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An Experiment in Survey Science

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AN EXPERIMENT IN SURVEY SCIENCE

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The objectives of higher education are being critically examined these days. In an earlier time culture was the attainment most sought — a culture which was rooted in the classical languages, Greek and Latin. Utilitarian subjects rated but little following. And the sciences such as they were, thrived around the philosophical round table and not in the laboratory.

Gradually the ideals of a liberal education have shifted to a new emphasis and with this shift the laboratory sciences are coming into their own. It is now generally recognized that every student who seeks a broad, well balanced college education must devote some time to the laboratory sciences, both physical and biological.

In the liberal arts, nonprofessional college the problem of the distribution of subjects seems to be fairly well solved. On the other hand the professional college — and I refer especially to teacher training institutions — still faces the question of "what price science."

In certain curricula science is a basic prerequisite. Such curricula include physical education, home economics, and preparation for teaching secondary school science. But the need for science as a tool is not so evident for primary and kindergarten teachers, for music teachers, for grade school teachers and for other departmentalized lines. The need, I say, is not so evident to the beginning teacher. Yet the experienced educator realizes that science applies all the way from the kindergarten through the senior high school. He also realizes the desperately short time and few credits which can be allotted to formal science courses in non-science curricula.

The Iowa State Teachers College at Cedar Falls has been disturbed by this situation. And it is interesting to note that this dissatisfaction with prevailing conditions was not confined to the science faculty; in fact, the initiative was actually assumed in the executive offices.

Accordingly the fall of 1936 witnessed the introduction into the curricula of that college of two courses, each giving five quarter hours of college credit — one the Survey of the Physical Sci-

ences and the other the Survey of the Biological Sciences. With few exceptions these courses are required of all students and are prerequisites to other science courses. Another paper on this program will deal with the second course; hence, I shall consider only the Physical Science Survey Course.

The search for a textbook was the first task. Our requirement was that such a text must really present fundamental science and not merely tell about science and that it should be scientifically accurate. In our judgment — in which we do not ask you to concur — no such text is obtainable.

As a corollary to the first requirement, we believed that such a course could best be presented, not by a teacher who had a fair knowledge of physics, chemistry, astronomy, geology and climatology along with an ordinary assortment of demonstration material. But we contended that these sciences should be taught by an expert in each field and one who could enrich the course with the wealth of illustrative material at hand in the various well equipped science departments.

Accordingly, it was agreed that a syllabus of the course should be carefully prepared and the subject matter grouped under four general headings — astronomy and climatology, geology, chemistry and physics. Laboratory manuals were also prepared. And finally — perhaps unique in this particular — three different instructors, experts in their own fields, would instruct each class.

The syllabus, since it should be subject to annual revision in the early years of the course, is published by planograph and bound spirally. The laboratory manuals are privately printed by each instructor. The staggered instructor system is handled by scheduling the entire class, numbering from 160 to 230, for the same period. To each instructor is assigned one-third of the class. The respective subjects are then offered to the three sections for four weeks. At the end of this period each section is shifted to its second instructor (in his own classroom and laboratories) for another four-week period; and during the last four weeks the sections study with their third instructor. Every effort is made, by cross references and illustrations in classroom and laboratory, to tie the sciences together and integrate their subject matter. Every lecture is enriched by carefully prepared lecture demonstrations ranging from a half dozen to a score of items. It might be pertinent at this point to examine the teaching techniques of the three instructors.

Instructor A presents astronomy, climatology and geology — his special fields. From 9:00 to 9:50 he presents the lectures on

Monday, Wednesday and Friday. The students have presumably read over in advance the outline of any given day's lecture in the syllabus. An occasional five-minute quiz at the beginning of the hour, touching upon some of the most obvious topics of the lecture, offers an incentive to this prereading. The lecture then covers the assigned unit and is supplemented with numerous demonstrations and interspersed by class participation.

Certain requirements are then placed upon the student for the next lecture. First, he must briefly read over the outline for the advance lecture, as mentioned above. Second, he must have mastered the subject matter of the preceding lecture and be prepared to demonstrate the fact if called upon in a short oral or written quiz. Third, he must hand in certain written work which demands of him some independent thought and supplementary reading.

To enforce the last requirement, the syllabus is provided with many perforated sheets carrying thought-provoking questions, with blanks for the answers. These sheets are filled out, detached and handed in by the student. They are corrected; their quality is recorded as a part of the course grade; and the student is informed of his errors. As a rule, the corrected sheets do not become the permanent property of the student to pass on to sorority and fraternity friends. This classroom system is employed by all three instructors.

Laboratory instruction by Mr. A is offered from 8:00 to 9:50 on Tuesday and Thursday. It is offered in the lecture room, in the laboratories and in the field. A manual entitled "Constellation Studies" is employed in astronomy. It is supplemented by flash cards and night study of the heavens. Weather maps and similar devices are used in climatology. Hundreds of minerals, cross sections and museum collections are identified and examined in geology. Numerous slides and motion pictures also find a place in the laboratory instruction.

