Name: Willard William Korth Date of Degree: May 25, 1958

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: THE PLACE OF PHYSICS IN SECONDARY EDUCATION

Pages in study: 30 Candidate for Degree of Master of Science

Major Field: Natural Science

Scope of Study: During the last few years there has been an increasing awareness of the inadequacies of present-day teaching of physics in the American secondary school. The traditional physics course has been subjected to much criticism and concern has been expressed in many quarters over its deficiencies. The purpose of this report is to consider some of the criticisms which have been leveled at the teaching of physics at the high school level and some of the suggested means for its improvement. This has been done by surveying some of the literature which has been written in the last few years by prominent educators and scientists regarding this subject. The report covers briefly the history of physics teaching in the United States, a review of some statistics on the enrollment in high school physics and a discussion of the aims and objectives of physics teaching. The present status of physics teaching is evaluated with consideration of the physics teacher, the course content and methods of teaching. The work of the Physical Science Study Committee is reviewed and consideration is given to the use of the general physical science course.

Findings and Conclusions: The diversity of opinion encountered in reading current material seems to indicate that the problems are complex and that there is no simple solution to the problems facing high school physics courses. This report does not attempt to suggest any such solutions but concerns itself with apparent trends and some of the more commonly expressed ideas. Most critics seem to agree that there is need for a change in many aspects of the physics curriculum but specific suggestions on what these changes should be vary greatly. Surveys indicate that there has been a steady decrease in the percentage of high school students taking a course in physics. Most critics agree that the conventional physics course tries to cover too much material and chooses that material unwisely. The key to the problems probably lie with the physics teacher himself. There is a great need for improvement in the status and qualifications of the secondary school physics teacher. The Physical Science Study Committee has proposed an interesting and entirely new type of physics course which they hope will answer many of the needs of high school physics.

ADVISER'S APPROVAL James H. Zant

THE PLACE OF PHYSICS IN SECONDARY EDUCATION

by

WILLARD WILLIAM KORTH

Bachelor of Arts

Wayne State Teachers College

Wayne, Nebraska

1950

Submitted to the faculty of the Graduate School of
Oklahoma State University
in partial fulfillment
of the requirements
for the degree of
MASTER OF SCIENCE
May, 1958

THE PLACE OF PHYSICS IN SECONDARY EDUCATION

Report Approved:

James H. Zant

Thesis Adviser

Robert MacVicar

Dean of the Graduate School

ACKNOWLEDGEMENTS

The writer wishes to express his sincere appreciation to the National Science Foundation for making this years work possible. The writer also wishes to express his sincere appreciation for the helpful guidance of Dr. James H. Zant, Professor of Mathematics, which has culminated in the presentation of this report.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

During the last few years there has been an increasing awareness of the inadequacies of present-day teaching of the physical sciences in secondary schools. The dissatisfaction is general, and efforts to improve the situation have generated various views concerning the fundamental purposes of science teaching, the material to be taught, and the teaching methods.

Renewed interest in the science of the secondary school program is evident today. Many citizens recognize that science and the applications of science have a profound relationship to their living. Professional societies concerned with our supply of scientists and engineers are interesting themselves to a considerable extent in attempting to shape the secondary school curriculum to meet the needs of students interested in science and technology. Organizations in professional education are concerning themselves on a broad basis with the nature of the curriculum and with the improvement of curricular offerings. Organizations of science teachers are showing concern for the problems of the field. The launching of the Russian satellite has done a great deal to arouse the American public to the realization that there is a need for improvement in many phases of our educational system.

The purpose of this report is to consider some of the criticisms which have been leveled at the teaching of physics in the secondary school and some of the suggestions which have been made for its improvement. This has been done by surveying some of the literature which has been written in the last few years by prominent educators and scientists regarding this subject. Criticism has not been limited to educators and scientists. Politicians, businessmen and many plain citizens have become concerned with the challenge to the scientific and technological supremacy of the United States. Today's newspapers and magazines contain many articles commenting on the present state of our system of education. A majority of the writers agree that there is need for improvement but specific suggestions on how to achieve these improvements vary greatly.

The diversity of opinion encountered in reading current material makes it obvious that the problems are complex and that there is no simple solution. This report will not attempt to suggest any such solution, but will concern itself with apparent trends and some of the more commonly expressed ideas.

The report will first survey the history of physics teaching in the United States, with the hope that a review of the past will give a better insight into our present situation.

