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ABSTRACT

A review of some recent educational and research activities is presented in this publication. Major articles compiled in this review include: An Innovative Approach to Laboratory Instruction; An Evaluation of the Mastery Strategy for General Biology Students, Food Science as a General Education Course in Biological Science; The Phase Achievement System; and A Model for Improving Articulation. Conclusive findings are given in the first two articles, and course descriptions are the main concern in the third and fourth articles. Failures at the departmental level are described as being frequently encountered in analyses of articulation between two- and four-year colleges. The remaining content deals with appropriateness of "creation theory" in textbook writing, American Institute of Biological Sciences (AIBS) recommendations on use of algae in laboratory experiments, project "BIOTECH" notes, and AIBS annual meeting information. (CC)

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AN INNOVATIVE APPROACH TO LABORATORY INSTRUCTION

Ruth C. Von Blum
Lawrence Hall of Science
University of California
Berkeley, California 94720

Introduction

One of the primary objectives of any course in science is to educate students to carry out scientific work at some level of competence. This involves the development of proficiency in three fundamental activities: (1) careful observation, (2) the use of scientific instruments and techniques, and (3) the processes of scientific investigation. The laboratory can be specifically designed to reach these objectives, but laboratories in most biology courses are viewed primarily as vehicles for observing material presented in lecture. The training aspect is usually treated peripherally and casually. The investigatory component is most often neglected.

Additional problems are faced at many large universities where enrollments are large and departmental resources are small. These laboratories are frequently run by teaching assistants who have little or no teaching experience.

In an attempt to improve the quality of laboratory instruction, a model was constructed based upon separation of the three major laboratory functions and precise definition of the educational objectives involved in each.

The Pilot Study – Testing the Model

One hundred students were selected at random from the general biology course for life science majors (Biology 1) at the University of California, Berkeley. For the three-week duration of the study, fifty students remained in their assigned laboratory sections, while the other fifty students attended the experimental laboratory. Plant growth and development was the lab topic presented to both groups. One half of each group was pre-tested to determine the incoming level of proficiency in both groups and confirm the equality of both groups. All students were post-tested at the conclusion of the study. The four-group design made it possible to determine the extent to which the pre-test itself acted as a teaching device. The experimental, or "open," laboratory was one room divided roughly into three areas, one for each function (observation, training, investigation). The laboratory was open three days a week from 9 a.m. to 5 p.m. One teaching assistant was on duty at all times to offer assistance when requested.

In approaching each laboratory function an attempt was made to use teaching techniques which have been shown to be effective in reaching particular learning objectives. The observational unit consisted of three written programmed tutorials designed to guide the students through their observations of seeds and primary and secondary growth in plants. Training was given in sterile technique and organ culture. Written programmed instruction was used to present the rationale behind the use of plant organ culture as an investigatory tool in biology. The actual training occurred in audio-tutorial booths using taped instructions such as are described by Postlethwait (1969). The third function of the laboratory, development of proficiency in the process of scientific investigation, requires preparation in all of the requisite manual and intellectual skills, an undertaking beyond the scope of the pilot study. The primary objective of the investigative unit in the study was simply to involve students in the process of scientific investigation. Students were given a written introduction into scientific investigation to help orient them. Then each student was required to do an individual research project.

The nature of the control laboratories was primarily determined by the faculty and was not specifically designed to be "typical" of general biology laboratories or to serve as a control for this study. The general topic of these laboratories was also plant growth and development. Some of the materials presented in the control labs were not included in the open laboratory and vice versa. These factors are considered during the evaluation of the results. The control laboratories did, however, offer the opportunity to compare an open versus a three-hour, scheduled laboratory, programmed material versus an unprogrammed laboratory manual, and specific separation of functions and precisely specified objectives versus non-separation of functions and lack of precisely specified objectives.

Results

Evaluation of the pilot study had to be made within the constraints of the available control laboratories. The following were observed or measured: (1) activities of the students in both groups, (2) attitudes of students in both groups, as determined by a questionnaire, (3) effectiveness of the observational unit, as determined by comparison of performance on a test of material covered by both groups, (4) effectiveness of the training unit, as determined by comparison of pre- and post-tests of the students in the open laboratory and by the ability of the students to produce and maintain uncontaminated cultures, and (5) effectiveness of the investigative unit, as determined by the quality of reports handed in by students in both groups.

The activity of the students in the open laboratory might best be categorized as independent, while the students in the control laboratories were generally heavily dependent upon the teaching assistants. Questions from students in the open laboratory were most often of an exploratory nature, delving more deeply into various aspects of the topics presented. Those from students in the control group were usually elementary, often on the same material which was explained via the programmed tutorial to the students in the open laboratory.

The students in the open laboratory also demonstrated a positive attitude toward their experience. In the questionnaire, almost twice the percentage of students in the open laboratory chose the words "well spent" to describe the time spent in the laboratory as did the control groups.

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Interviews with students in the open laboratory and students' comments on the questionnaire also revealed very positive attitudes towards the methods of presentation of materials and towards the open aspect of the laboratory.

The effectiveness of the observational materials in reaching stated objectives is demonstrated in Fig. 1. The students in the open laboratory scored significantly higher on the post-test than did those in the control group on material, primarily observational, covered in both groups.

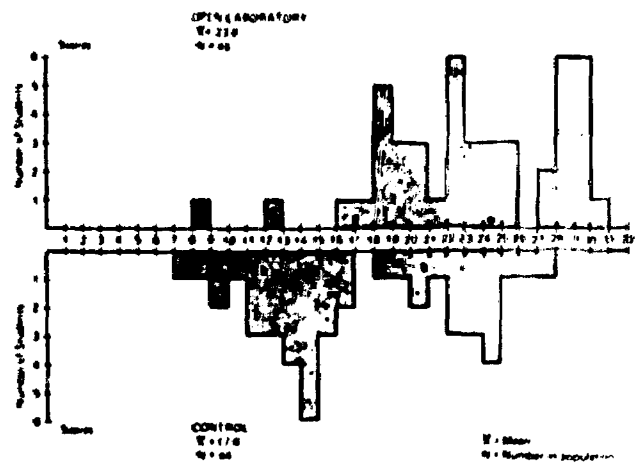

Fig. 1. **Post-test results. Open laboratory and control groups. Questions on the observational unit.**

Effectiveness of the training unit was determined not by comparison with a control group, since the control group was not trained in organ culture, but by examination of the root cultures passed in by the students and by performance on a criterion test. There was a significant increase in scores from pre-test and post-test, and 95% of the students passed in at least two uncontaminated culture dishes with growing root tips. In addition, the students felt so confident about their skills that nearly 50% of them went on to use the techniques in their special projects.

The students in the control group carried out independent investigations similar to those undertaken in the open laboratory. As expected, there was no difference between the groups in either attitude or performance on the special projects. The primary difference between the two groups was the number of students in the open laboratory who used their newly-acquired skill in organ culture for their projects. This may indicate that mastery of a certain skill can act as an impetus for investigative work by students.

Discussion

One of the principal advantages to the open laboratory model as tested in the pilot study is the efficiency that results from the diversification of activities within the laboratory. Students were able to function in a room with only six compound and six dissecting microscopes, and a few of each type of prepared slide. If a student found that there was no room in the facilities provided for one unit, he could move to another unit until space became available. Thus, fewer pieces of equipment were needed at one time.

