THE NEED FOR IN-SERVICE
TRAINING OF SECONDARY
SCIENCE TEACHERS

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1950

Submitted to the faculty of the Graduate School of
the Oklahoma Agricultural and Mechanical College
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1957

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Report Approved:

Report Advisor

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PREFACE

There is no doubt that something is wrong with education. The evidence of this fact can be easily seen if the results are studied. The three "R's" are slighted somewhere. The fact that young people cannot write, spell, or cipher is pointed out by industries of all sorts. Worst of all, however, there seems to be a certain loathing for self discipline and a distaste for concentrated effort of any kind. The "something for nothing" attitude is taken by too many young products of our public education.

Many investigators believe that education on the secondary level is suffering the greatest deterioration especially in the sciences. Even if the educational system were no worse than it was some years ago, that is, if the public education system is holding it's own; this fact cannot be pointed to with pride. In this dynamic world where scientific and technological knowledge is increasing by leaps and bounds, yesterday's curriculums cannot be adequate for the training of tomorrow's scientists. We must produce scientists and technologists to propagate our machine age or we will fall by the wayside in the struggle for survival among nations.

It is generally conceded that something is wrong with public education and that steps should be taken to correct this inadequacy. Opinions differ, however, as to what is wrong, and what should be done about it. Educators say more money is needed; whereas, many corporations smarting under heavy tax loads undertake investigations to prove that less tax money is needed to insure good public education. They aspire to prove that what is needed is more efficiency.

The fact that many students in colleges are avoiding science and mathematics courses and the fact that of the students who enter college with the desire to enter science and mathematical pursuits up to fifty per cent fail, seems to indicate that school science and mathematics departments are unable to meet the needs of college bound students. Another function of high school science is to teach the student a better concept of science so that his living will reflect better health habits and wiser purchasing practices. From public health statistics and from the low level of advertising media, there can be little doubt that the science curriculum is failing also in this important task. There is also a purely aesthetic training that should be provided by science education. The appreciation of and conservation of our natural heritage in the way of natural resources is of vital import to the public welfare. Although some evidence exists that many people are strongly aware of our natural resources and their conservation, we seem to be failing to reach the majority as evidenced by hunting practices, trash dumping practices, and the like.

The assumption can be made that there exists a need for secondary science education to do something toward reaching a better position to meet the needs of the high school student. The realization of the problem is not the most difficult part of the task in this case. Finding the point or points of weakness in the secondary science program is not an easy job; furthermore, science departments vary in their weaknesses from system to system. Probably the most difficult task of all is deciding what can and must be done to minimize the weaknesses.

In order to find the weakness of science instruction, the investigator must explore the modern education trends and philosophy as a whole. The trend in teacher training institutions toward a minimum of subject matter in the field to be taught and a maximum of methods of teaching, as seen by the "educators" has hurt all fields in public education. The science phase of this problem has been covered by many articles in the literature.[1] The teachers college curriculum is a basic source of the present difficulty and this problem will be explored by the present study.[2]

It would seem then that if the secondary science teacher is poorly prepared in many if not most cases, then a study of what he is doing to better himself by basic study and constant effort to keep up in his field will not be amiss.

Indebtedness is acknowledged to Dr. James H. Zant, for his valuable guidance, and to the following for inspiration and assistance:
Dr. Richard V. Andree, Dr. Frank M. Durbin, Dr. George Gorin, Dr. Imy V. Holt, and Dr. Leslie Bruneau.

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[1] Oscar Riddle, "High Schools and Biological Literacy in the United States", _American Biology Teacher_, XVI (1954), pp. 179-181.

[2] Arnold J. Currier, "Trends in Chemical Education", _Journal of Chemical Education_, XXXII (1954), pp. 286-289.

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CHAPTER I

THE PROBLEM

Statement of the Problem.

