SCIENCE DEMONSTRATIONS BY SECONDARY SCHOOL STUDENTS

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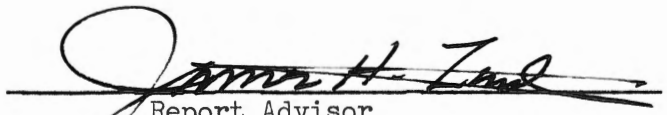

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PREFACE

Following the Little White House Committee report on education public interest in what our schools are doing ran high and in many communities interested groups held meetings to discuss their own particular situation. The author of this paper attended several such meetings and was impressed by the general public's lack of information about their own schools. Actually many teachers have little knowledge about what other teachers in their own school are doing.

The purpose of this paper is to present some work that is being done along with information about how it will help improve our training of the students who are our responsibility.

The author wishes to express his appreciation to Dr. James H. Zant for his assistance in preparing this paper.

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CHAPTER I

INTRODUCTION

The United States has achieved an unexampled level of material prosperity thanks to science and technology and, since we are so prosperous, many Americans tend to go merrily on their way confident that we will always somehow manage to "come out on top". In the last year or so there has been much publicity suggesting that our enemies may be passing us in this area of science and technology. This fact has caused some doubt about our security as the world leader in scientific development.

This suggestion has caused many responsible people to re-examine our position and they have found that we are falling short in the production of new scientists and engineers and that unless we do something about it the situation will become drastic in the next few years. There is much argument about the number of various personnel needed but all agree we do need more capable people. When we think of the greater numbers of trained people which we must have in following years we naturally look to the school systems of our country to see if more young people are enrolling in courses which will lead into these fields. We find seventy-two per cent of all tenth graders enrolled in biology, thirty-two per cent of all eleventh graders enrolled in chemistry and twenty-three and one half per cent of all twelfth graders enrolled in physics.[1] Of course, this does not mean that

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[1] "High Science Enrollment in Nation's High Schools." Science News Letter, Vol. 69 (February 18, 1956), p. 105.

all these students will become scientists but it is an indication of how many young people are laying the groundwork. This is a numerical increase but percentagewise it is only slightly above past figures. Dr. Charles Dollard,[2] Chairman of the National Science Board's Committee on Scientific Personnel and Education says:

> We can measure the numbers attracted to science and this is frightening but the most frightening is the very small percentage of our population attracted to science who are capable of first rate intellectual work. This is the part that may be fatal.

That we must interest more capable young people in scientific fields is obvious, but how, is another and a more difficult question. In some countries tests would be given to determine the aptitude and ability of young people and the most promising then enrolled in courses leading to the needed careers regardless of the desires of the individuals concerned. Since we believe the individual has the right to decide for himself what he will do, we must take a harder and slower way. We must try to show people what they are qualified to do and hope they decide to follow some line where they will be useful citizens.

Most people who have considered the problem think one important way to help is to improve our teaching so that interest will be aroused and more students continue studying science. This in itself must be viewed from several sides. Concerning industry's luring teachers away at all levels Dr. Dollard[3] says, "We are eating our seed corn." Dr. Arthur S. Fleming,[4] Director of the Office of Defense Mobilization has this to say:

> When the conscious of America is aroused, however, to the place where teachers are paid a decent salary, we will

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[2]Charles Dollard, "Current Problems in Perspective." The Scientific Monthly, Vol. 82 (June, 1956), p. 277-82.

[3]Ibid.

[4]Arthur S. Fleming, "Nations Interest in Scientists and Engineers." The Scientific Monthly, Vol. 82 (June, 1956), p. 282

> attract and retain in our secondary school system teachers who will strenghten and improve the curriculum. Furthermore, we will provide these teachers with adequate facilities.