This diversification also reduced the cost of such a laboratory. Written programs do not require special booths or audio equipment. The students may work on part of the programs at home and may take the finished programs home for review.

The open laboratory experiment described here incorporated the following major elements: (1) separation of the three major functions of the laboratory, (2) individualized instruction via written and taped tutorials, and (3) open scheduling. It is possible that any one of these elements, coupled with more traditional approaches to the laboratory, could have had similar results. The design of the experiment, however, was not constructed to reveal such detailed information. What the results did reveal is that students in the open laboratory fulfilled the stated objectives, scored significantly higher on a criterion test designed to test their understanding of observations made in the laboratory, and demonstrated a generally favorable attitude towards the experience.

The pilot study also demonstrated that mere involvement in scientific investigation is no guarantee of an understanding of scientific methodology. What is needed is a systematic attack on the problem of teaching heuristic strategies for investigation. One approach may be to provide instruction in some of the requisite skills of investigation such as hypothesis formulation, experimentation, and the interpretation of results. It is reasonable to assume that such skills can be developed over a substantial period of time. The investigatory portion of the laboratory, therefore, might consist of an increasingly complex series of steps, until at the end of the course the student is capable of performing an investigation by himself from inception to conclusion, using the facilities of a resource room. This is similar to the approach suggested by the Commission on Undergraduate Education on the Biological Sciences (Holt et al. 1967).

Conclusion

The results of the pilot study are sufficiently encouraging to lead us to implement the model. One of the chief barriers to the establishment of open laboratories has been the expense of the instructional booths and equipment. This experiment clearly shows that written programmed instruction is especially suitable for an observational type of laboratory, and it requires neither booths nor equipment.

The separation of the laboratory into its component elements is another easily adopted aspect of the model. Substantial work is required to develop sets of objectives and careful instructional materials, but the results are effective teaching tools. For example, training units could be developed for the use of the microscope, oscilloscope, spectrophotometer, micro-technique, or any other piece of equipment or technique. A whole series of such units could be established and kept on file to be used by both undergraduates and graduate students.

Personal interviews with some of the faculty members who have experience with laboratories using individualized instruction (mostly audio-tutorial) over several years often reveal a sterility settling into the system. The laboratories become mechanized and dull, and the students and faculty lose interest. It is possible that this can be avoided by using a flexible approach such as the one described.

The primary objective of any science laboratory is to produce students who are capable of approaching problems scientifically. While the pilot study could not evaluate the extent to which this overall objective was met, in a limited context it does indicate that a laboratory based on a model designed to reach this objective can operate effectively and efficiently. Further investigation is currently underway to attempt to modify and extend the model to increase its utility, not only for instruction in biology, but in other sciences as well.

Acknowledgments

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AN EVALUATION OF THE MASTERY STRATEGY FOR GENERAL BIOLOGY STUDENTS

Phillip D. Sparks
Department of Biology
University of Wisconsin
LaCrosse, Wisconsin 54601

A typical educational program provides a group of students with the same type and quantity of instruction regardless of the individual variations which may exist within the class. On the other hand, an educational program designed for mastery learning will provide for variations in the learning rate and aptitudes of its students. The first useful conceptual model for mastery was outlined by Carroll (1963) and further developed by Bloom (1968). In general, a strategy designed for mastery learning takes into account individual differences in learners and relates these variations to the teaching process. Several formats have evolved for implementing the mastery strategy; however, they have not been widely tested (Block 1971).

The general biology course is taught at the University of Wisconsin–La Crosse using the audio-tutorial (A-T) method of instruction. When compared with conventional methods, student achievement is improved slightly using the audio-tutorial technique (Sparks and Unbehaun 1971). While this format permits students to master individual segments of the biology program in sequence, they typically take notes on an entire tape to study later without mastering the objectives for the individual segments. This behavior is very much like that found in a conventional classroom and does not meet the criteria for mastery learning. Consequently, a strategy for mastery learning should be particularly beneficial to biology students using the audio-tutorial format. The hypothesis being tested is that *if* such a strategy were implemented, then achievement would be significantly improved.

The experiment included two groups of students, an experimental group (MAST) and a control group (CONT). The groups were composed of students registering for two separate sections of general biology. Students chose the section without knowing that any experiment or procedural differences were involved. The control section enrolled 183 students and the experimental section enrolled 163 students.

Of fifteen broad topical units, one was available to the student each week. The students in the control section attended a general assembly, were given a set of behavioral objectives, went to independent study (audio-taped lab), and attended a small assembly each week. The experimental section was handled the same way except that each week's unit was further broken down into individual conceptual subunits similar to the mini-course format (Postlethwait 1969). Each unit consisted of from two to three conceptual subunits.

After the student completed each subunit he was required to take a short diagnostic test. Students who failed to achieve mastery of the subunit (80%) attended a short tutorial session or reviewed a segment of the tape. Students who failed on a second try to achieve mastery participated in an extended tutorial session after which the instructor determined whether the subunit was satisfactorily completed.

Four times during the semester both groups were given examinations that contained a total of 332 common test items known as Biology Achievement Test (BAT), which was constructed to evaluate whether or not the behavioral objectives had been achieved.

During the first meeting of the class a pretest (PRET) was administered to both groups to evaluate the comparable achievement level of the sections prior to being exposed to the treatment. Scores on the Biology Achievement Test (BAT) of the two groups were adjusted (BAT-ADJ), based on the pretest, then compared using an analysis of covariance (Winer 1962).

Since the mastery strategy was designed to increase the number of students which could be called "good students," achieving above 75%, an analysis of the grade distribution for the control and the experimental group was conducted. The chi-square analysis was designed to determine whether the grade distribution based on the BAT was different for the control and the experimental group and whether the numbers of "good" students (above 75%) was different for the two groups.

Each week students recorded the time spent in the laboratory and at the end of the semester the lab times of the two groups were compared. Also the students were asked on the questionnaire how much time they devoted to the course in addition to the laboratory so that the total time commitment could be compared for the two sections.

The number of students in each section who did not attend lab during a week was also noted.

The results of the pretest and the Biology Achievement Test shown in Table 1 indicate that there is a difference in the two groups. The analysis suggests that the mastery strategy was effective in helping achieve the objectives for the course.

Table 1.
Effect of mastery on achievement of students

	PRET X	BAT-ADJ X
CONT	20.36	234.96
MAST	19.98	[1]242.49

[1]Significant at the 95% confidence level.

Table 2.
Percent of students achieving specific marks based on the BAT

	CONT	MAST
A (85-100%)	16.9	11.7
B (75-84%)	20.6	32.4
C (60-74%)	43.8	44.8
D (50-59%)	13.7	9.7
F (below 50%)	5.0	1.4

Table 3.
Questionnaire

	Percent of Students	
	CONT	MAST
1. If the choice were mine to make again, I would prefer to take a biology course using:		
a. a lab-lecture system	20	5
b. an A-T system	75	93
c. I have no preference	5	2
2. The A-T course, more than any one of my other courses, helped me to develop a sense of *responsibility for my own success.*		
a. True	64	72
b. False	36	28
3. If the choice were mine to make, I would prefer to take a section of biology which:		
a. used the mastery strategy		89
b. did not use the mastery strategy		11
4. As a result of the mastery strategy I feel that I:		
a. did poorer on the major exams than I would have by just taking weekly quizzes in GAS		10
b. did about the same on the exams as I would have by just taking weekly quizzes in GAS		20
c. did better on the exams than I would have by just taking weekly quizzes in GAS		70
5. If made available, I would select sections of other general education courses which were taught using the mastery strategy.		
a. True		82
b. False		18

Table 4.
Time comparisons

	Lab time/wk	Out of class time/wk[1]	Zero time
CONT	2.08	1.35	13.7%
MAST	3.13	1.27	7.7%
Significant	yes[2]	no	yes[2]

[1]Reported by students on a questionnaire.
[2]Significant at the 95% confidence level.

