:2, 3:3, 2:4, 1:5, and 0:6. The ratio 6:0, 5:1, and 4:2 means that the teacher dominated the output actions. The pupil dominated in the ratios of 2:4, 1:5, and 0:6.

Figure 2 shows areas of teaching modes. These are hypothesized as interpretation areas, describing proportions of a learning environment spent in a particular teaching mode. There are essentially three teaching modes: lecture, lecture-recitation, and inquiry.[1]

FIGURE 2

SIX SET SYSTEM MATRIX, INTERPRETATION OF AREAS



Analysis procedure of the verbal classroom interaction was accomplished by taking at random a selection of ten minutes of tape from those made by each teacher.

[1] Ibid., Moser and Feldgoise, p. 26.

Table 1 compares the type of pupil responses for BSCS and non-BSCS students. The matrix revealed some differences that exist between the two classroom environments. The BSCS teachers have developed in their students a particular confidence to question facts (24.7 per cent) and to seek explanations (19.0 per cent). The responses indicated by PQ (pupil questions) were basically designed to challenge authority. By doing so, the BSCS material is thought to be developing an inquiring student, one who seeks more explanation about scientific phenomena.

Moser and Feldgoise have defined inquiry in terms of pupil verbal interaction. Table 1 fails to indicate this trend for BSCS and non-BSCS classroom environment. This factor is shown by the low percentage of pupil outputs (PRX, PSX, PVX). The chart does reflect that problem-solving for the BSCS is more widely distributed with an 0.9 per cent for PR, 2.8 per cent for PS, and 0.9 per cent for PV. This indicates a variety of student responses. The non-BSCS problem-solving percentages of four per cent reflects a forced problem-solving technique.

The total from Table 1 suggests that BSCS students participate and co-operate as co-workers towards the mastery of fundamental academic skills as revealed in oral participation. This is evident when one compares pupil self-initiated statements (PS) 19.8 per cent for BSCS students with pupil self-initiated statements 8.0 per cent for non-BSCS student statements. The self-initiating statements describe that the student made verbal actions were not solicited by the teacher. Moser[1] has conjectured that student self-initiated events are interpreted as inquiry. Mascolo[2] in his study concluded that the very nature of the BSCS biology course may develop effective inquiry skills. From the evidence, it can be viewed that BSCS biology, as measured by verbal interaction analysis, appears to have initiated the process of developing some inquiry for the BSCS students. While changes such as these are suggestive, further studies should be accomplished to test this hypothesis. Further conclusions are noted concerning the totals for pupils who volunteer (PV). These favor the non-BSCS students. Volunteering was in the form of a response to a specific question asked by the teacher. Again, the desired outcome of stimulating students to ask questions (PQ) overwhelmingly favors the BSCS students.

The Six Set System of Interaction Analysis constituted the third method used to investigate the verbal classroom environment. The results from the data obtained an added strength to the conclusion that neither BSCS nor non-BSCS teachers favored or developed the inquiry approach. As previously stated, the area designated by 0:6 and 1:5 ratios categorized the inquiry mode of teaching. Figure 3 describes the interaction matrices for the six biology teachers in this study. Interpretation of similar tables revealed a pattern

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[1] Ibid., Moser and Feldgoise, p. 26.

[2] Richard Mascolo, "Performance in Conceptualizing: Relationship between Conceptual Framework and Skills of Inquiry," Journal of Research in Science Teaching, Vol. 6, (1969), p. 34.

which identified at least two teaching modes. One dominated by teacher output, and the other by lecture to lecture-recitation.

TABLE 1

THE NATURE OF BSCS AND NON-BSCS STUDENT OUTPUTS, PERCENTAGES

	BSCS				NON-BSCS			
	PR	PS	PV	PQ	PR	PS	PV	PQ
Definition	7.6	6.7	0.9	6.7	8.0	0.0	0.0	0.0
Fact	12.3	9.4	4.7	24.7	48.0	4.0	20.0	0.0
Explanation	1.9	0.9	0.0	19.0	8.0	0.0	0.0	0.0
Values	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nature of Science	0.0	0.0	0.0	0.0	0.0	4.0	4.0	0.0
Problem-Solving	0.9	2.8	0.9	0.0	4.0	0.0	0.0	0.0
Lack of Knowledge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	22.7	19.8	6.5	50.4	68.0	8.0	24.0	0.0

Based upon the data, the following conclusions were particularly significant:

a. A majority of the six biology teachers (BSCS and non-BSCS) rate high in the 6:0 and 5:1 areas, on the Six Set System Analysis. These areas identify the teachers as functioning as lecturers.

b. By contrast, BSCS teachers 1 and 5 are beginning to permit students to respond more frequently in class, a type of inquiry.

c. By contrast, it can be noted that BSCS teachers 2 and 6 are more traditional than progressive, hence lacking in using the inquiry method.

d. It is evident that the non-BSCS teachers 3 and 4 are teaching by traditional methods, utilizing the lecture approach.

FIGURE 3

SAMPLE SIX SET SYSTEM ANALYSIS
FOR TEACHER 1 (BSCS)

	6:0	5:1	4:2	3:3	2:4	1:5	0:6
6:0	2	3					
5:1		1	3	1			
4:2	2		2	1			
3:3	1			1	1		
2:4		1					
1:5							
0:6							

N = 114

SAMPLE SIX SET SYSTEM ANALYSIS
FOR TEACHER 2 (BSCS)

	6:0	5:1	4:2	3:3	2:4	1:5	0:6
6:0	1	4		1			
5:1	3	1	2	2			
4:2	1	1	1				
3:3		2					
2:4							
1:5							
0:6							

N = 114

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