It is the purpose of this study to explore the necessity for in-service training of secondary science teachers. As a part of this undertaking an inquiry will be made to ascertain just what the individual science teacher is doing for himself in this respect. Just what is the practicing science teacher doing to keep up with the new developments in science and mathematics in the face of over crowded class rooms, heavy class loads, and low salary scales?

Importance of the Study.

The study is concerned with secondary teachers of all scientific disciplines. Most authorities[1] agree that it is within the vast framework of secondary schools that the scientific flame of youth is either fanned or quenched. Many people do not realize, however, just how much of the desire of secondary school students to avoid science and mathematics classes is due to the difficulties experienced by the poorly prepared teacher, rather than the difficulty of subject matter at hand. It is unfortunate that a secondary teacher often teaches the same way he was taught in formal teachers college training. It would be more tragic, however, if secondary teachers presisted in teaching only what they

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[1] J. D. Dodd, "A Modern Fountain for Youth", American Biology Teacher, XV (1953), pp. 20-21.

learned in teachers college training, especially if that formal training took place many years ago. That science is by its very nature dynamic and that much is added to every discipline involved almost hour by hour can be ascertained by any child who has acquired the ability to read the daily newspaper. It is no wonder that students feel no enthusiasm for the fringed disciplines of 1910, when they can glance out the window and see the streamlined products of modern scientific technology. What then, is being done by those intrusted with the task of kindling the desire of today's youth to excell in today's modern scientific disciplines? More specifically, what are they doing to keep abreast of the newest discoveries in their field?

It is within the scope of this study also to explore some of the more formal methods now being used to help the secondary science teacher keep up with the latest discoveries in his field.

CHAPTER II

REVIEW OF THE LITERATURE

Much more has been written in the literature about the problem of poorly prepared science teachers than about what to do to bring the science teaching competence up to adequate and superior levels.

The science teachers responsibility in up-grading his own training is well stated by Johnson[1] as follows:

> There is a crying need to improve and expand science teaching. Science teaching has been tried and found wanting, the critics say. As science teachers we would agree that all is not well with science teaching, but we may have reasons for this condition which are quite different from those of our critics. Furthermore, we may be of a disposition to resist the efforts of the expediters who give widespread publicity to the defects of science teaching without knowing very much about the factors involved in the actual teaching situations. Who is going to improve science teaching?
>
> We may find a helpful hint if we look at some other groups. Who does the most to up-grade and improve conditions and practices in the legal profession? Who does the most to maintain high standards in the medical profession? Who does the most to bring about improvements in the various trades? We have to admit that the leaders of these groups are well trained. They keep in close contact with new developments, and these groups are well organized.

The need for continuous training by science teachers is well understood by many leaders in the field of science education. It can be readily seen that if science education is to stay abreast of research and technology, then the individual science teacher must feel the

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[1] Philip G. Johnson, "Who is Going to Improve Science Teaching?", Science Teacher, XII (1945), pp. 150-151.

responsibility to constantly study the current research results in his field. An awareness of the need for constant, cheerful curiosity by the science teacher is pointed out by Crummy.[2]

> If we are to believe the many implications of today with its vast production of airplanes and other agents of rapid transportation, to say nothing of the advertiser's dreams, it would appear that tomorrow will be an age of streamlined speed. Our accelerated educational programs suggest that teaching in general and science teaching in particular is being and perhaps must be streamlined to keep pace with material developments. Certainly improvements in teaching and teaching methods as well as skills must be made frequently in order that capabilities of our youth be cultivated to their fullest.

Dunning[3] shows how antiquated teaching methods along with antiquated ideas can drive students from elective secondary science courses. He tells of a case in which a physics teacher could not understand why enrollment was dropping in his classes while he was admittedly teaching from a 1911 outline of a general physics course.

He is very emphatic in stating that we cannot hope for success unless we teach a modern course to modern students.

Riddle[4] further shows that the products of the modern public educational system, especially where scientific literacy is concerned, stand as living proofs of a teaching job poorly done.