Even though there were not significantly more students above 75% in the experimental group, the data in Table 2 suggests that the number of students receiving D and F grades for the course is reduced. Currently I am investigating the possibility that the mastery strategy significantly improves performances of the low achiever.

The objectives of the questionnaire were: 1) to determine course acceptance and 2) to investigate the attitude of the experimental group toward the mastery strategy. The results are summarized in Table 3. In general both groups accepted the audio-tutorial system of instruction, but significantly more students of the experimental group favored the A-T system.

Sampled student opinion indicates that the experimental group accepted the mastery strategy as useful and that the students in the experimental section thought their performance on the BAT was improved because of the mastery strategy.

A summary of the comparable time investments for the control and the experimental groups is given in Table 4. Lab time refers to the average time spent per student per week in independent study and was obtained from the students' time card. The time spent in independent study (lab) was significantly higher for the experimental group. Out of class time was estimated using the student's questionnaire response. Time spent out of class was not significantly different for the two groups, but significantly more students in the control section missed the independent study session each week than those in the experimental group. In summary, the lab time was different presumably for three reasons: 1) Students in the experimental section spent more time on each unit. 2) Some time was required to take the tests. 3) The students in the experimental group were more regular in their attendance in independent study since they had to be present in order to take the tests. It may be that the difference of the two groups on the BAT was because the mastery strategy was successful in getting students to class who otherwise would not have attended.

Conclusions

1. The mastery strategy is effective in improving achievement of students in a large general biology course.

2. The mastery strategy did not significantly affect the grade distribution; however, there appears to be an upward skewing of grades in the experimental section with a reduced number of D and F marks.

3. The experimental group devoted significantly more time to the course than the control group.

4. Student opinion indicates the experimental group accepted the mastery strategy as useful.

Acknowledgment

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FOOD SCIENCE AS A GENERAL EDUCATION COURSE IN BIOLOGICAL SCIENCE

F. M. Clydesdale
Department of Food Science and Technology
University of Massachusetts
Amherst, Mass.

In a recent issue of *AIBS Education Division News* (1, (6), 11-13) I read with interest the article on Human Nutrition as a General Education Course in Biological Science.

In somewhat the same area we have experienced some success in a Food Science course. Undergraduate students in the College of Arts and Science at the University of Massachusetts are required to take 3 science courses in order to graduate. We of the Department of Food Science and Technology have designed what we consider to be a novel introductory Food Science course for these non-science majors.

This course, "The Struggle for Food," grew out of our belief that we food scientists are often guilty of talking to no one but ourselves and that even as we are chatting away in our highly technical language, we are ignoring the plight of the general public, the people for whom we are supposedly working. We felt that we had a moral obligation to begin teaching the rest of the people on our campus about food and how it relates to their lives.

When we sat down 2 years ago to begin developing "The Struggle for Food," we found that we had little experience to go on. The department had never attempted to teach non-science majors, and we honestly had no idea what English, History, or Art majors would want to bring away with them after the semester was over. We were certain, however, that new methods would have to be developed.

Our investigative research into this area of introductory science courses for non-science majors demonstrated that on some campuses departments were simply watering down the same course which they gave to their majors. Instructors were taking their notes and deleting about half of the material. We decided that a similar approach on our part would doom us to failure.

So we took a field trip to the other side of the campus, to the College of Arts and Science, and began asking English, History, and Art majors what they would like to know about food. Their questions to us reinforced our belief that if we were willing to tailor a course to their needs, we would get strong student response.

We drew up a course that we hoped would be "scientifically conceptually oriented." The student who took the course would not be expected to learn long lists or complex formulas, nor would he be subjected to 3-hour lab sessions filled with those frightening pyrex tubes and bubbling compounds. Rather, he would be introduced to concepts. One concept would build from another – a process which would hopefully aid him in attaining an overview, a general picture, of how food relates to him. Beyond that, he would, again hopefully, begin to understand the problem of the world food shortage, how it might be alleviated, and, most important, how he as a non-science major could play a significant role in man's search for answers in this field.

To our surprise, we discovered that scores of students were involved in extreme dietary experiments; many were eating nothing but wheat germ and claiming in the campus newspaper that they were experiencing "highs" unlike any other. We decided to spend at least part of our time in class discussing the history of such dietary fads (from Fletcher to the present) and then try to explain the reason why these wheat germ eaters were experiencing euphoria.

We were also surprised to hear from so many students that they no longer had any faith in the large food industry. Ralph Nader, according to these students, had proved that food additives and preservatives and "other chemicals" had made much of the food poisonous.

We were shocked to learn that many of these students were spending up to 4 times the retail price for fresh vegetables which were "organically" grown. Many of these students were refusing to eat in the university cafeterias because they were afraid of the poisons. We decided to do our utmost to expose, at least for the students on our campus, the health food industry.

In our first lecture, we explained to the students that there is a tremendous credibility gap between the people who are eating food and the people who are producing food, and that the more sophisticated the food industry becomes, the greater that credibility gap will be.

We went on to explain that it is to the food industry's benefit to provide the consumer with the most healthful food possible and that much of their resources go toward product improvement. We explained in detail and by example how large companies are constantly policing themselves and spending millions of dollars on research and testing.

As the semester progressed, the question and answer session at the beginning of every class became the most popular part of the lecture. We were especially pleased to note that as the students became more knowledgeable about the food science field, the questions became more sophisticated.

Another encouraging sign was that after each class scores of students remained in the lecture hall asking questions, demanding clarifications, bringing up new topics. On most days, we would spend an additional hour or so with these students. On one particular day, we showed a CBS documentary film entitled "Hunger in America." Most of the students were shocked by what they saw, and there was a flurry of activity on campus.

Students began to comb the newspapers each day, and we were flooded with clippings: "Federal Lunch Program Failure," "Food Stamp Program Criticized," "Fad Diets Dangerous." We tried to answer all the questions and comment on all of the clippings. The student response was remarkable.

As "The Struggle for Food" progressed toward a third semester, a crisis developed which threatened the course's future. Probably because of the newspaper and radio coverage, students preregistered for the course in record numbers. More than 3,000 students wanted to take "The Struggle for Food," and the university didn't have a lecture hall which was large enough.

We agreed to teach 2 sections, but this would only allow 1,200 students to take the course. Angered by the possibility of some 1,800 students being denied admittance, the Student Committee on Academic Affairs petitioned the administration for a meeting, and hopefully, an answer to the problem.

The university's Associate Provost for Special Programs and his staff spent much of the week before final registration attempting to find a solution. The students pressured the administration to allow us to use the school's gymnasium, but there were complications and prior commitments which made that idea unfeasible.

Finally a compromise was worked out between the students and the administration whereby next semester some type of closed circuitry would be utilized to preclude anyone's being dropped from the course. In the meantime, we agreed to enroll any senior who needed to take a science requirement in order to graduate.

We should mention that we realize closed circuitry has its limitations, especially in a course where there is a need to develop a special rapport with students. We are continuing to discuss other potential solutions with the university administration and are hopeful that students need never again be turned away from the course.