Since the objectives of physics teaching have been subjected to a great deal of scrutiny, the report will try to survey the traditional objectives of physics teaching. Special attention will be given to determining if these objectives have been achieved in the traditional physics course and whether these objectives apply to our modern concept of education.

The report will then attempt to evaluate the present status of physics teaching in the United States. This will be done by considering some of the more common criticisms of our present secondary school physics course. This will include a review of course content, methods of teaching and the status of the physics teacher.

The remaining portion of the report will consider some of the suggested ways of improving physics instruction. Special attention will be given to a look at the general physical science course and to the work of the Physical Science Study Committee.

The report is designed to present a study of the place of physics in the secondary school curriculum. Traditional physics has been subjected to much criticism by advocates of "modern" education and by many college and university physics instructors who have found that many of their students are poorly prepared for college work in physics. The extent of this criticism demands that the high school physics teacher take a good look at his methods of teaching and the content of his course. It is hoped that this report will help to understand the importance of teaching physics and suggest methods by which physics instruction may be improved.

CHAPTER II

THE HISTORY OF HIGH SCHOOL PHYSICS

In order to fully understand the problem it is necessary to review the development and evolution of physics in the American secondary school. Science as a secondary school subject was apparently first taught in the public academies. The first of these academies was begun by Fenjamin Franklin in Philadelphia in 1751, its announced purpose being to provide practical education. His academy included in its curriculum a course in natural philosophy whose content evolved, in part, into present day physics; another part of the course included content from earth science and astronomy. Even though academies were established with utilitarian values in mind, over a period of a few decades they evolved into college preparatory institutions.

The first high school was established in Boston in 1825. The curriculum of this school included natural philosophy, chemistry and natural history. Science in the high school at that time included little or no laboratory work and few demonstrations. There was emphasis on the learning of facts. The primary objective was the acquiring of information that seemed to have practical value, although it was believed that nature study also served to reveal the glories of God. Initially there was no particular emphasis on college entrance requirements, the high school having been planned to meet the functional needs of young people.

The acceptability of high school science courses for college entrance was announced by Harvard College in 1872; other colleges soon followed suit. Following this statement of the acceptability of high school science courses the colleges and universities soon provided lists of acceptable and required experiments. These institutions also provided courses of study and syllabuses to be followed as prerequisite to college entrance. Soon many colleges were requiring courses in science for entrance. Added to such factors as the courses of study and the lists of required experiments was the influence of the science teacher who brought to his work in the high school a fresh recollection of his experiences in college. Perhaps unconsciously the high school physics course became an imitation of the college course with reduced content. This natural tendency was encouraged by the entrance requirements of the colleges and universities, with the result that before many decades had passed the domination by the college was quite strong.

Since 1900 the formal domination of high school science by the colleges has diminished. The high school has become the general or common school, being a required experience for a large majority of the nations children. As a general school, the secondary school's major function is to serve the needs of young people in all aspects of their living. This point has become one of the major areas of contention in the criticism of the present high school physics situation. Many of the critics have contended that secondary school physics has retained too much of its college preparatory characteristics and in its traditional form does not provide for the needs of a majority of the present high school population. This question will be further explored in one of the following chapters of this report.

In 1900 the physics syllabus consisted essentially of Newtonian physics and was divided into the traditional areas of mechanics, light, sound, heat and electricity and magnetism. Since that time the syllabus has remained essentially the same with the addition of what is generally called "modern physics" which covers some of the newer discoveries in the field. In addition to this more and more modern technology has been added.

In recent years many schools have introduced subjects related to physics under such titles as senior science, applied science, physical science, applied physics, photography, electricity, household physics and aeronautics. These have been an attempt to teach many of the principles of physics in a form related to the everyday experiences of boys and girls. The development of this group of subjects is one of the best indications that physics in its traditional form does not meet the educational needs of many students.

CHAPTER III

ENROLLMENT IN HIGH SCHOOL PHYSICS

Surveys on the enrollment in secondary school physics have shown that although the number of students who take high school physics has increased in the last few decades the increase has not been in proportion to the increase in over-all high school enrollment. The surveys do not agree in the extent of decrease but they show that there has been a gradual but definite drop in the percentage of secondary school students taking physics since 1900.