Other students of American education are equally disturbed by the scientific illiteracy of the public in general. This lack of understanding concerning basic scientific principles handicaps citizens of a democracy much more than citizens of other forms of government because they must make the basic decisions upon which the country depends.

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[2] Pressley L. Crummy, "Science Teaching for Tomorrow", Science Teacher, XII (1945), pp. 20-21.

[3] Gordon M. Dunning, "The Need for an Improved Program for Training High School Physics Teachers", Science Education, XXXV (1951), pp. 291-295.

[4] Oscar Riddle, "High Schools and Biological Literacy". In the United States, American Biology Teacher, XVI (1954), pp. 179-181.

Dodd[5] shows the college teachers view point. He feels that there is something basically wrong with high school science teaching.

> In my contacts with college freshmen who, after all, were high school students just a few months back, I have come to accept their "go ahead and teach me something, I dare you" look as a stimulating challenge. None-the-less, reasons for the existence of that look cannot be ignored. Nor can one help asking why it is that so many students come to the fountain of science, take a few half hearted sips, and turn away. What has happened to that bouncing, brash, and wonderful curiosity that those same kids had back in the seventh and eighth grades?

Where is secondary science teaching missing the boat in inspiring the youth to work and excell in science studies? In order to partially answer this question it is worth while to examine some views of leaders in science education concerning what is necessary for good science teaching.

Hodges[6] has some positive views on this subject.

> What are the characteristics of the science teacher who can inspire boys and girls of high school age to commit themselves to a career in science? It is essential for him to have the respect of his students if he is to have any influence on their intellectual development. The first step toward obtaining this respect is for the teacher to have subject-matter preparation, experience, and interest in what he is teaching. Effective science teaching demands an appreciation and familiarity with the laboratory approach to science.
>
> But too often such a teacher is unavailable. It is not unusual to find high school teachers attempting to give instruction in subjects in which they have little or no college preparation.
>
> These people are well grounded in professional courses and know how to teach any subject. The text book and a few mediocre films are their only recognizable tools. They can never develop the troubled feeling which plagues the true science teacher when classroom activities rely on books as the authority rather than planned experiments and demonstrations.

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5 J. D. Dodd, "A Modern Fountain for Youth", American Biology Teacher, XV (1953), pp. 20-21.

6 Edith V. Hodges, "The Role of the Secondary School in Science Training", Journal of Chemical Education, (1956) XXXIII, pp. 404-405.

There are several ways in which science teaching could be improved. First of all, of course, would be to obtain teachers who know and love science rather than teachers who "know how to teach science". Although the subject matter, per se, has no particular interest for them. There should be increased opportunities for in-service training for science teachers. Industry and colleges could supply consultation services whereby they (the teachers) could talk over their problems with other scientists. Finally, the prestige of the science teacher should be improved.

Dodd[7] listed nine questions that a science teacher should ask himself in self evaluation. He compared the well of scientific knowledge possessed by the science teacher to a fountain.

1. Is the water in your fountain always clear and sparkling? Do students become thirsty just watching it?
2. Is it free from any taint of bias, boredome or bunk?
3. Is the pressure adjustable, so each student can drink his fill without choking or without becoming disgusted because it flows too slowly?
4. Do you shut off the fountain at 4 o'clock sharp?
5. Can you accept the fact that most of the water goes down the drain and console yourself with the thought that the little which is imbibed has important metabolic implications?
6. Do you have enough well-springs of information so the fountain never runs dry (I do not mean a lesson plan full of busy work)?
7. Are you patient with the eager ones who always manage to fall in the fountain?
8. Can you recognize the timid ones who are desperately thirsty but unable to crowd around a busy fountain?
9. And, finally, do you ever take a little drink yourself, just to see if the stuff is as good as advertised?

Although the leaders in the field of science education (by this I do not imply the usual reference to the school of education) differ on some points as to just what constitutes a good science teacher, they all agree that he must know the sciences well and he must eagerly continue to search for further truths in his field.

