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The Multistructured Course - A Preliminary Analysis

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Abstract. An experimental program in which students may enroll in courses for varying amounts of credit, and select course objectives that are in line with their educational goals is described. A preliminary analysis of the results indicates that students tend strongly to approve of the goals of the experiment, have performed well, and, on the whole, react positively to the educational conditions involved. Early evaluation appears to show that some of the techniques commonly used for introductory courses are applicable, and others not very applicable, to education in courses involving upper division and graduate students.

Fortunately, we live in an age when students are less inclined to supinely accept whatever a school or a professor has to offer. The more idealistic ones want to see how what they are asked to learn can contribute to the pressing social problems of our times. The less idealistic ones, no less skeptical, want to know how the courses they take can help them achieve their personal goals. The challenge of university consumers asking to have something to say about the quality of their purchase, its quality in terms of their own objectives and goals, is a stimulating one. To the extent that we can meet this challenge, we can materially improve our educational programs.

No department in the modern university has a more varied population of student majors than the Biology department. Student goals vary from vocational to professional, and the range of professions and vocations related to Microbiology, Botany, and Zoology is very wide.

Coming to terms with such diversity is not easy. Some departments have a core program through most of the undergraduate major, ignoring differences in student interests and needs. Others bristle with courses specially designed for those interested in nursing, medical technology, teaching, forestry, and the like. In most schools, a rather wide spectrum of courses is offered. No student takes them all, but a program more or less related to his educational goals is built in consultation with an advisor. The extent to which a broad background in the field as a whole, a goal generally recognized as desirable, can be maintained in the face of a diversified undergraduate curriculum depends on the educational philos-

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ophy of the college and the department, as well as on the average number of credit hours granted per course. More recently, and especially in small colleges with relatively large funds available for educational programs, experiments have been undertaken involving greater dependence on individual work by students, with varying degrees of success. Without a great deal of time-consuming and expensive aid from a professor, most undergraduates achieve little. Largely through lack of experience, they do not possess the critical capacity needed to distinguish between important and insignificant facts and ideas.

One is forced to conclude that each of the principal methods of assembling a department program has its limitations. The traditional approach, using a wide range of courses, including many structured specifically for special interest groups, may fail to provide a well-rounded background in biology. At the worst, it may expose a student to such excessive early specialization that he develops a narrow competence, and is committed to a field before he is sure it fits him. The core program suffers from the danger of providing an excessively generalized experience, one that does not provide a sound training for technically oriented students who do not go to graduate or professional school. At the worst, it may make it difficult for a student to develop the skills and knowledge areas needed for successful graduate work. The highly individualized program is admirably flexible, but is likely to be ineffective or, alternatively, too expensive for general use.

It seems to me that the optimal departmental program would be one in which the gradual commitment of a student to a field of biology and to the service he can give to his society through it, is accompanied by opportunities for moderate specialization in the light of his developing interests. All too often, as specific interests develop, courses not directly related to them seem ever more irrelevant to the student, for he is often asked to achieve course goals unrealistic for his own objectives, goals related to the minutae and skills involved in the field rather than the basic background in theory that he probably needs.

The Idea of the Multistructured Course

Several hypotheses formed the framework around which the multistructured course was designed. These were:

1. For most of his work, the undergraduate needs some kind of course structure to channel his activities along maximally profitable lines.
2. To meet most of his educational obligations efficiently, the professor needs some kind of course structure.
3. As students develop special interests, they come to have different needs with respect to the fields covered by courses. For example, the outcomes of an introductory course in embryology need not and should not be identical for a future high school teacher and a future medical

student.

4. As students take courses for different reasons (to become familiar with a biological area as a part of their general background, or to develop skills and knowledge needed for their vocational aims or for future specalization in graduate or professional school, e.g.), it would be useful if they could do more intensive work in some areas, and more superficial work in others.

The problem, then, was to design a course flexible enough to permit students to vary their objectives with their needs, specific enough to provide adequate structure despite their differences, and fair enough for them to feel that they are evaluated justly despite the differences in their goals.