Arousing student interest in science is no simple matter, but rather it is a complicated problem involving the human mind. There are many factors to be reckoned with and only a few will be mentioned here since the primary purpose of this paper is an explanation of the use of illustrated talks, experiments or explanation of models by high school students to encourage more of the right kind of students to pursue science. More specifically, it deals with how demonstrations by high school students in elementary and junior high classes can play an important part in building this interest.

Benefits of a program where secondary school students prepare and present demonstrations are many. Three groups are helped by this activity--the student himself, the group to which the demonstration is given and in many cases the teacher of this group. Numerous references show student's interests are developed very early, hence, if we are to succeed, we must contact the student as early as possible. An article by Robert D. MacCurdy and Robert M. Thompson[5] states:

> Our task of alleviating the shortage begins with identifying the potential scientists and engineers at the earliest practicable age and stimulating, guiding and encouraging them to the consumation of their gifts, and then providing them with an education commensurate with their high abilities.

Later in the same article it is indicated that sixty-nine per cent of two hundred twenty-two young people in the Massachusetts state science fair had experienced their first interest by the sixth grade or thirteen years of age.

A school principal in Philadelphia has this to say about science

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[5]Robert M. Thompson and Robert D. MacCurdy, "Science Interest is Born." School and Society, Vol. 185 (February 16, 1957), p. 56-57.

instruction in the lower grades, "Women are scared of science, unless we watch, some children reach grade six without even learning any astronomy."[6] He goes on to state that teachers may slide over material in a syllabus because they feel the students are better prepared than they themselves. He further comments that one poor teacher can snuff out interest. Lag in interest starting in the seventh grade may not be so much the result of teaching techniques at that level, but may be the results of the fact that the student has never been exposed and learned that science can be fun.

The above is not intended as a criticism of elementary teachers for it is certainly not true of all or perhaps even a majority, but it is a condition which does exist to some degree and it is this condition to which our students activities as demonstrators is directed.

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[6] Mary Mitchel, "Children are Smarter Than You Think." Saturday Evening Post, Vol. 229 (March 8, 1957), p. 289.

CHAPTER II

PURPOSE

Bluntly the purpose of the proposed activity is to interest more students in becoming science teachers or going into science, or engineering as a profession. As has been stated this is not an easy thing to accomplish, in fact we are all too aware that we do not know all the answers. We can, however, determine some of the things which cause the students to develop interests and ultimately select certain careers.

Motivation

Dr. A. M. Jordan[1] in a text on educational psychology defines a motive as:

> A state or set of an individual which deposes him for certain behavior and for seeking certain goals...Needs or drives which motivate students are the need for security, mastery, approval, status and for independance...There is also a type of motive aroused in the learning processes themselves. It may be aroused because there is interest in the activity itself because somehow it continues what the child has been thinking about, what he has been participating in, and is stronger if he is personally involved in the activity. It fulfills his own desires. Under such conditions motives arise out of interests which are related to childrens attempts to solve their own problems, to live their own lives.
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> To utilize these interests effectively we must first find what they are. In the second place we must furnish procedures with appropriate illustrations for utilizing these interests.

By observing student's interests in class it is often possible to show

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[1] A. M. Jordan, Educational Psychology. (New York, 1956), p. 202.

them some of the areas in which they are interested might be further developed for a demonstration to be given to some other group. With such a goal students have greater incentive to go all out searching for ideas and information which becomes an ideal learning situation.

> With success in carrying out short range plans, the person gains confidence in his ability and enough interest to sustain a longer activity. The teacher who helps pupils set and attain clear short-term goals will assist them to develop foresight. Short-term goals can provide frequent rewarding accomplishment without discouraging stretches where the only satisfaction seems unattainably remote... The small landmarks divide the pathway into challanging and satisfaction giving segments.[2]

It is not unusual for a student so stimulated to dig out much more information than the instructor himself knows. Dr. Alan T. Waterman,[3] Director of the National Science Foundation, talking to a group of some science fair participants who had studied intensively, each in his own area told them:

> We are building a small beachead of pro-intellectualism... There seems to be a trend away from intellectualism in our country and a related decline in academic standards... We offer a vast assortment of trivial courses that cater to the weak and tempt the strong to take the easy rather than the difficult route to a baccalaureate degree.