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[7] J. D. Dodd, "A Modern Fountain For Youth", American Biology Teacher, XV (1953), pp. 20-21.

Kirk[8] recognized the need for competence in the sciences as well as the need for constant self training.

> A young person with a thorough training in his science with an enthusiasm for subject matter, and with a keen interest in the problems and growth of human individuals will become a good teacher if he has the burning desire to do so.

Edwards[9] contends that a teacher in any science discipline must know a number of others as well as mathematics to be successful as a secondary science teacher.

> Actually a good chemistry teacher must not only know chemistry, he must know other things, too. He needs a solid grounding in physics and at least a nodding acquaintance with geology, and perhaps with other physical sciences. He should have a thorough knowledge of the process of method or philosophy of science. He must have facility with language, since language is used to communicate the abstract concepts of chemistry, and he must have facility with the necessary mathematics. All of this knowledge requires fairly constant revision, revision that demands opportunity for serious conversation with a number of broadly cultivated people.

It would seem from the literature on the subject that many if not most leaders in science education realize the necessity for thorough knowledge of science on the part of science teachers, as well as constant vigil on the part of the teacher to see new concepts of science as they come into view over the scientific horizon.

There is a disturbing evidence that many teachers of science avoid the rigorous path of constant study in science and without any qualms do their post graduate work and workshop training in the field of pure "education".

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[8] Raymond E. Kirk, "And Gladly Teach", Journal of Chemical Education, XXXI (1954) pp. 587.

[9] T. Bently Edwards, "The Summer Conferences", Journal of Chemical Education, XXXIII (1956), pp. 352-353.

Currier[10] shows by a study carried on at Pennsylvania State University that of students taking masters degrees in education fields, only two percent did their major work in the sciences. The study was carried on from 1949 to 1953, and it concerned 1454 candidates for the master of education degree.

Many students of public education, whether they be citizen or scientist, are becoming increasingly disturbed by the trend in teachers colleges to place a minimum emphasis on subject matter training in the field to be taught and a maximum emphasis on pedagogy. This trend is particularly insidious in the training of secondary science teachers. It is much easier to flounder in the frothy verbage of "education" courses and pass with what the "educators" call success, than to acquire skill and knowledge in the exact disciplines of science. The distrubing trend toward slighting subject matter in the teachers colleges today is pointed out by Riddle.[11]

> The short comings of the public schools stem largely from inadequacies in the education of teachers. The center of the trouble in the teachers colleges is their philosophy. The troubles are so radical that correction will come only from outside the traditions and organizations which now control the schools.

So called "education" teaches pedagogy and not education. "Educators" cannot claim more know-how within a particular discipline than those teaching that discipline.

The need for keeping abreast of the latest dynamic trends in the fields of science is pointed out by Blanc.[12] He shows an understanding

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[10] Arnold J. Currier, "Trends in Chemical Education", Journal of Chemical Education, XXXII (1955), pp. 286-289.

[11] Oscar Riddle, "High Schools and Biological Literacy In the United States", American Biology Teacher, XVI (1954), pp. 179-181.

[12] Sam S. Blanc. "Review of the General Goals in Science Teaching", Science Education, XXXVI (1952), pp. 47-52.

of the problem of disinterest as shown by many science students.

> When we consider the fact that we are also living in an age of entertainment, movies, radio, television, comic books, etc. There should be little wonder that children are detracted from the rigorous school work as it is presented by most teachers of science today. Science to the average child is a bug-bear. The mere suggestion of the subject connotes something cold and uninteresting, something that is mastered only with great difficulty, and by individuals with the unusual abilities.

Fitzpatrick[13] showed from United States Office of Education figures that out of 385,434 students graduating from institutions of higher education in the United States for the academic year 1950-51 only 24,000 were in the field of science, and of these only 2,778 were in the field of physics. This is distrubing when the facts of atomic technology are considered. Fitzpatrick further considers that the situation is deteriorating all the time. He bases his observations on other partial reports. He also considered the engineering education situation as significant.