When we began teaching "The Struggle for Food," we were aware that we were meeting an entirely different student population from the one we usually work with in the advanced Food Science courses, and, as we have mentioned, we were teaching a different kind of course. But in the back of our minds we also knew that if we did a good job, if we lit a few sparks here and there, we might have the chance to convince a few History, English, and Art majors that Food Science is a vital and viable field, something they might want to explore as a career.

Last semester, twelve students decided to become Food Science majors, and we are hopeful that as many will join us this semester. And, perhaps even more important, those who came just for this one course returned to their field not only with some useful information, but with a new-found respect for science.

Nevertheless, we have had some disappointments. When we originally planned the course, we had hoped to have close interaction with our students. But despite the nature of the course and the students' interest, sheer numbers have made it impossible for us to develop close relationships with the students. In the lecture hall, we face a sea of faces and often come away wondering whether we reached them. Ultimately, the answer would be small group discussions once every week, but financial restraints will probably preclude that as a solution.

Grading is also a big problem. With so many students, we have had to utilize machine-graded examinations, and many of the students have reacted violently to this. In addition, these machine-graded exams provide us with very little feedback as to our effectiveness in the lecture hall.

We hope that in the near future, the university will give us permission to teach the course on a pass-fail basis. This would, we feel, preclude the inequities to many students. The only way we will ever get realistic feedback about our effectiveness is to constantly make efforts to talk with students on a one-to-one basis.

We would not want to assert that "The Struggle for Food" is, in any way, a panacea. It is only a first step, a beginning. We plan to write articles specifically for people with non-technical backgrounds, and hope to get them published in newspapers and magazines. We are negotiating with radio people for permission to present a series of discussions with local politicians and bureaucrats. We will continue to accept every opportunity to speak about food at schools, fraternity houses, businessmen's lunches – and anywhere else we are invited. We will continue to debate the issues with the local health food gods who are bilking those ignorant of the facts.

Necessarily, this activity will compete with teaching and research here at the university. But we are positive it is time – has been time – for us to move away from the classic methods of getting the word to the people. We feel that for too long we have been ignoring our moral responsibilities to them.

For us, "The Struggle for Food" is a first step. We will continue to listen: to undergraduates, to housewives, to our fellow food scientists. We are anxious for new ideas, new approaches in educating those whom we serve.

THE PHASE ACHIEVEMENT SYSTEM

An Instructional Management System for Large Enrollment Lecture Sections

W. D. Dolphin, R. G. Franke, F. G. Covert, C. D. Jorgensen
Biology Program
Iowa State University
Ames, Iowa 50010

Recent approaches to the improvement of learning systems stress concern for the progress of the individual and can be grouped into at least three categories (Milton 1971): acceleration programs in which an able student can secure an undergraduate degree in less than four years (Carnegie Conv. on Higher Education, 1970); experiential learning which encourages education outside of the classroom; and personalized, individualized, or process instruction (PIP).

PIP applications usually are characterized by: 1) a clear statement of objectives, 2) student responsibility for learning, 3) self-paced student learning, 4) mastery of "easy" work before proceeding to more difficult material, 5) lectures for motivating students as well as for relaying information, and 6) personalized learning, repeated testing, immediate scoring, and extensive tutoring.

In PIP, modularized course material allows flexibility in the teaching-learning situation. For example, basic modules could be used in a beginning course for majors, some of them plus others could be used in a course for non-majors, and still others could be repeated at the beginning of advanced courses.

In 1969 I.S.U. started a core program in biology which included a basic course entitled "Principles of Biology." The enrollment in this course was approximately 3,300 the first year. Lecture sections of 600 students accentuated the problems present in any large enrollment course. The lectures were necessarily impersonal; Socratic methods were impossible and even disrupting; and personal acquaintance with the instructor was improbable. Lectures and exams were directed at a mythical "average" student, and as a result, the needs of either rapid or slow learners were seldom met. Examinations were viewed by students and instructors with anxiety and dissatisfaction. They were necessarily "objective," infrequent, consumed a large amount of the instructor's energy in routine clerical tasks and rarely functioned as learning devices. This, coupled with traditional student loaf-cram study patterns, made the exams appear as "now or never" situations with the test grade as the only reward. Consequently, anxiety over exam performance often supplanted concern with subject matter competence. Grades were awarded on a normalized basis without a clear statement of academic standards.

These problems are not unique to our course or university. Other large institutions have encountered similar situations and the previously described approaches are possible solutions. However, none of these methods alone would alleviate our immediate problems, though aspects of PIP seemed to offer the most advantages. At this point, we decided to design a system which would cope with the diverse problems from the student to the administrative level. The result was the development of the Phase Achievement System (PAS). This system is currently in use at I.S.U. and has served approximately 3,200 students.

In creating PAS, a list of the constraints that exist in large lecture sections was used in designing the system. These were:

1. How to teach several thousand students of highly diverse backgrounds each term with a limited number of instructors.
2. How to individualize the teaching-learning situation in large lecture sections and structure it so that the responsibility for learning is primarily the student's.
3. How to be more certain that students acquire specific basic biological information.
4. How to increase concern for subject matter competence over grade competition as the main notive for learning.
5. How to use tests for evaluation and learning.
6. How to expedite record keeping, exam preparation and gathering of statistical information.
7. How to offer quality instruction to many students without encountering prohibitive costs.

Solutions to our problems involved three areas. Course content would have to be restructured, testing and grading procedures would have to be revised, and data processing would have to be improved.

Three instructors of diverse biological training organized the course material into eight major conceptual areas (phases). Each phase was subidivided into subordinate conceptual areas and detailed objectives were written for these subareas. These objectives became the major statement of the course curriculum and were used in writing lectures, in choosing texts, and in creating multiple choice test questions (Fig. 1). In the future, any supplementary instructional devices such as audiovisual tutorial modules, visual or audio tapes that are created will be based on these objectives. Students use the objectives as a study guide and are urged to use instructors, textbooks, libraries, and supplementary materials to find the answers to specific questions. Therefore, the responsibility for learning is on

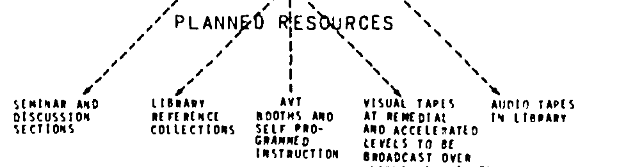

Fig. 1. Organization of curricular aspects of a course under PAS. Conceptual objectives are central portion of course. Lectures, tests, and other university resources as well as examinations are derived from these objectives. Dashed lines indicate proposed resources to be developed at a later date.

the student. The lecturer is not the central figure in the course whose every utterance must be recorded for reiteration at an examination. Instead, he becomes a university resource to be exploited to gain understanding of a particular topic. Our experience with objectives reinforces Varagunam's (1971) conclusion that students will do better when they know what to do!

The objectives also provide a great deal of flexibility for instructors in our multisection course. They may skim some objectives and dwell on those which are closer to their own training or enthusiasm. In fact, the objectives allow instructors to even omit some topics from the lectures. Though the student must search elsewhere for information, such as reference books or textbooks, he has a statement of what he is expected to know. In this manner, independent study involving consultation with many sources is encouraged.