Stereotypes

The relationship between the trend away from academic interest and the next phase of this problem is so close they cannot be entirely separated. We know that interests are developed early before vocational and educational experience are encountered and we also know that most students have most of the impressions they will have for deciding their

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[2] Lee J. Cranbach, Educational Psychology. (New York, 1954), p. 418.

[3] Alan T. Waterman, "Role of the Federal Government in Science Education." The Scientific Monthly, Vol. 82 (June, 1956), p. 286-93.

careers by the ninth grade.[4] One of the most important factors in deciding on a career is the young person's idea of that career. In most people's minds, including students, various careers are stereotyped. Whether they are correct or not, and they are most likely to be incorrect, these are the concepts that guide the student's decision. Melvin Barnes,[5] Assistant Superintendent of Oklahoma City Schools conducted a survey of high school students to find out why they did not take more mathematics and science. Their responses were they thought scientists were, "Einsteins, long hair and a sweat shirt, squares and little old men with beards working in musty laboratories." Most thought science and mathematics courses were dull and that job opportunities in science fields were poor. If this is the attitude of teanagers about scientists how can we hope to interest them. "If we want to sell something we must make it attractive to the prospective buyer."[6]

There are many ways we can help students form correct ideas about scientific and teaching careers. Outside speakers, visits to laboratories and any other ideas which are helpful should be used but it is well to keep in mind that students are in school for twelve years and at the end of that time few know what itis really like to be a teacher so their stereotype of teaching is usually far from correct. This illustrates the importance of the point of view from which the student gains his information. Just observing something, while better than nothing, does not always lead to the correct conclusions about that particular occupation.

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[4]Charles Dollard, p. 279.

[5]James G. Busse, "Summer Jobs for High School Students." Science, Vol. 123 (February 3, 1956), p. 185.

[6]Donald N. Micheal, "What We Need To Know and Why We Need to Know It." Scientific Monthly, Vol. 84 (March, 1957), p. 137.

The following is a student's suggestion published in Science:[7]

> Place the task of encouraging students to choose a scientific career in the hands of all members of the scientific field...One summer of actual work in a field of science is a greater encouragement to decide upon a scientific career than a year of constant lecturing on the subject by a teacher.

Raising Academic Interest

Presenting demonstrations in school classes cannot substitute for summer work in laboratories but it is excellent, first hand teaching experience. The satisfaction received from telling or showing something to others is a new experience for many students. This is an excellent way to give students the correct concept of what teaching really is and perhaps interest them in this field where they are needed so badly. For students who do not wish to teach it has definite values also. After a student has worked hard to learn all he can about some particular subject he realized that he is not an egghead just because he has done something worth while. This reaction is somewhat contagious and other students are apt to become interested in what has given this student so much satisfaction. This it is hoped will help raise the academic standards of the whole group who now seem proud of the fact that no one really learns more than is necessary to just get by.

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[7] James G. Busse, p. 185.

CHAPTER III

PROCEDURE

Two types of demonstration programs will be discussed here as appropriate for use in the elementary and junior high schools. They are interest stimulating programs whose goal is to attract attention and create interest for science in general and informative programs whose purpose is to develop interest and growth in science by giving students a chance to learn of the many fascinating but not necessarily spectacular things about science.