> Why don't we have more engineering students? Objective answers to such queries are not readily available but there are some evidences which strongly suggest that the answer may be found in study of secondary school science programs, and enrolments.

Abbis[14] in preliminary discussion of a study on practices and philosophies of science teachers discussed the nature of and the training and presentation of material by science teachers. He believes that science teachers by the nature of their training in the scientific method should be the first to experiment with new methods and materials. In his study of the philosophies of science teachers in the states of

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[13] F. L. Fitzpatrick, "Scientific Man Power, The Problem and It's Solution", Science Education, XXXIX (1955), pp. 97-102.

[14] Ahmed A. Abbis, "Second Annual Review of Research in Science Teaching", Science Education, XXXVIII (1954) pp. 333-347.

New York, Colorado, California, and New Mexico he found the majority of high school science teachers were likely to accept and to practice educational experimentalism and that nearly one-tenth of the science teachers represented in the survey accepted and were likely to practice educational authoritarianism, whereas nearly all of them rejected educational Laissez-faire. The higher the educational qualifications of the science teacher involved, the more likely he was to endorse and practice educational experimentalism. The load of the science teacher was a significant factor in influencing his philosophy of education (science teachers with a weekly class load of more than 25 classes displayed a greater degree of indifference than teachers with a lighter load). Older teachers were more likely to accept and practice educational authoritarianism than the younger teachers.

Much has been written about the more formal aspects of teacher in-service training in science.

Christian[15] describes a college summer program that is designed to train experienced elementary teachers to teach science. The program is, however, mainly training in use of visual aids, community resources, and formal texts.

Curtis[16] in evaluating replies of 569 science teachers of varying experience and training showed that 459 teachers felt that appropriate opportunities should be provided for the in-service training of science teachers, 57 teachers were of the opinion that such training is unnecessary, whereas 17 were undecided. The teachers responses as to the form in which this training should be presented are graphically shown

[15] Wayne G. Christian, "Teaching Teachers of Elementary Science", Science Education, XXXIV (1950), pp. 261-262.

[16] William C. Curtis, "The Improvement of Instruction in Elementary Science", Science Education, XXXIV (1950), pp. 235-238.

below.

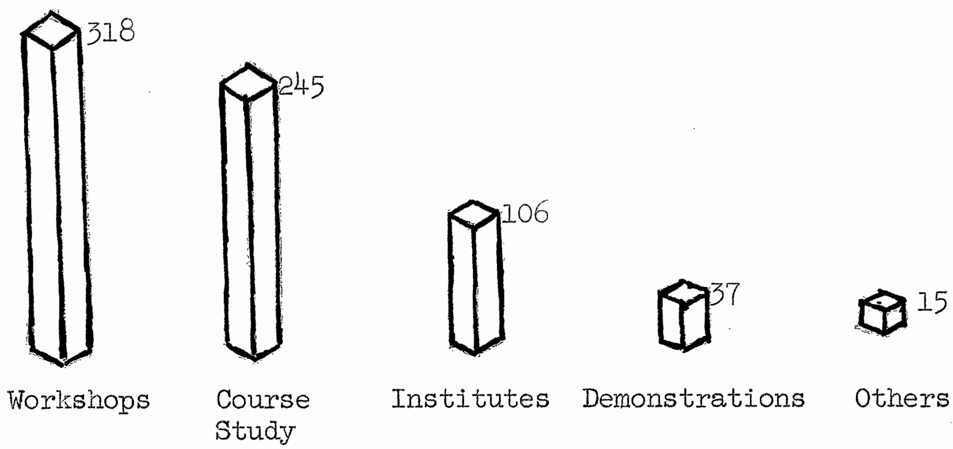

Figure 1

Preferable Forms of In-Service Training

Curtis also gives a detailed list of the responses to the question of needs in in-service training in science. The responses are given in the table below.