With the modularized format of objectives in phases and subphases, certain areas can be designated as core material and other areas as elective material. Core areas could be used by all instructors and elective areas could be used by only certain instructors, according to their interests and ideas of importance.

With the objectives as a guide, test questions were written or gathered from colleagues at our and other universities. Approximately 2,400 multiple-choice questions were compiled into a question pool. Each question was assigned to a phase and conceptual area according to the objective for which it tests. These questions, stored on magnetic tape, are assembled into exams by a computer and are offered six times during a ten-week quarter.

The modularized and multiple testing system, backed up by computer test scoring and generation, allowed the implementation of a grading policy differing from that in most university courses. In order to pass a course under PAS, a student must achieve a passing score on a specified number of units, in our course seven out of the eight phases. "Passing" was set according to the difficulty of the items in the question pool and was empirically derived during system implementation. In effect, this policy sets two thresholds – one for breadth of comprehension and the other for depth of comprehension. Any student who passes our course has demonstrated at least minimum mastery of seven of the eight phases and the letter grade reflects his depth of comprehension. In an introductory core course which serves as a prerequisite for other courses in the biological sciences, this grade structuring is desirable. These components of a PAS grade are compared to a traditional grade in Figs. 2A and B. As in traditional systems, grades under PAS are defined, but the grade awarded under PAS has greater resolution including the F (Failure) and I (Incomplete).

At the beginning of the term a test over each phase, a "test out exam," is administered to students who feel prepared. Any student who passes seven out of eight phases can at this point receive course credit, if he desires. Students who do not test out attend lectures or otherwise prepare themselves. At two-week intervals during the term the student may retake any exam over any phase not previously passed or passed with a personally unsatisfying score. Since there are several opportunities for a student to pass a phase or raise a grade on a phase, the depth of his knowledge can be self-determined through an individually arranged exam schedule. At the end of the term students who accumulate passing grades on seven out of eight phases receive a passing course grade. Students who complete at least four of the seven phases, and who take exams over other phases but do not pass, are eligible for a grade of Incomplete (I). To receive this grade the student signs a written agreement accepting an Incomplete. He has another term to develop understanding and bring his record up to passing seven out of eight phases. Thus, the slower learning individual may have added time to complete the course without compromising academic standards. Students who do not pass seven out of eight phases during this additional quarter or who originally failed to meet the incomplete requirements are given an "F." These procedures are illustrated in a generalized flow chart in Fig. 3.

PAS provides a flexible program of learning for students to progress at their own rate. Well prepared students need not waste time repeating what they already know, those less well prepared can take the time necessary to master the course. Failure usually results from lack of participation in the learning process by the student. Because of the retesting provision, competition for grades among classmates is minimized and the student competes primarily with himself against standards set by the instructor and outlined in the objectives.

Since the subject material and testing is modularized, once a student completes an eight phase exam he knows where his deficiencies in biology lie and he can efficiently concentrate his studies. Students with deficiencies may study independently using the objectives and only attend lectures dealing with conceptually difficult material or may attend all lectures as they sequentially work their way through the course. Since tests occur every two weeks, can be kept by the student, and are usually scored within 24 hours, they become learning as well as evaluation devices.

Other advantages of PAS are seen at the course management level. Grades which are earned under this system represent a mastery of a defined amount of biological information which is not necessarily assured under traditional grading regimes. Course revision is greatly facilitated by the modular format because curricular areas can easily be added, deleted, or partially modified to suit current topics or individual instructors without changing the total course. Supplementary teaching materials may now be introduced into the course and closely related to a unit in the course. Modules also allow instructors to relate one conceptual area to the entire curriculum and to give an integrated presentation of biology. Core and elective modules provide a flexibility necessary for multisectional courses with several instructors.

PAS requires that students develop self discipline. Lecturers attempt to offer counsel as well as instruction to assist students in their use of the system and growth in self discipline. Although most avail themselves of this counsel, some do not. The multiple testing format allows instructors and students to perceive a failure pattern with sufficient

ANALYSIS OF THE ELEMENTS OF A GRADE

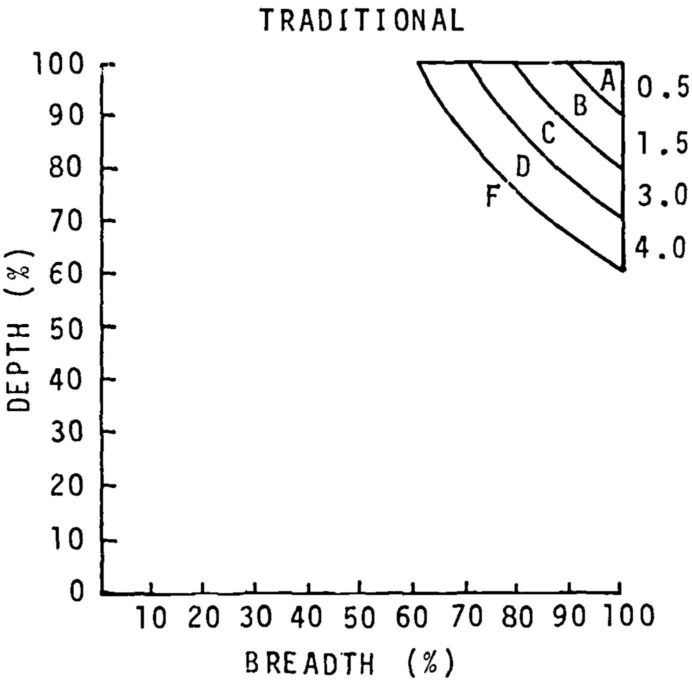

Fig. 2A

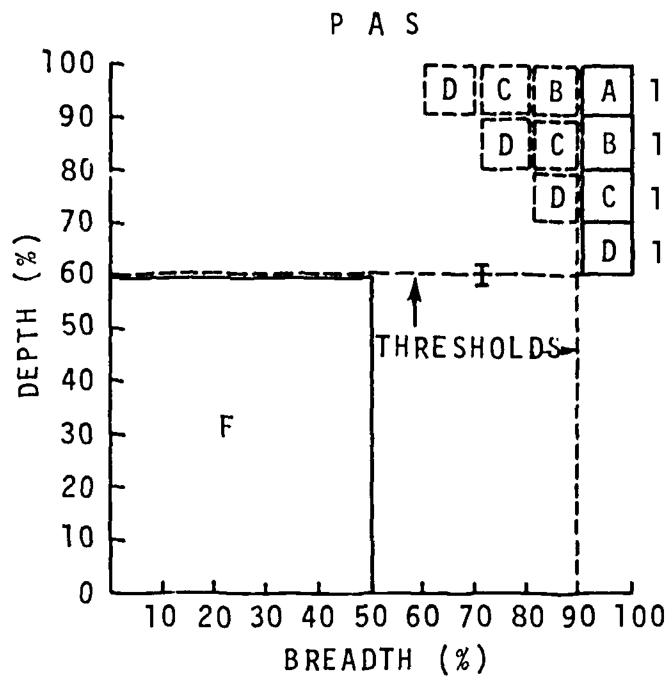

Fig. 2B

Fig. 2. Analysis of elements of a grade. Breadth is defined as curriculum (content) of course. Depth is defined as student's understanding in an area of the curriculum.

A. A linear plot of what a grade in a traditionally taught course represents in terms of depth and breadth of student understanding. If a 60% score is considered passing, then area of passing performance is outlined by figure in upper right. Letter grades are set up at 60%, 70%, 80%, 90%. Numbers to right of figure give relative areas of performance for each grade. (cf. to Fig. 2B).