Much publicity has been given in recent years to the fact that enrollments in high school physics have not been increasing along with total high school enrollments. In fact, in the October, 1957 issue of School Science and Mathematics, Summerer[1] has reported that physics enrollments have been decreasing for the last six decades. This report stated for instance, that in 1895 23% of all high school students were enrolled in physics and that 95% of the students that graduated that year had taken a course in physics. This becomes rather startling when it is pointed out that in 1952 only 4.3% of all high school students were enrolled in physics and about 21% of that years graduating class had studied physics. This low percentage of students enrolled in physics,

---

[1]Kenneth H. Summerer, "Some Suggestions for Unifying High School Physics Around the Concept of Energy," School Science and Mathematics, October, 1957, p. 536.

when viewed along with the well publicized national problem of the shortage of scientists, makes it necessary to scrutinize the curriculum of high school physics.

Dees[2] also comments, "Although the studies available relative to high school physics enrollments over the past several decades are somewhat less than adequate, there seems to be rather convincing evidence that there has been a significant drop in the percentage of high school students taking physics in this country since 1900." Mallinson[3] in 1955 reported that less than one-half of the secondary schools in the United States offered physics.

The Board of Directors of the National Science Teachers Association[4] in a study published in 1957 took a more optimistic view of physics enrollments. Using data compiled by the United States Bureau of the Census and from publications of the United States Office of Education they presented the comparisons reproduced below in part.

	HERE ARE SOME COMPARISONS	1900	1954
(a)	Total youth aged 14-17 in U.S. population	6,131,000	9,011,000
(b)	Total enrollment grades 9-12	500,000	6,500,000
(c)	Actual enrollment in high school physics	98,846	302,800
(d)	Per cent (c) is of (a)	1.6%	3.4%
(e)	Per cent (c) is of (b)	19.0%	4.6%

The writers of this article pointed out that there has been a

[2]Bowden C. Dees, "Some Current Problems and Needs in Science Education," American Journal of Physics, December, 1956, pp. 616-623.

[3]George G. Mallinson, "The Role of Physics in the Emerging High School Curriculum," School Science and Mathematics, March, 1955, pp. 211-216.

[4]Board of Directors of the National Science Teachers Association, "On the Target," The Science Teacher, April, 1957.

200 per cent increase in the actual enrollment in high school physics, although the percentage of those taking physics when compared to the total enrollment has decreased from 19 per cent to only 4.6 per cent. This report also stated that although about 23 per cent of the high schools in 1954-55 offered neither chemistry or physics; these schools enrolled only about 5.8 per cent of all high school students. It thus appears that nearly 95 per cent of all students reaching the twelfth grade have the opportunity to take chemistry and physics.

It is apparent from these studies that the popularity of physics as a high school subject has been decreasing. Many theories have been advanced in an attempt to explain this decrease in enrollment. Most of them are related to the basic objectives of teaching physics and the fundamental nature of our educational system and educational philosophy. One of the more obvious reasons can be found in the increased number of elective subjects the high school student of today is allowed to take. Dees[5] believes that this situation has caused some students, who under different circumstances might have become productive scientists, to take vocationally-oriented courses directed toward training salesman, printers and mechanics. He argues that it is often, if not always, unwise to allow ninth grade youngsters to determine irrevocably their future careers through electing with little or no guidance special terminal courses upon entry into high school.

Others have placed the blame squarely upon the course itself. They contend that the course, as it is usually taught, does not meet the needs of many students and is avoided as having little meaning or

---

[5]Dees, p. 617.

value to them. Hurd, in a strong denunciation of the traditional physics course has said;[6]

> One of the most incongruous situations in secondary school science is to be found in the teaching of high school physics. As a science physics has played an important and dynamic role in the development of our scientific age yet it is the most likely subject to be eliminated from the high school curriculum within the next decade as a separate science. A review of the data seems to indicate that physics with its traditional objectives, organization and content has lost its place as a high school subject. It does not fit into either the high school or college pattern for modern education. Over fifty years of continuous emphasis on the need to make high school physics more functional in terms of the everyday life of the learner has been largely ignored by those responsible for elementary physics courses.

It appears that many students who could benefit from taking the physics course in its present form are not doing so. The need for improved guidance in the secondary school is evident. It seems that the public and educators themselves have not been "sold" on the importance of physics and that this attitude is reflected in the decrease in enrollment.

---

[6] Paul DeH. Hurd, "The Case Against High School Physics," <u>School Science and Mathematics</u>, June, 1953, pp. 439-449.

CHAPTER IV

THE AIMS AND OBJECTIVES OF PHYSICS TEACHING

Who should take high school physics? This is a question which must be considered in determining the aims and objectives of the high school physics course. In the previous chapter it was established that a relatively small percentage of the high school students take a course in high school physics. This group is made up essentially of the brighter students, most of them preparing for college entrance. Physics is avoided by most of the secondary school population as being too hard or because it does not apply to their daily living.