Interest Stimulating Programs

Students are always interested in spectacular science displays. Some teachers object to using this type program to induce students to study science but it is one way to get more students into science classes. Of those who enroll because of this type activity, some who would otherwise never have been attracted will become genuinely interested. Students cannot be taught and led further in science if they do not enroll and in most schools they are free to either take or not take science, as is their fancy. Spectacular displays such as pyrotechnics, rockets, ultra sonics and chemical oddities are good for presentation to any group for popularizing science. This has been done in Albuquerque, New Mexico where teams of students have gone into junior high schools and grade school situations to put on demonstrations. Typical responses have been, "This is wonderful" and "How can I get in on it?" (The demonstration team). In three years enrollment in

physics, chemistry and biology doubled and in three more years had doubled again.[1] These facts give us an idea about how successful such a plan can be if the teacher who is willing to expend the time and effort required for assisting with development demonstration and organization of the program.

Informative Programs

The informative type program is not as spectacular or eye catching but has been found equally successful. Although many teachers encourage better students to help slower students and have coaching teams set up in their classrooms, no information has been found describing organized demonstrations by high school students. This has been tried in the Los Alamos, New Mexico public schools. The program has been in use just a little over one year so no figures are yet available to show what effect it may have on enrollment in science classes. Response from students and teachers has been very encouraging and indicate it will be highly successful.

The informative type program is more versatile and less cumbersome in that little equipment is usually required and only one or perhaps a few students are involved on any one occasion. Programs can be adapted for science club meetings, Parent Teacher Association meetings, in elementary and junior high schools or in high school classes. For example, physics, chemistry or biology students may be interested in material that will be very helpful in general science. Concepts from nuclear physics can be useful in any high school science class; or a chemistry student might be able to show the relation between chemistry and plant nutrition to a biology class.

The primary use of this plan, however, has been in the elementary

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[1] A. G. Maisel, "Doc Harrington's Dawn Patrol." Readers Digest, Vol. 69 (November, 1956), p. 142.

schools. It may be difficult for high school students to present material at the various age levels and will certainly require constant checking by the instructor but it is of value to the student to do so. He cannot get by with repeating some complicated phrase he has memorized, but must understand what he is explaining well enough to restate it so that the younger, less experienced mind can comprehend what it is all about. Not only must the student adapt his demonstration for some particular age level, but he must continually do so for the same student demonstrator may appear before classes ranging from lower elementary through high school. It should be emphasized that high school students cannot be expected to determine for themselves what is suitable for any age group, although some with younger brothers or sisters have a surprising ability to do so. They must be continually assisted by the high school instructor in charge and in many cases by the elementary teachers participating.

The demonstration program is also a good device to encourage the inquisitive students to dig a little deeper into interesting areas, or it may be used as a reward mechanism for some one who has done a very fine piece of work along some line. Teachers are always aware of the need for some worthwhile outlet for the better students and this program properly handled provides adequate breadth and depth for any student.

Type of Program

Programs put on by students have been referred to as programs, activities and demonstrations. Actually, there need be no limit as to what they do, if it helps explain or demonstrate the topic they have selected. Lecturing by students is discouraged, rather they are encouraged to have something to show and explain. For example, various unusual sea animals such as coral, hydra, sponges and the like stimulate

questions about animals of the oceans. Sometimes models already available or those made by the student are the basis for explanations. Pictures, such as those from Life Magazine are sometimes very useful in illustrating some phase of science.

Length

The length of the student's program will have to be suited to the situation. Some elementary teachers want some small demonstration for only a few minutes, others for an hour. It is up to the student to rearrange his material to fit these needs. Here again is a good learning experience. Out of an hours material the student must select the most important fourth, half or whatever part is needed and reorganize it with illustrations, models, experiments or whatever media he is using.

Equipment

Although most students will want to accumulate much complicated equipment, very little is usually needed and programs seem more successful without it. For example, many elementary schools have limited facilities for water, gas or electricity and it may be unhandy to darken the room or go to a projection room, hence the use of these facilities is discouraged. The use of self contained equipment such as pictures, alcohol burners and the like has been found adequate. If the demonstration is to be presented to a large group such as a Parent Teachers Association, where advance preparations are feasible, then other equipment may be more practical.