B. A plot of the elements involved in a grade awarded under PAS. For simplicity, we have hypothetically assumed ten phases of which nine must be passed to earn a grade. A score of 60% has been set as "passing." PAS imposes a dual threshold on student. He must reach a certain level on a phase to pass that phase and he must pass nine phases to pass the course. Once these thresholds are exceeded his grade is determined by his depth performance alone. In this way, both the breadth and depth of a student earning a grade can be specified. Students not passing five out of ten phases fail. Students passing at least five but not nine phases receive an incomplete grade (I). Grades enclosed in dashed lines indicate alternative grading schemes that could be used if breadth control was not utilized i.e., passing 80% of the course with a 90% or greater average would equal B. This feature would allow the PAS grading scheme to approach the traditional (Fig. 2A). Numbers to the right of the figure indicate relative areas of performance for passing grades under PAS.

time remaining for self correction. For those who neglect these indicators, perhaps the lesson being taught is more significant than any biological information that could have been conveyed.

Implementation of PAS requires that a large amount of faculty time be spent in evaluating curriculum, writing objectives and creating test questions. Since the teaching of our course involves several instructors, systematic discussion must go on regarding revisions of curriculum and questions to keep the course timely and to accommodate the concerns of all involved faculty. Though the time spent improves course quality, some individuals may view this as a disadvantage. There is also the danger that the curriculum might be over planned and too much might be expected of the student. The correct balance can be derived only through personal experience and the university context in which the system is implemented. Our experience indicates, however, that a greater understanding of biological principles can be expected of the student.

Some concern has been expressed that the modularized course and testing format does not allow the integration of the biological concepts. While the system can be interpreted and used in such a manner, we have attempted to overcome this problem in curricular design. The objectives and the lectures attempt to guide the student to relate current material to past material and to anticipate future material. We do not visualize our phases as conceptually separate entities but more as part of a larger integrated whole. In addition, we have observed that many students repeatedly take exams not just to pass a phase but also to achieve a higher score. Hopefully, such student initiated studying leads to greater understanding and integration of previously

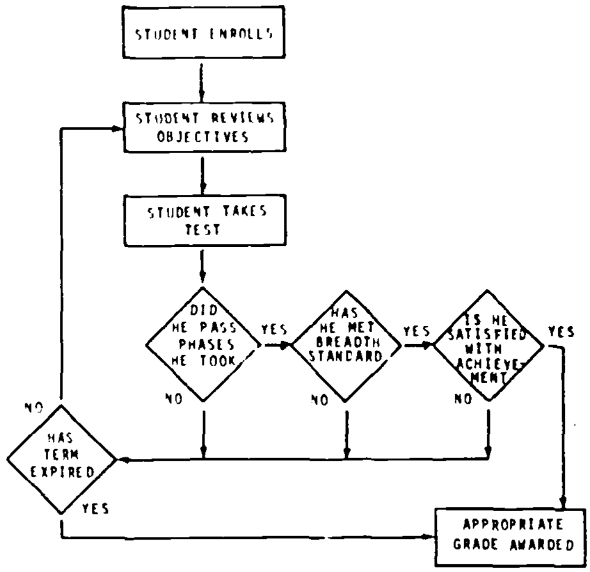

Fig. 3. Flow chart of the pathways that students may follow in the Phase Achievement System.

taught material with the "current" lectures. A prerequisite system could be created within the course where one phase must be passed before another phase is attempted in order to achieve integration. This, however, is an artificial administrative device. If prerequisites are in fact necessary, then it should be impossible to pass one phase before the previous one is passed.

Perhaps, the greatest obstacles to implementing PAS on a large scale are the logistical ones. With each student having a chance to take 48 phase tests during a quarter and with enrollments of at least a thousand students during the quarter, a rather large number of tests must be prepared, graded, and scores recorded. This would not be practical without some type of "automated" support system. For our implementation we have used a computer in these clerical duties. A description of this system and its contingencies is reported in another paper (Covert et al. 1973). Our philosophy, of course, need not be implemented on a large scale. A program could be created in small sections with essay exams that would use the basic tenets of the Phase Achievement System.

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A MODEL FOR IMPROVING ARTICULATION

W. H. Hertig, Jr.
West Virginia University
Morgantown, West Virginia

Many students now in four-year colleges and universities have transferred from two-year colleges, and as enrollments increase, even greater numbers will do so. Thus, there is a need for articulating institutional policies and practices as well as departmental curricula between these two kinds of institutions.

The broad aspects of articulation have received considerable attention and some useful guidelines have been set forth in a publication sponsored by the American Council on Education (1966). Schultz (1969) identifies five general problem areas and submits five recommendations for improving articulation. Knoell and Medsker (1965) have reported on factors affecting performances of transfer students from two to four-year colleges with implications for coordination and articulation. Nelson and Giles (1965) present five basic principles within which a number of specific guidelines are developed for improving articulation. These works, and others, have dealt with the problems at an institutional level, but a precise articulation model is needed which can be used within a given discipline.

Basically, articulation problems stem from three basic failures at the departmental level:

1. a lack of mutual respect and acceptance among two and four-year college faculty.
2. failure to recognize the necessity of attacking articulation problems on a local or, at most, regional scale.
3. the absence of mechanisms which:
   a. allow for curricular planning and interdigitation.
   b. provide for student follow-up.
   c. allow for and encourage the mixing of disciplinary counterparts from two and four-year colleges.

The Commission on Undergraduate Education in the Biological Sciences (CUEBS) demonstrated a vital interest in the two-year colleges by establishing the Panel on Biology in the Two Year College in 1965. As a biologist who participated in this work over a number of years, I believe the information gleaned from the Panel's activities, as well as that obtained from other known efforts across the country, serves as the base for the construction of the following model.

Mutual Respect and Acceptance

The foundation upon which any articulation effort must rest is a *mutual respect and acceptance* among two and four-year college biologists. Gordon Bender of Arizona State, in a letter to CUEBS describing the conference held there, said:

> The articulation effort in Arizona began with two basic premises: One, that all of us are professional biologists and, as such, there is no distinction between those teaching in two-year colleges and four-year colleges, and two, the purpose of communicating with one another is

to learn what each of us is doing and not for the purpose of standardization.

The following remarks by one participant at a conference held at Grand Valley State College might be considered an expansion upon the first of Dr. Bender's premises:

> Tension between two-year colleges and four-year college faculties often stems from the attitude that the two-year college staff is inferior (an attitude often shared by the two-year college biologists themselves). Failure of some two-year college introductory biology courses to transfer for majors can be attributed to the unwillingness of some four-year biologists to accept their two-year college counterparts as professionals. By acknowledging that the two-year college instructor is competent to teach general biology even though he may lack the background for more specialized instruction, the four-year college faculty can alleviate some problems of articulation.

A significant part of the problem of mutual respect and acceptance hinges on an interpretation of "professionalism." Four-year college biologists have tradition as a base for their professionalism and it is a difficult matter for them to view biologists who function in educational institutions outside of four-year colleges and universities as being "real" professionals.

It is apparent that this element of the model is largely a matter of attitude revision on the part of four year college biologists. A great deal of progress has been made in this area but there is still a lot of "mind opening" needed if articulation is to occur in a manner consistent with the best interest of students who transfer.

