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Introduction

The Science Foundations program at the University of Iowa consists of a sequence of general science courses designed specifically for the non-science student. The program is unique both in course content and instructional strategy. Recognizing that student backgrounds and needs differ greatly between the science and non-science major, the Foundations program is offered as an alternative to the traditional lecture-based science courses. Whereas the lecture-based courses emphasize the recall and application of factual material, Science Foundations stresses problem-solving strategies based on laboratory experience. Consequently, practically all of a student's time is devoted to "hands-on" activity with problems in the Foundations program.

Program Rationale

The entire Science Foundations sequence is based on the premise that general science for the non-science major is presented best in a learning environment where process and content can be integrated through meaningful personal experience. Translated into actual instructional strategy, this means presenting basic concepts of science through an open-ended,problem-solving approach. Under this procedure the student is challenged with a problem or question dealing with basic concepts of science and given the opportunity to investigate the problem in a stimulus-rich working environment. Each problem is designed to encompass certain science concepts but is in no way meant to be prescriptive, thus demanding active involvement of each and every student. It is in this factor of non-prescriptive procedure that the Science Foundations program more closely approximates an "individualized" science program than the conventional program based on "cookbook" experimentation or the progressive strategy, sometimes erroneously called "inquiry teaching," where the teacher has one answer or solution in mind and every student is supposed to get the same answer.

Activities Strategies

The laboratory activities growing out of the problems presented to the student lie at the heart of the Science Foundations program. It is through these activities that students come to deal with the basic concepts and

content of the sciences and hopefully gain some understanding and insight into these areas. It is recognized, however, that not all students, if any, entering the Foundations sequence have the sophistication or the confidence to plunge into a problem and experience the many facets of science. The "scientific method" is not generally part of the Foundations students' everyday operations manual nor can it be taught in abstraction. The problem-solving process implied by the scientific method is rather complex and somewhat foreign to the Foundations student and this fact is taken into account in the overall organization of the program.

At present there are approximately 25 activities or problem areas available to students for investigation. These areas can be divided into three distinct groups based on the combination of nature and level of student involvement with the activity. The division is a radical departure from the content lines imposed by individual disciplines such as physics, biology and geology, but is functional in view of the laboratory basis of the program.

The first group of activities can be classified as "non-experimental" with the major emphasis on describing or imposing order on physical systems. Generally these activities involve static sets of objects, such as rock or soil samples or dynamic systems, such as plants or animals which can be examined for comparisons and give rise to descriptive analyses. In this first group of activities the student would most likely focus on the descriptive aspects of the systems, though in practically all the systems the interactions of the parts of the systems with each other or with other systems could be studied in an experimental approach by the more sophisticated investigator.

An example of a Group I (non-experimental) activity is "Plant Taxonomy." In this activity the student is presented with a set of 10-14 selected potted plants and given the problem of developing a scheme for classifying the plants according to one or more criteria of their choosing. Examples of plants used are bachelor buttons, marigolds, coleus, salvia, sweet basil, petunia, tobacco, corn, wheat and fern, to name a few. The selection of plants is critical because students must be forced to try various characteristics (leaf structure, stem structure, flower structure) in deciding which factor or group of factors is most useful in classification. The emphasis in this activity is on the problem inherent in classifying not on coming up with the common or scientific names for plants.

The second and third groups of activities are actually sub-groups of a larger set called "Experimental Studies." In both groups the activities provide opportunities to investigate the interaction of variables in dynamic systems and differ from each other only in the nature of the variables implicit in the investigations and the purpose to which data collected in these investigations can be applied. Specifically, Group II activities are characterized by systems in which one or more of the principle variables most likely to be investigated by students is descriptive in nature or discontinuous in measure. Mealworms,

planaria, and fruit flies can be studied experimentally by Foundations students, but generally in terms of gross, descriptive measures. For instance, a student might investigate the effect of temperature on fruit fly pupation period in a carefully controlled experiment and find that some sort of relationship does exist. It is very unlikely, however, that a Foundations student would be able to pursue this finding beyond this point due to the complexity of the variables involved.

Group III experiments, on the other hand, lend themselves to more extensive data interpretation due to the quantitative character of the variables most likely to be pursued in student investigations. The ease with which data can be generated in the more simple physical systems, such as pendulums, magnets, pulleys, and sliding objects, provides opportunities for students to go beyond the systems at hand by deriving quantitative relationships from their data which can be further tested in the laboratory.

Each of these groups, the non-experimental or descriptive study and the qualitative experimental study, represents a different but equally important aspect of scientific investigation. Ideally, each student progressing through the Science Foundations program experiences activities from each of these groups.

Instructor's Role

From what has been described thus far, it is obvious that the instructor in Science Foundations cannot assume the stereotype of "Mr. Wizard" in the laboratory. Initially most students tend to look to the instructor for **the** answer or the right explanation. It takes a conscious effort on the instructor's part not to communicate that he or she does have all the answers. Telling students answers or volunteering lengthy explanations regarding what the student has observed or, worse yet, what the student should have observed is avoided in favor of questions designed to challenge the student and facilitate further experimentation.

Concluding Remarks

The Science Foundations program is continually evolving in terms of the activities used and the strategies employed. It is not the intent of this paper to portray Foundations as a program with all the answers and free from problems. On the contrary, the problems of evaluating student performance, for instance, are monumental in such an offering. Currently, student laboratory activity is evaluated on a cumulative basis throughout the semester and comprises 75% of their course grade. The other 25% is based on a two-part examination covering the semester's activities. However, because all students are allowed to pursue activities of their own choosing, the final exams must be tailor-made to each student--no small task in itself.

The art of "not telling", however, is a very difficult one to master, especially for most science instructors, and the students don't make it any easier for the instructor in this regard. Students are accustomed to being told whether they are right or wrong and tend to badger the instructor for this kind of evaluation. Sometimes students become frustrated because ideas or solutions don't come quickly. These are trying times for both student and instructor. But the instructor must keep in mind that the long-range benefits of student-generated solutions far outweigh the short-term relief offered by matter-of-fact, instructor answers.

A second problem concerns the scope and diversity of the activities offered. On the one hand, it is important to expand continually the pool of activities available to students, thus insuring greater involvement of students in areas which interest them. There are problems with expanding activities. First, very few traditional laboratory activities from basic areas such as physics, chemistry, biology and earth science can be adopted wholesale into the Foundations program without drastic modification or revision. A second problem with an expanding activity pool is that the job of administering the activities soon gets out of control--especially if staff and funds are in short supply.

It is this author's contention, however, that the advantages to the non-science major in an activity-oriented program such as Science Foundations far outweigh the disadvantages and inconveniences to the instructor. The needs of the non-science student have been ignored too long and new instructional strategies have been too slow in coming. The Science Foundations program, in our view, is the necessary first step on the path to more meaningful science instruction for the non-science student.

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NSTA to Assist Local Drive-in Conferences

Individual NSTA members, chapters, and associated groups interested in sponsoring local or drive-in conferences are invited to write in for application forms. Limited grants of up to $150 will be made available depending on available funds.

It is hoped that conferences will concentrate on promoting communication among teachers within a convenient driving radius. Actual content and arrangements will of course vary widely, with conferences focusing on local problems, experiences, and interests.

Administration of the conferences is handled by Dorothy K. Culbert, NSTA Director, Division of Field Services. For information and application forms, write to Mrs. Culbert at NSTA Headquarters.