Use of Invironmental Material	387
Laboratory Experience	371
Laboratory Constructions	365
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Table 1

Responses of 569 Teachers to the Question of Needs in In-Service Training in Science

Curtis in his study was well aware that other factors were concerned in teaching performance besides a lack of sufficient training. This fact was shown in the conclusion reached in the study.

> The data at hand does not take into account the effects of such factors as the overwhelming demands of so many subjects and activities and so much clerical work on the teaching program. Nevertheless, it is apparent that one of the major flaws in the local program is a lack of sufficient training on the part of many of the science teachers for their work in science. The teachers are for the most part well aware of this fact.

The value of summer workshops as in-service training tools was aptly stated by Bingham[17] who stated concerning summer workshops.

> I know of no other organization than a workshop, which could provide an effective learning situation for a group with such divergent backgrounds. Science teachers have such divergent backgrounds.

The work shop conducted by Bingham helped the science teachers in different ways. One significant result of a questionaire filled out by the members of the workshop at its close was that only nineteen out of eighty science teachers felt that subject matter in the experiments and latest trends in science was of significant value to them.

Dunning[18] points out the need for science teachers to keep up with the progress in their fields.

> To point up the great need for improving our program of training high school physics teachers, let me first briefly review a part of the certification law of Pennsylvania. A student may go into the public schools of Pennsylvania and teach physics if he has completed as little as three hours of college physics plus twelve hours of any science. This can be completed with a "D" grade and still be acceptable. (Incidentally, no mathematics is required for certification).

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[17] N. E. Bingham, "Workshop for Science Teachers", Science Education, XXXV (1951), pp. 177-184.

[18] Gordon M. Dunning, "The Need for an Improved Program for Training High School Physics Teachers", Science Education, XXXV (1951), pp. 291-295.

Ferguson[19] made a study of the public schools of Ohio which revealed that about one-half of the science teachers in the state did not meet the minimum requirements for certification. If Ferguson's study is near correct then the need for in-service training in science teaching is a very pressing need.

The literature is more specific about the need for in-service training than about specific proposals of just what is to be done about it. A case in point is Johnson's[20] discussion of the needs and short comings of science teachers.

> Great numbers of science teachers are submerged in an ocean of details. Large classes, laboratory sections experiments to be arranged and tried out, equipment to be cleaned up and put away, textbook outlines frayed through wear, lost and found articles, class parties, football ticket-taking, assembly programs, and dozens of other items might be listed. Such details coupled with traditional methods make the educational media for the pupils cloudy if not murky. There are reports, now and then, of new materials and procedures and these reports are eagerly discussed by a few teachers, but there isn't much change in what happens in the school.

The problem of determining the extent of the secondary science teacher's classroom short comings is difficult to determine. Some investigators have been quite ingenious in formulating methods of determining classroom competence.

Abbot[21] points out a correlation between the biology teachers grasp of his subject and his use of live specimens. He investigated the biology teachers methods by means of a questionaire. He used equal distributions of high school sizes from 200 students upward. He investigated one

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[19] Thomas Curie Ferguson, "Second Annual Review of Research in Science Teaching", Science Education, XXXVIII (1954), pp. 333-347.

[20] Philip G. Johnson, "Todays Need for Better Science Education", Science Education, XXXIV (1950), pp. 310-317.

[21] Cyril E. Abbot, "Do Biology Teachers Use Live Materials", American Biology Teacher, XV (1953), p. 15.

thousand teachers. The results he obtained are shown below in the form of a graph, which shows the percentage of biology teachers relying on various types of specimens, slides, and charts.