The Scope of Articulation is Local

Evidence gathered at the CUEBS Michigan Conferences showed that two of the nine two-year colleges transferring students to that institution accounted for 68% of the biology transfer students. On the other hand, one of the two-year colleges represented at the conference sent 97% of its transfer students to only 4 four-year colleges. These data suggest that articulation is a local, or, at most, regional problem. Experience gained at the North Carolina Articulation Conference, which involved representatives from the University of North Carolina and all of the two-year colleges in the state, firmly supports the notion that articulation problems must be resolved on the local level.

A Formal Communication System

An important element of an articulation model is the establishment of a mechanism which permits effective and efficient communication between the two kinds of institutions. Biology departments in the four-year institutions with a significant number of two-year transfer students should appoint one individual to identify the problems of students from two-year colleges, to identify course equivalencies, and to communicate pertinent information directly with two-year college biologists.

The biology departments of two-year colleges should assign one or more individuals to look outwardly toward the principal absorber four-year colleges and to negotiate with their counterparts in the four-year colleges when questions of course equivalency and the like arise. This individual in the two-year college should also look inwardly to identify potential majors and help them to locate a suitable transfer institution.

Some four-year institutions include in their catalogues course equivalencies that a two-year college student might transfer. These are quite valuable especially if they have been derived via communication of detailed course content between the two and four-year college biologists.

Student Follow-up

Another extremely important aspect of articulation involves student follow-up. Upon transfer, the student technically ceases to be of concern to the two-year college. A great deal of information can be gained by the two-year college faculty by following a student through the completion of his baccalaureate program in the four-year college. Information about the areas of strength and weakness of transfer students can be relayed from the four-year college and can serve as an evaluative mechanism for the two-year college.

A mechanism for student follow-up would require the development of evaluative instruments which are mutually acceptable to both two and four-year institutions and a process for monitoring a student's progress through baccalaureate and graduate programs to employment.

Curriculum Development

Another critical issue in articulation is the number and kinds of advanced courses taught at a two-year college. This becomes a particularly difficult problem when one views the CUEBS recommendation:

> Biology majors should complete all necessary lower division courses in chemistry, physics, and mathematics before transferring, hence two-year college biology departments should limit their course offerings beyond introductory biology.

This recommendation is not to be interpreted as excluding upper level courses, but rather to encourage a highly judicious selection of advanced biology courses to be taught within the two-year college.

Thus, a rational approach to a two-year college biology curriculum is to determine the principal four-year colleges which receive most of its transfer students and then decide on the courses which match the primary course option beyond the introductory course at the absorber institution.

Naturally, there are some problems attached to this approach. For example, there is the danger that the two-year college will find itself in a position of offering "home town" versions of courses given at the senior institution; there is the problem of filling a given course with students aimed at the institution which accepts that course as part of the major's curriculum; and there is the problem of students having to choose their transfer institutions at a relatively early stage in their educational experience. I believe that these are problems which are now with us anyway, but if courses beyond the freshman offering are added to the curriculum in a two-year college following the above rationale, at least these problems are placed in a manageable context with some promise of resolution.

Professional Identification

A final important aspect of a model has to take into account the fact that articulation involves more than dealing with transfer problems. The professional identification of two-year college biologists could be fostered by frequent interaction with biologists in the four-year institutions. A mechanism could be established for promoting visits between institutions, seminars and lecture programs in which two-year and four-year colleges can reciprocate, thereby increasing the extent of communication and expanding the flow of information.

The National Science Foundation, with its Cooperative Science Improvement Program projects leading to consortial arrangements between two and four-year colleges has gone a long way toward improving the relationship between biologists in these two kinds of institutions, thereby reducing the problems students encounter in transfer. E.g. The NSF SCIP project, Bio-Co-TIE, centered at Colorado State University, is an example of a joint effort between a population of two-year colleges and a single university to develop a curricular continuum to reduce transfer problems for biology students. All of these efforts and others have each contributed in some measure toward resolving one or more of the aspects of the total problem of articulation.

No known program or project, however, has worked on resolving articulation problems from a preconceived model. It is hoped that some identifiable group of two-year colleges will take the initiative to identify their principal absorber four-year colleges and begin the negotiations necessary to implement this model.

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DIVINE CREATION: A THEORY (?)

Richard A. Dodge
AIBS Staff

A recent California State Board of Education Meeting (14-15 December 1972) adopted a resolution relative to the selection of science textbooks for grades kindergarten through eighth. The nearly perfunctory action changed the submitted resolution little except to involve the State Board in the revision of state adopted textbooks. Indeed, the board mandated itself to direct such revisions. In so doing, the California State Board of Education also required specifically "on the subject of *Origins* in the science textbooks. . . . That dogmatism be changed to conditional statements where speculation is offered as explanation for origins . . ." and ". . . that science emphasize 'how' and not 'ultimate cause' for Origins." "In addition, the Board appointed a committee of four to work on behalf of the Board . . . in their negotiations with the publishers in the sections (of textbooks) on origins alone." The committee appointed included Board Member John Ford, M.D., often considered the leader of pro-creation proponents, Board Member Rev. David Hubbard, Dr. Richard Bube, Professor of Materials Science at Stanford University, Dr. Robert Fisher, Dean of Science at California State University, Dominguez Hills, and three staff members from the California State Department of Education.

This latest action represents one more step in a nearly ten year effort to insert a "theory of divine creation" into the teaching of science in California Elementary Schools, particularly in sections dealing with origins.

During December 1963, the California State Board unanimously approved a policy statement that future state textbooks should refer to Darwinian evolution as an important scientific theory or hypothesis and that California teachers should be encouraged to teach Darwinian evolution as theory rather than permanent unchanging truth. Fundamentalist forces were not satisfied with this policy and embarked upon a campaign to require equal stature for divine creation in textbook sections dealing with origins.

In 1969 the State Curriculum Commission, representing the views of nearly 5000 classroom teachers who review, screen, and recommend textbooks for adoption, submitted a framework outlining specifications for textbook publishers indicating there is only one scientific theory for origin of man and that was evolution.

This did not find universal acceptance with a new board of education reflecting the conservative view of the administration of Governor Ronald Reagan. The Board of Education added additional instructions to publishers of textbooks desiring to sell books to the State of California, namely that "all scientific evidence to date concerning the origin of life implies at least dualism or the necessity to use several theories to fully explain relationships between established data points; and, while the Bible and other philosophic treatises also mention creation, *science* has independently postulated the various *theories of creation.* Therefore, creation in scientific terms is not a religious or philosophic belief." This statement was added by the State Board of Education against the advice of the State Advisory Committee on Science Education.

Even though textbook publishers were notified they would have to include creation as a scientific explanation for origins, only two textbooks of the dozens submitted attempted to meet the dictated origins criteria. Neither of these were recommended by the textbook commission for reasons including lack of quality. Thus the failure of publishing companies to acquiesce to the dictation of the

State Board of Education would seem to have stymied the anti-evolution movement to include "creation theory" in the textbooks of California school children.

California, however, frequently does not buy printed textbooks from outside publishers, but rather buys the right to print existing textbooks in the state run printing office and often, in the past, has rewritten sections of the various textbooks printed by the state. Therefore, the committee designated by the State Board of Education is editing and rewriting potential textbooks in order to conform to the controversial framework. If the publishers fail to make the changes, the State Printing Office could, as it has in the past, carry out the mandated charges.