Organization

In order to start such a program it is wise to work from the elementary

school level and determine it's desirability. Most elementary teachers are glad to have help but diplomacy must be used. Informal offers might be best at first until elementary teachers who are less enthusiastic about science see how it works. Grade school principals must be contacted and as the program developes they may be of great assistance in encouraging teachers to stress science and in arranging schedules in their respective buildings.

After the idea is familiar to the principals and teachers, they are notified that high school students are prepared to discuss and demonstrate certain subjects. A list of these subjects is sent to each school and teachers who can use one of these may then contact the high school instructor responsible for scheduling. A list of possible subjects is as follows:

1. Reptiles and Amphibians
2. Atomic Energy
3. The Human Body (Anatomy)
4. The Human Body (Physiology)
5. Electricity
6. Poisonous Animals
7. Air
8. Cloud Chamber
9. Glaciers
10. Balanced Aquaria
11. Optics
12. Astronomy
13. Genetics
14. Acids, Bases and Salts
15. Chemical and Physical Changes
16. Rocks and Minerals

Brief descriptions of the material covered will help the elementary teachers select which topics can be of value in their classes. As new subjects are developed, corrected lists can be sent out which will refresh the elementary teacher's mind of availability.

After each demonstration the elementary teacher is asked to fill out a short form evaluating that particular student's presentation and listing constructive suggestions. These are discussed with the student

involved at the discretion of the high school instructor. Care must be taken not to discourage the student, yet poor demonstrations cannot continually be presented if the entire program is to suceed.

Scheduling and Transportation

Most elementary teachers have a fairly flexible schedule and can arrange their classes so the time for demonstration will be more convenient for the high school student. If possible, time should be arranged so the student utilizes study periods or possibly science class time rather than disrupt other academic classes. Taking students from other classes creates ill will toward the activity from other high school teachers and it may also cause the student academic difficulties due to missing too many classes.

If the room to be visited is in the same building or within a few minutes walking distance, no transportation difficulties should be encountered. If buildings to be visited are widely scattered transportation may become a real difficulty. If the student has his own car or is permitted to drive it may be permissable to allow him to do so. Science teachers whose free time for lesson preparation happens to fall at the same time as the demonstration may assist but in many cases some other source of transportation must be found. It will be more satisfactory if some responsible adult in the school whose position allows him to leave occasionally (such as a maintenance man who may also drive a school bus) is assigned this task. In any case, since the school is responsible for the student at this time definite arrangements should be made ahead of time so that minimum risk of irregularities is assured.

SUMMARY

We know there is a very definite shortage of science teachers, further complicating the shortage of scientists and engineers who are so essential for our countries continued well-being. Since young people receive impressions during elementary school which ultimately are very important in their selection of a career, it is important that we encourage as much science education as possible at the lower levels.

Elementary school children are very inquisitive about science and demonstrations by secondary school students can help encourage this curiosity and also help the elementary teacher by such stimulation or by assisting in areas where the teacher herself feels inadequate.

The use of demonstrations by high school pupils, whether for entertainment or for information, definitely has value, both for those giving a and those receiving. Statistics from Albuquerque, New Mexico show in six years science enrollment increased nine times after the use of demonstration teams in elementary and junior high classrooms. It encourages interest in subject material and can be a very real aid in forming a group of students who are interested in intellectual achievement. It also assists students to learn more first hand information about teaching and to some extent about various areas of science so their concepts to be used in career selection may be more nearly correct.

Programs discussed here may be presented at science club meetings, Parent Teacher Association meetings, in related high school classes and in junior high and elementary school classes. Careful instruction and

supervision must be given each participant concerning how the subject in which he is interested may best be presented, its suitability as to age and group, length, and needed equipment. The instructor must carefully plan schedules and arrange transportation. Effectively carried out, this is another method of encouraging more capable students in the field of science and thus helping to overcome our shortage or science teachers, scientists and engineers.

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