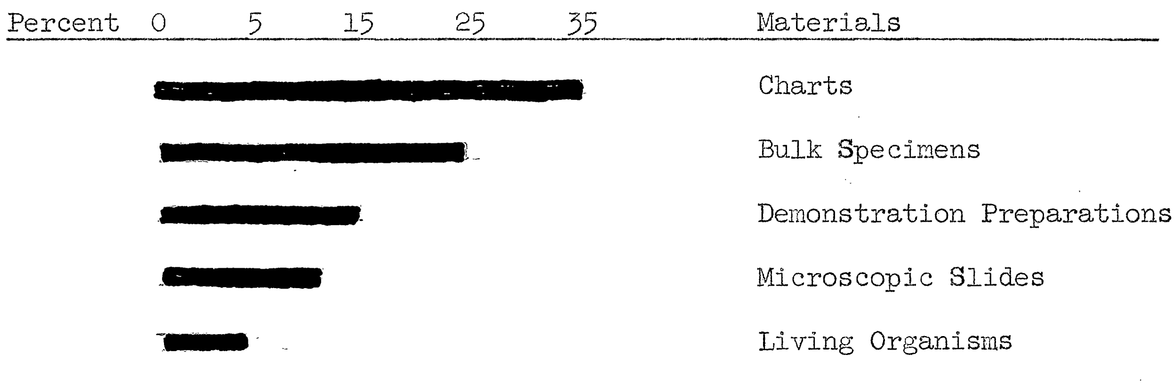

Figure 3

Comparison of Teaching Materials Used by Biology Teachers

If the better prepared biology teachers use live organisms in their teaching of biology, then it will be seen that only eight per cent of the biology teachers investigated are of this desirable type; however, it must be pointed out that this criterion alone cannot be the only source of judgement in evaluating a teachers effectiveness.

CHAPTER III

THE MATERIALS USED AND GROUPS STUDIED

This study is an attempt to find out in a preliminary way the scope of a very important, and perhaps the most important reason for the staggering drop in students in elective science courses. It is not meant to be in any way the last word on the problem at hand. If it can stimulate other investigations into the heart of listless teaching and bored student response then it has served its purpose. The main concern of this investigation is a search of the literature in connection with the need for in-service training of high school science teachers, however, a further investigation was made to determine the needs and opinions of practicing science teachers. The investigation of individual science teachers was conducted by informal interviews and discussion groups. The largest group discussion involved was twenty-five National Science Foundation students selected to take a year of advanced study to bring them up in their weaknesses in science. The modern trends in science were also emphasized in their advanced study.

A total of forty National Science Foundation students as well as fifteen other secondary science teachers were involved in the science teacher praticipation phase of the investigation. The science teachers involved were selected only because of their contact with the investigator, however, eighty per cent of the teachers involved were from small or medium sized high schools.

The discussions and informal interviews were centered around four questions, but they were by no means restricted to them. Many teachers had strong sentiments on the subject at hand and they were encouraged to express them. The questions used as the center of the interviews were:

1. Do you have any kind of system, formal of otherwise, for keeping up with the advancements in your field? What is your method?
2. Do you feel that you do enough toward keeping abreast of the latest findings in science?
3. If you could find the time and money what more would you do to keep up with modern science training?
4. What do you think is the science teachers most pressing need in the way of in-service training?

The informal method used has many drawbacks not the least of which is the personality of the interviewer. If the interviewer is biased toward some particular view, he may tend to draw out answers to back up his view. There are also some advantages to this method. The discussion may reveal more than could be hoped for otherwise. It was intended in the study at hand that the interviewer had no preconcieved ideas concerning the interview questions.

The search of the literature was attempted with no idea as to what had been written concerning science teacher in-service training. The investigator knew nothing of science educator's views on in-service needs or methods. The investigation was restricted to literature concerned with science education in the different disciplines. Whereever possible the literature search was restricted to secondary science teachers problems and training.

CHAPTER IV

RESULTS OF THE STUDY

The investigator in this study started with the exalted belief that he was the only person who was really interested in the academic short comings of secondary science teachers. He was very quickly and very rudely brought to the realization that not only are most, if not all, scientists deeply concerned about the problem, but many ordinary citizens are deeply concerned also.