Recently many scientists and educators have asserted that a knowledge of many of the principles and subject matter of physics has become necessary to any intelligent citizen. The areas of science in which greatest progress have been made in the last few years (rockets, jets, television, electronics, atomic fission, thermonuclear fission) and which demand of the layman more and more attention, require a knowledge of physics. Mallinson[7] has stated, "The physicist and teacher of physics must realize that the study of physics is of value for many persons other than the genius, the college bound and the future physicist and physics teacher." Friedman[8] expressed a similar idea when he wrote, "The history of discovery and invention in physical science is

---

[7] Mallinson, p. 212.

[8] Francis L. Friedman, "A Blueprint," The Science Teacher, November, 1957. pp. 320-332.

> interwoven with all human history, and our picture of the physical world is one of the triumphs of thought. Both the present picture and the story of how we are extending it are an essential part of our culture. We need some understanding of both the state and the process of physical science to live effectively in our world. The future lawyers, doctors, politicians, and "candlestick makers" should have an opportunity to learn how science evolves.

Several studies of the objectives of science teaching have been made. These reveal a wide variety of goals, some stated very specifically, others quite generally. However justifiable they may be, from the standpoint of the classroom teacher such lists suffer from their lack of conciseness. In spite of the possible variety and complexity of the statements of objectives which science teaching can serve, it should be possible to formulate a relatively simple series that can be used by the teacher. The acceptance by the science teacher of some series of objectives is necessary if his teaching is to have direction. It is relatively easy for the teacher to accept as his goal the surveying of enough information by the students to enable them to answer from memory a minimum percentage of the questions on an examination. But many teachers will not accept such a limited goal.

Richardson[10] has listed six objectives for science teaching in general but which apply very well when considering physics alone. He has hypothesized that the science teacher should teach in such ways that the student will:

1. Develop the ability to think critically, to use the method of science effectively.

2. Acquire the principles, concepts, facts, and appreciations through which they can better understand and appreciate the nature of

---

[10] John S. Richardson, Science Teaching in Secondary Schools, (Englewood Cliffs, N. J., 1957), pp. 8-9.

the earth, its inhabitants, and the universe.

3. Use wisely and effectively the natural resourses of our earth as well as the products of science and technology.

4. Understand the social function of science and think and act in relation to the implications of science and technology for society.

5. Develop understanding that will contribute positively to their physical and mental health and their recreational interest.

6. Acquire information, understandings, and appreciations that will contribute to their educational and vocational guidance.

In defining the functions of science in the adjustment of the individual, Heiss, Obourn and Hoffman[11] have set forth what to them would seem to be the major goals of science teaching. They are to develop;

1. A fund of interpretive understandings.

2. A fund of appreciations.

3. A group of attitudes or mind-sets.

4. A method of attack on problems.

These lists of objectives show that science instruction must do more than teach factual material. It must be concerned with the values of science materials as they may help the individual to interpret and adjust himself to the problems of modern living which have technological implications.

Many critics of high school physics have emphasized that a high school course in any science cannot be vocational preparation. Dees[12]

---

[11] Elwood D. Heiss, Ellsworth S. Obourn and C. Wesley Hoffman, Modern Methods and Materials for Teaching Science, (New York, 1940) pp. 9-18.

[12] Dees, p. 617.

considers one of the major problems in science education today to be over emphasis on the contribution which a specific science course can make to vocational preparation of students taking the course. Especially in high school, science courses should aim to be something more than pre-professional courses for future scientists.

Teaching high school physics with the sole aim of preparing students for work in college has also been subjected to a great deal of comment. Many college physics instructors seem to feel that even a good physics course in high school has little, if any, effect on the work done in college. Some have even gone so far as to suggest that it does more harm than good. Dees in commenting on the decreasing enrollment in high school physics has said;[13]

> A few years ago when I was teaching physics to freshman engineers this (eliminating high school physics) would probably have struck me as being good news, for I often felt that the problem of knocking out of some students minds misconceptions acquired in high school physics courses was more difficult than teaching them from a fresh start when they got to college. I suspect that quite a few college physics teachers still feel much the same way. However, more considered judgment suggests that to remove physics from the high school curriculum would be an extremely unwise step lest many youngsters who do not go to college be denied the opportunity of learning any physics - at least while they are in school. Furthermore, if available studies are trustworthy, the motivation for a large fraction of students who eventually become physicists receives its major impetus from high school courses in physics. Although one way of eliminating inept teaching of physics in high school is to eliminate all teaching of high school physics, in my view this is a case of the cure being worse than the disease.