Any course designed along these lines obviously presupposes that everyone in the same course should not necessarily do the same things. This principle has long been established in disciplines in which laboratory work is not used. Readings in the library may be infinitely varied, and assignments of term papers or other projects have been used in the sciences as well as the liberal arts to permit some skewing of course outcomes in line with student interests. In the sciences, however, the expectations of the professor as well as the outcomes for the student depend in no small measure on laboratory work. It is here that the student learns the skills needed for gaining new knowledge; the precision of data-gathering, on which new concepts are based; and the kind of approach inherent in the analysis of the field up to the present. It is here, also, that modifications are required if student time is to be used efficiently in the light of their own goals.

The system used for course design was simple enough. It began with two questions. "If I were to design a course for students planning to (teach in high schools, go on to graduate school, enter medical or dental schools, etc.), what would I ask them to read, to do in the laboratory; what examinations would I give them?" "What are the essentials that each group should master?"

A design for each group for which the course was structured was put together. All of these designs were put together in a total course summary, hopefully realistic for all concerned. A laboratory syllabus based on the summed work was put together, and plans for examinations and accessory course material were made.

Inasmuch as students were not all going to be doing the same things in the laboratory, there was no advantage in having them meet at the same time, so the laboratory hours were put on an arrange basis, save for one hour each week, when students falling into the different interest groups were scheduled to meet for a discussion of work to be done for the week, and a demonstration of how to do it. To provide maximal flexibility, students were permitted to enroll in the course for varied numbers of credit hours

(2-5 hours per semester in Invertebrate Zoology; 3-5 hours in Vertebrate Embryology).

An Experiment with Two Courses

To test the feasibility of the multistructured course, an experiment was initiated with two courses, one in Invertebrate Zoology, and one in Vertebrate Embryology. Three substructures were planned for each course. Invertebrate Zoology was substructured for those who plan to become biology teachers, for standard undergraduate majors with a high interest in zoology, and for graduate students just getting their introduction to the field. Vertebrate Embryology was substructured for those planning to become high school teachers, for premedical and predentistry students, and for majors expecting to enter graduate school in some experimental field.

Some materials were prepared during the summer of 1968; the two experimental courses were (and are) being given during the school year of 1968-69.

Course Mechanics

Each course was designed to include two lectures a week, shared by all but with certain lectures designated as not required for students claiming minimal credit. Each student signed up for a laboratory orientation period, called a discussion section, choosing the section which best represented his interests. All laboratory work beyond this hour is on an arranged basis. Students are permitted to take major examinations when prepared to do so, but are strongly encouraged to remain within a week of normal stock-taking times.

Some special problems in dispensing materials appear because of the variety of materials used, and the fact that students are doing different things. The mechanics of dispensing need not be discussed here, however.

The variety of laboratory work being done, and the extent to which students are working under independent conditions, demand more kinds of aids. Moreover, accessory lecture materials are required to buttress some course structures. The system of teaching aids that were planned include:

1. A brief laboratory syllabus including all of the work that all of the substructures require.

2. Planning sheets for the various units of the courses, listing all of the work. Students individually check the work they select to do, and thus indicate the material over which they may be tested. The planning sheets are collected by the instructor before the end of a work unit.

3. Audio-visual and other aids providing specific directions or orientation to laboratory experiments or observations.

4. Tape-recorded lectures, illustrated by kodachromes, either going more deeply into topics, summarizing key topics for review, or providing alternatives to laboratory observations in specific areas for students taking the course for minimal credit. In the last instance, the illustrated tapes are intended to buttress the gaps in a block-gap system.

5. A system of self-tests, to aid the student in deciding that he has covered an area adequately and is ready to go on.

The discussion sections are essential to the proper working of the system, as presently visualized. Here the students make decisions about what laboratory materials they will elect; here, also, demonstrations of techniques or material are carried out to partially supplant the normal informal aid given by the professor in the laboratory section. Here, too, discussions of difficulties encountered in past work as well as ideas not well understood are possible.

Once his selections are made, the student arrives at the laboratory as an individual. He uses tapes, slides, and other materials and completes the laboratory work and studies the material available. The student is encouraged to assign a part of his study time to the laboratory, to permit maximal use of accessory materials. If they do not understand something or are having difficulties with an experiment, they are invited to go the office of the instructor to discuss their problems.