These facts serve to keep investigators in their place, but the most gratifying and hopeful finding was that every secondary science teacher contacted by the investigator was deeply concerned with his own academic weaknesses and those of his colleagues.

The most encouraging part of the entire study was that no teacher interviewed felt that he was doing enough to keep abreast of his field. The main reason given for not doing more about keeping up in their particular discipline was over-crowded teaching schedules. Twelve secondary science teachers in addition to heavy teaching loads were athletic coaches. Five were teaching principals. Seventy per cent of the secondary science teachers felt that they were handicapped in their formal pursuit of a better professional background by the low prevailing salary scale in an inflated economy.

All of the science teachers involved felt that they were doing at least something toward digesting the latest technical progress.

The secondary science teachers contacted ranged from almost disinterest in the latest research to flaming zeal with all gradations in between. Eighty-four per cent of the teachers contacted felt compelled toward continuous scientific growth. They agree, however, that due to a multiplicity of fatigueing factors such as public scorn, heavy teaching loads, and rewards somewhat below the union scale, they found quite a spread between their intentions and their performances.

The science teachers varied as to just what they were doing to keep from being left behind as the new discoveries in science are being put into our technology. The methods vary from a casual scanning of semi-technical literature to weekly or bimonthly system wide meetings with an invited authority on some phase of the latest research in the discipline involved. Only eight of those contacted, however, were fortunate enough to be in such systems. The remainder had to rely on the literature and personal research. All of the science teachers contacted had been involved in summer training of a work-shop or summer term nature beyond the degree level.

As to the question of what would be done in the way of training if the time and money could be found, the responses were of two general classes. Twenty-six teachers had a preference for better training in laboratory and class room presentation. Twenty-nine teachers wanted more training of a basic and advanced modern nature in the sciences.

In response to the question as to the basic in-service need of the science teacher the consensus of opinion was that the majority of science teachers need a better concept of the subjects that they are teaching as well as at least some training in more interesting presentation methods.

The literature shows a decided concern about secondary science teaching. Most scientists concerned with science education feel that teacher training is basicly unsound especially where subject matter in the sciences is slighted for many dull hours of pedagogical training. The certification laws have allowed many teachers with little if any science training to teach science.

CHAPTER V

SUMMARY AND CONCLUSIONS

The haunting feeling persists that more studies should be carried out in this basic phase of science in-service training. Whether the teacher involved resorts to self training or training of a more formal nature makes little difference. The fact remains that if he is to be of interest and value to his students he must teach new concepts to new generations: Even though the selective nature of the group involved limits the value of the present study, there seems to be little doubt that at least something is being done by the secondary teacher himself to keep abreast of the scientific times. The fact that no teacher involved was satisfied with his performance or present state of knowledge was the most healthy sign revealed by this study. The science teacher of today is more aware of his short comings and less willing to compromise his class room performance than at any time since the modern "education" philosophy swept through the public school systems. It should be pointed out here, however, that even though there are healthy signs, many phases of secondary science education are still weak. Some of these weaknesses are basic to the secondary school system as a whole. The National Science Foundation as well as many more restricted organizations deserve much credit for formal attempts to better the quality of science know-ledge of the science teacher.

This study has included in the term science, the discipline of mathematics. The discipline of mathematics is undoubtedly of more value on the secondary level to the college bound student than any other discipline. Indeed, the other sciences would have little to offer without the tool of mathematics.

Many older concepts of science are of as much value today as they were yesterday, therefore this study is not meant to imply any ridicule of the basic concepts. The nature of this study does not emphasize the older concepts of science. It is mainly concerned with the newer discoveries.

The science teacher who stays with the often thankless task of inspiring the youth, while his comrades desert him for greener pastures, and fortune leaves him penniless and almost destitute, deserves more credit than the public or his more fortunate colleagues have as yet been willing to give.

The fact that he cheerfully struggles on in the face of adversity proves that spiritual evolution is more of a dynamic factor than many people are willing to admit.

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