Laboratory instruction in physics involves the actual, individual manipulation of apparatus, supplemented by discussions bearing upon fundamental principles, logical interpretations and pertinent applications. To this end, several experimental units applying to mechanics, heat, sound, light, electricity and so forth are previously set up at different points in the appropriate laboratories. A group of from four to seven students is assigned to each unit under instructional guidance. A reasonable time is then allowed for each group to complete its investigation, after which it is shifted to a second experimental set-up and so on until each group has worked

with all of the day's equipment. The instructors pass from group to group, directing, questioning and discussing the work. For the larger classes this procedure is, of necessity, modified. In the modified technique the laboratory class is divided equally into two sections. The instructor in charge of the course, call him Mr. B, spends an hour with each section in the lecture room while the other section devotes an hour to the laboratory units. The lecture room time is devoted to a discussion of the experiments while the laboratory time is confined to continuous experimentation. This technique is no more time-consuming than that first described, because by either method the time must be about equally divided between experimentation and discussion.

Mr. C is in charge of the chemistry laboratory. Chemical experimentation lends itself admirably to individual laboratory work. Fortunately, the large general chemistry laboratory will easily accommodate about eighty students, giving each an individual desk. The survey course students are not given access to the lockers with their extensive sets of apparatus, nor are they charged laboratory fees nor for nominal breakage. The experiments covering the eight laboratory days are so designed as to require a minimum of equipment. In fact, most of the experiments are so simple and practical that they can be conducted in the ordinary small town school with its usual dearth of chemical equipment.

For each student there is provided a numbered, woven wire basket, six by six by ten inches which easily holds all of his equipment within its dimensions. These baskets are distributed to the assigned places the evening before the laboratory day and collected at the end of the course and a breakage charge is made only in case of excessive breakage. Such charges seldom need to be levied. If special items of equipment are needed for a given unit they are placed on the desks near each basket and collected separately at the end of the hour. Sets of chemicals for any given day's work are set out for the day at several points in the laboratory and from six to nine students are assigned to each set. Before each experiment is undertaken the instructor lays the background by questioning and discussion and at the completion of each experiment questioning by the instructor brings out the results, conclusions and applications. In so far as possible the student is encouraged to fill out the answers to the manual questions as his experiment proceeds. The more difficult questions are answered during the discussion. Perfect order and quiet is maintained during the discussion period by requiring that no apparatus shall be handled

during such periods. A tinkle of apparatus by an offending student brings most unwelcome publicity. Transitions between experimental and discussion periods are signalled by a small call bell. Weekly the laboratory manuals are corrected and graded. The instructor circulates among the class during the experimental period and for discussion work he is stationed on an elevated platform adjacent to the indispensable black board. Although the classes are very large the system here described has resulted in the smoothest operating laboratory section of any in the department.

The grades in each of the three-month-long courses are very carefully evaluated from several items, including the informal questioning and short quizzes, the laboratory notebooks, the exercise sheets from the syllabus and — most important of all — the objective tests. The latter include two or three sectional tests and a course examination at the end of the month. All grades for the month are integrated and distributed on a normal grade curve. Then the monthly grades of the three instructors are averaged for each student to obtain the term grade.

Certain interesting statistics emerge from a critical examination of course data.

A considerable number of the students have previously studied physics in high school; a much smaller proportion have studied chemistry; and relatively few have studied geology or astronomy. We would therefore expect and actually do find quite wide variations in accomplishment in any one subject within the course. Hence adjustments must be made by the individual teacher. But when the grades for a given class, worked out independently by each instructor, are compared student by student this fact appears, viz. in most cases the three grades assigned each student come within the same letter range and it is exceptional to find a grade spread that extends beyond the adjacent letter range. It might be stated here that each instructor grades in letters such as B—, C+, C and C—. By mutual arrangement these are translated into numerical grades which are then averaged, and the average reconverted into the letter grade which is reported to the registrar's office.

Other useful statistical results were derived from placement tests. A 247 item objective placement test was constructed and given to all freshmen at the time of registration. The same test was administered to the classes upon completion of the survey course. In the case of one hundred ten students who wrote the Physical Science examinations the results were as follows: In the pretest, of the 247 items the average score was 42.1 or 17% of a

perfect score. At the end of the course the average score was 128.1 or 51.9% of a perfect score. Thus this group showed an average gain of 86 items or a gain of 34.8% toward a perfect score.

A decile study was also made of this group. Ranging from the tenth decile down to the first, the pretest scores ran: 79-57-52-47-43-39-35-29-21 and 13. The scores made at the end of the course ran: 170-148-142-131-137-119-109-97-110 and 113 and hence these represent an average gain down the deciles of: 92-91-90-83-94-79-74-68-89 and 99. The relatively large gains in the lower deciles are not surprising — in fact they would be expected.

If the scores of the final examinations in both physical and biological science are consolidated, they show the following data: number of items — 407; average score — 247.5; per cent of perfect score — 60.8.

Class evaluation of the course was obtained from one section at the close of the quarter. Items included clarity of syllabus and lectures, coördination of lectures and laboratory work, the laboratory instructional technique, system and nature of tests, library reference plan, level of difficulty in relation to high school subject matter, and amount of material presented. This evaluation was collected by the Bureau of Research by means of questionnaires. Students did not sign their names. The preponderance of opinion was favorable to the course as presented in all items except the last. The criticism against the crowding of subject matter is justified. But the fault is hard to correct when but one college quarter can be allotted to each survey course.

The courses are far from perfect and a constant study is being made both by the instructors concerned and by the Research Bureau. It is safe to state, however, that our objectives of survey science are being realized and that our major premises seem to be justified.

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