At appropriate intervals, examinations and practicals are given, as in traditional courses.

Teaching Problems

One of the goals of this year's experiment has been to see if the instructor could live with this kind of course. The original idea seemed basically sound, but the preparation of materials was going to be very time-consuming, and uncertainties about the time required of the instructor where students are working individually were pretty large.

The experiment is still in progress, so a final report cannot be made. However, as it has been in action since the beginning of the fall term, a preliminary analysis is worth while.

The only pressing problem, from the instructor's point of view, have arisen in keeping the class properly supplied with audio-visual materials. This problem was expected to be a serious one the first year. If the time spent in preparing such materials were cut by two-thirds, an estimate based on the idea that such materials should be replaced or heavily edited about once in three years, experience so far indicates that the courses would require about the same

teaching time as traditional courses. Students do come into the office for help; they have not done so to such an extent that their visits exceed or even equal hours that would have been spent in a traditionally scheduled laboratory course. Indeed, a few do not come as often as they should, although it entails only walking up a flight of stairs.

On the other hand, some real teaching advantages have appeared. Some of these had been hoped for, while others are unexpected dividends.

Teaching Advantages

Everyone who has taught a laboratory section is, of course, all too aware of the inability of students to hear directions the first time they are given. A part of this is inattention, stemming from the fact that students work at slightly different rates. Directions given too soon are missed; these students will ask for repetitions later. Others need directions before most students need them; these, too, require individual instruction. Illustrated tapes, or printed directions accompanied by 2 x 2 transparencies, are available when the student needs them, and may be studied several times if necessary. Fewer students find directions incomprehensible or inadequate, and repetitions are taken care of by mechanical equipment.

Freed from the time consumed by talking to a laboratory section as a whole and repeating directions for single students, one can talk more about important things in most of his contacts with the students. I find that I do not know the students less well than in traditional laboratory sections. Most of them I know better, especially in terms of their goals and problems.

A smaller amount of laboratory gear is needed. In the traditional laboratory, about two dozen students appear simultaneously, all needing the same material and equipment. When students spread themselves out over a week, a much smaller set of microscopes and other equipment is needed. Under present conditions, no more than a third of the students in a course are present under peak conditions.

A student meeting arranged laboratory hours can compensate more easily for such emergencies as a big test in another course more easily. In traditional courses, such times often involve a drop in class performance, one that is serious because there is no mechanism for making up the lost time. So far, students enrolled in the courses have, on the whole, done well with their freedom. A few, of course, have tended to permit things to slide too long, but these have been a very small minority. Probably strong encouragement to take examinations very close to normally scheduled times has been helpful here.

The advantages mentioned so far are those that were originally hoped for. Several other advantages have appeared, either not anticipated or not considered during initial planning periods.

The more flexible course format permits programs that could not be implemented under a more traditional format. Students have sometimes found that the course topics were more interesting, or applied more directly to their goals than was originally anticipated. Using the system that has been developed, it is not difficult, even at the middle of a semester, to permit a student to add to his credit hours. It is not difficult for him to go back to pick up accessory material, or to add to the work that is to be accomplished during the last part of the semester.

It also permits a modular approach, at least in Invertebrate Zoology. A student interested in a more intensive study of arthropods who has had a course in Invertebrate Zoology, can be served easily by arranging for him to audit the lectures on the arthropods, to use all of the accessory material that is available, and to carry out laboratory work impossible during his first course. An educational situation that would have required special topic treatment previously is largely handled by existing material.

Perhaps the break in teaching routine is an advantage that should be mentioned. No two weeks are quite the same. It is probable that the less routinized teaching situation provides a real stimulus, leading to better lectures and a higher sustained interest on the part of the instructor.

Student Achievement

Inasmuch as the Invertebrate Zoology course was greatly altered when the new format was introduced, it is not possible to make direct comparisons of student achievement with results in the traditional course. Student achievement was judged excellent at the end of the first term, certainly no less good than in the past.