The practice of changing textbooks in California is common and origins is not the only subject to be so treated. Numerous committees of lay and professional advisors are employed for this practice. It is significant, however, that the subject of origins has been selected for extra consideration and a special select committee identified by the Board was empanelled to carry out its will: that the two Board of Education representatives have gone on record as opposed to the scientific theory of Darwinian evolution but instead insist on the inclusion of "creation theory" as a scientific doctrine: it is of additional interest that no biologist is included on the committee even though numerous biologists of national repute and recognized for their professional and scientific competence have stepped forward to offer their assistance.

There is still a powerful segment of the California State Board of Education dedicated to inserting theology into the science textbooks of more than one million California school children. The report of the special committee, at this writing, has not been submitted but is scheduled for airing at the 8, 9 March State Board of Education Meeting in Los Angeles. It is thought by many this will be an opportunity for the pro-creation advocates to once again insist on inserting the "theory of divine creation" into science textbooks as an alternate but equal explanation of the origin of life.

The American Institute of Biological Sciences, along with several other scientific organizations, has, through its Governing Board, gone on record as opposed to the inclusion of "creation theory" in science teaching with the following resolution:

> The American Institute of Biological Sciences deplores the efforts of groups in California and elsewhere to interject the teaching of religious accounts of creation into science courses.
>
> The present knowledge of biological evolution is based on a firm body of scientific facts, verified through observation, cross-checking, and experiment. Other explanations for the origin and continuance of life, including man, generated non-scientifically are not arguable on scientific grounds and should not be required as part of a science course.
>
> We therefore condemn all efforts to insist that religious beliefs and values be presented as if they comprise a part of the body of scientific knowledge. We call upon all responsible groups including the California State Board of Education to reject all such efforts.

TEACHING WITH ALGAE

Donald S. Dean
Teaching Section of Botanical Society
Baldwin-Wallace College
Berea, Ohio 44017

A significant venture in biology teaching will be a feature of the AIBS Meetings at Amherst 19 and 20 June. Phycologists of the country are cooperating with the Teaching Section of the Botanical Society in a special symposium on *Teaching with Algae.*

In what promises to be an exciting program, experts will show ideas for adding new vitality to laboratory teaching through use of algae to teach beginning biology, beginning botany, genetics, physiology, and ecology. Special attention will be given to practical tips on how to have the best live material available in top condition. As many as two-hundred live cultures will be demonstrated.

The idea is not to report the latest new discoveries in phycology but to stimulate vital, inquiry-oriented laboratories using an incomparable material: algae.

Members of both the Phycological Society of America and the Phycological Section of the Botanical Society have been especially helpful in giving advice in the organization of the program and in participating. Both societies will cosponsor the program.

Sessions will be chaired by Sanford Tepfer, Chairman of the Teaching Section, Elwood B. Ehrle, Secretary, and Donald S. Dean, Program Chairman.

EDUCATION DIVISION PROGRAM
AIBS ANNUAL MEETING, UNIVERSITY OF MASSACHUSETTS

	Monday, 18 June	Tuesday, 19 June	Wednesday, 20 June	Thursday, 21 June
8-10 a.m.	Minicourse in module making will meet daily Monday through Friday. Sponsored by the AIBS Education Division Consultants Bureau			
Symposia: 10 a.m.-noon	Graduate Education: Current Problems and Future Prospects	Manpower Concerns: Supply and Demand	Research in Biological Education	Environment: Reason, Regulation, and Resolution
1-2 p.m.	Open discussion each afternoon following from issues raised in morning symposium			
2-3 p.m.	How to start a student chapter	Students' concerns about manpower	Open discussion	What can AIBS do for students?
3-4 p.m.	Innovations in graduate education	Ideas on dealing with discrimination	Open discussion	What can AIBS do for women?
4-5 p.m.	Problems of chairmen[1] of graduate departments	Chairmen's concerns about manpower	Adapting departmental structure to educational innovation	What can AIBS do for chairmen?
Evening Sessions	Plenary Session: Manpower: Supply and Demand. Co-sponsored by AIBS, FASEB and SMC		Future structure of biological education	

[1] Women are of course welcome – we just haven't found the right word for your position!

REGISTER NOW

Mini-Course on Module Making

A hands on workshop in which the participants will write, develop and produce an audio-tutorial module.

Place:	24th Annual AIBS Meeting, University of Massachusetts, Amherst, Massachusetts.
Sponsor:	AIBS Education Division Consultant Bureau.
Time:	8:00 a.m.-10:00 a.m., Monday through Friday, 18-22 June 1973.
Staff:	Dr. Robert Hurst, Mini-Course Development Project, Purdue University. Dr. Darrell Murray, University of Illinois at Chicago Circle. AIBS Education Division Staff.
Registration:	Limited to 30 individuals. Deadline, 11 June 1973.
Registration Fee:	$5.00.

Send a letter expressing intention to attend the mini-course, and enclose a *check* in the amount of $5.00 to the American Institute of Biological Sciences, attention of: Richard B. Glazer, Associate Director, Project BIOTECH, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016. Include your name, address and telephone number. *Participants must also register for the Annual AIBS Meeting.*

Project BIOTECH Notes

Richard B. Glazer
Project BIOTECH

The testing and evaluation of BIOTECH modules is now being carried out by two year colleges, technical schools and training centers in many parts of the country. Evaluations are beginning to come in, and the general reaction appears to be very favorable.

To aid individuals in writing BIOTECH modules, several developers' workshops have been held to acquaint biologists with BIOTECH modules and other audio-tutorial modules and to train and encourage the participants to write and submit a module for possible acceptance by Project BIOTECH. Developers of acceptable modules receive an honorarium.

BIOTECH staff and Council Members are also continuing their efforts to inform biologists about the goals, philosophy, and progress of the project through presentations or demonstrations of BIOTECH modules at as many scientific and regional meetings as possible. Members of the BIOTECH staff will be demonstrating modules at the Annual Meeting of the Federation of American Societies for Experimental Biology (FASEB) which will be held in Atlantic City, 16-20 April. The Annual AIBS Meeting, 18-22 June at the University of Massachusetts, Amherst, will have a full schedule of BIOTECH programs

24th ANNUAL AIBS MEETING

University of Massachusetts, Amherst
17-22 June 1973

PREMEETING CONFERENCE
17 June 1973
Current Thought in Plant Ecology

A premeeting conference on "Current Thought in Plant Ecology," cosponsored by the Committee on Education of the Botanical Society of America and the AIBS Education Division will be held on Sunday, 17 June 1973, prior to the Annual AIBS Meeting at the University of Massachusetts in Amherst. The program will include:

9:00 a.m.-10:15 a.m.	Biophysical Ecology -- The Analytical Science David M. Gates, University of Michigan
10:45 a.m.-12:00 noon	Allelopathy and Its Importance in Ecology Elroy L. Rice, University of Oklahoma
1:15 p.m.- 2:30 p.m.	Multivariate Analyses of the Structure and Dynamics of Algal Communities Timothy F. Allen, University of Wisconsin
2:45 p.m.- 4:00 p.m.	Ethnobotany and Ecology: A Synthesis Richard I. Ford, University of Michigan
	Symposium Coordinators: Nicholas C. Maravolo Edward L. David

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I wish to attend the premeeting conference on "Current Thought in Plant Ecology" cosponsored by the Committee on Education of the Botanical Society of America and the AIBS Education Division at the University of Massachusetts in Amherst on 17 June 1973.

NAME ____

MAILING ADDRESS __________________________________

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