More direct comparisons can be made with the Vertebrate Embryology course, which has not been changed so greatly. As this course is still in progress, any statements are, of course, preliminary. The examinations given so far have indicated that class performance in general facts and ideas is well above that of classes in the past. Scores on practical examinations tend to improve constantly in a field like embryology as students learn to deal more effectively with serial sections. Early scores suggest a slightly lower performance on laboratory practicals. The slight disadvantage is more than counterbalanced by the considerably higher performance on written examinations.

Student Reactions

Student reactions are very difficult to obtain and to evaluate. Generally, they tend to be somewhat more negative or positive than the situation actually deserves, in my opinion, with a high probability that reactions are fallaciously positive on the average because of personal interactions with the professor, of overevaluation of something that breaks the routine, and of lack of knowledge of went on before from the standpoint of a participant.

Most of the techniques that have been used are identical with, or very similar to, methods that have been used in introductory courses to cope with the problems of mass education. To the best of my knowledge, they have not been applied, except in a very limited way, to upper division or graduate education. Techniques that are very successful with freshmen may prove to be useless or nearly so with upper division students.

The pressure of preparing materials has prevented a formal study of effectiveness this year, and only informal evaluation has been possible. So far, students have appeared to adapt well to the techniques that have been used. They have been complimentary in talking about the courses, but as most of them are nice young people, this is not very significant. A method of formal evaluation has been devised, but cannot be initiated until the end of this year's experiment. At the start of each semester, each student claims an identifying number, which is held by a member of the class until after the grades have been turned in. The identifying number is used on student opinion sheets on which specific criticisms of the value and effectiveness of the classroom aids are sought. Opinion sheets have been requested this year, but have not been analyzed, as the full value of the answers given cannot be extracted until the end of the course. With their aid, differences in the opinions of males and females, juniors, seniors, and graduate students, and those making higher and lower grades will be examined.

At the present time, the only formalized student opinions are the results of a short questionnaire distributed to those who had completed the first semester of the course in Invertebrate Zoology. From the responses, the following general comments appear to be justified.

1. The students, universally, have indicated that they feel that the goals of the experiment with a multistructured course are valid, and if successfully implemented could contribute to their educational experience.

2. Certain aids appear to be far less important for upper division than for freshman students. Upper division and graduate students tend to feel that special materials for the development of

dissection programs, as well as photographic aids to plan dissections, are neither effective nor necessary. On the other hand, students intending to go into high school teaching have tended to respond well to such aids.

3. Illustrated, taped lectures and discussions are very popular, and students feel that they have some advantages over ordinary classroom lectures. Upper division students study these in a way that freshmen probably do not. The system used permits students to stop the tape to take notes, or to go back over parts that were not fully understood, at their own pleasure. A thirty minute tape often occupies an hour or more of their study time. The opinion, universally, is that these are well worth their time and effort.

4. Some feel that there is some loss in the laboratory situation because of the absence of an instructor while they are working. At the present, no pattern is emerging from the responses so far obtained. Fortunately, all students so far responding have indicated that they did not feel that the course was overly impersonalized because of the relatively easy access to the instructor.

5. Fortunately, also, all students so far responding have felt that they have been fairly evaluated. The problems of producing modular examinations which could be reasonably fair to students taking the course for differing amounts of credit, and having had different experiences in the laboratory have been severe. Several techniques have been used, but experience is not yet adequate to comment on relative effectiveness.

Conclusions

It is far too early to draw any firm conclusions. The program that has been undertaken is an arduous one, insofar as preparation of material is concerned. Student reactions and student performance are good enough to indicate that further development of the program is definitely worth while. The problems that have been encountered are not insurmountable, and student reactions indicate that the goals of the program are very valuable ones in their opinion. At least some of the techniques of educational media programs are applicable to teaching at the upper division and graduate levels, although considerable experimentation and evaluation are needed to ascertain what methods are most promising. Under the conditions that obtain in the program so far, multistructuring need not raise problems of unfair evaluation or of dissatisfaction about requirements in the light of differences in credit hours claimed by students, or of differences based on differences of educational objectives.