In surveying the aims and objectives of the physics course it can be seen that the teacher is faced with two distinct groups of students, the college-bound and the students who will terminate their formal education when they graduate from high school. In considering the goals

---

[13]Ibid, p. 620-621.

of the physics course the teacher must consider the needs of both groups. The question then arises, "Can a single course possibly meet the needs of both of these distinct groups?" Some educators and scientists believe that this can be done. Dees[14] has suggested that one of the ways we should consider modifying our thinking about science education is in the direction of humanizing science, of making it accessible to all future citizens and not solely or chiefly to those planning careers in science. The likelihood of freely accomplishing one of our major educational tasks in science - encouraging more able students to consider science as a career - would at the same time be tremendously increased.

[14] Ibid, p. 622.

CHAPTER V

THE COURSE CONTENT

With the possible exception of the physics teacher himself, the phase of physics instruction which has been subjected to the most discussion and criticism has been the course content. It has been variously described as being, "Outmoded", "Too cumbersome and voluminous for effective teaching", and as consisting of "Eighteenth century physics with twentieth century technology".

Hurd has described the typical physics course in the following manner.[15]

> Physics courses and their organization are about the same now as fifty years ago. The volume of content is greater for each topic, but the five major divisions remain the same. The most notable innovation is a sixth section to many physics books, variously called, but all implying something described as "modern physics". This section is usually found at the end of the textbook. The standard content of high school physics is being and has been rejected by students and curriculum advisers for decades. Yet it persists, where physics is still offered.

In discussing the problems which are of greatest concern in regard to the secondary school syllabus, Little has described it in this way.[16]

> Structurally it goes back to the early part of the century, and despite the adjustments of the past five decades it represents quite clearly the state out of which science was even then beginning to pass. The syllabus is built around Newtonian me-

---

[15]Hurd, p, 445.

[16]Elbert P. Little, "From These Beginnings," The Science Teacher, November, 1957. pp. 316-317.

chanics, which ruled physics for more than two centuries. The universe, as the physicist then saw it, was a Newtonian universe. A diagram of the solar system constituted a most appropriate frontispiece for a textbook on physics, for the universe as a whole was the solar system in the large, just as atoms and molecules were the solar system in the small. Accordingly, the course began with statics, went on to kinematics and dynamics, and in the light of these disciplines undertook to explain, one after another, heat, light and sound. Such an organization of the subject was beyond criticism; it had a logical unity and it reflected both the current state of knowledge and the general attitude of the physicists.

Since the beginning of this century physics has thrust out much wider roots. Quantum theory and relativity have been postulated and developed; wave mechanics has come into being and recreated the physicists basic outlook; attention has shifted from the particle to the atom, and then to the nucleus. Newtonian mechanics has lost none of its significance, but its status has changed; it no longer represents the manner in which the physicist regards his universe.

The physics syllabus could not possibly remain isolated from all these changes. As the science developed, the new subject matter was interpolated or added, as seemed most suitable. Technology was crowded in where it seemed pertinent. Textbooks grew in size and consequently diminished in comprehensibility. Because Newtonian mechanics rapidly ceased to serve as a unifying concept, the subject compartmentalized; physics became several distinct and disconnected subjects - mechanics, optics, heat, sound, electricity, the atom, the nucleus - grouped into one for pedagogic purposes.

For some time, scientists and educators have been aware that this altered state of affairs is inadequately represented in secondary education. They contend that the conventional physics course must be changed to more adequately represent the true nature of physics today.

Little in discussing the need for revision of the physics curriculum has said;[17]

> The teaching of science in the secondary school has indeed changed, and changed substantially, in the last half century, both in content and technique. But on the whole, the changes have consisted in additions to the structure that existed 50 years ago, or in alterations to the existing structure. Lately there have been intimations that this piecemeal reconstruction has long since failed in tis purpose; that a new structure is now necessary; and that it must be designed from the ground up.

He further asserted that since none of the tremendous volume of material now contained in the physics course could be covered as well as it shou d be in the time at the teacher's disposal, the temptation has grown to shift the emphasis from the science to the technology. The student could then be given, at the least, some insight into the workings of an internal combustion engine, a refrigerator, a radio, and (more recently) a space ship, thus answering at least to the superficial interests of the student and rendering the subject matter manageable. Under circumstances such as these, the task of the science teacher has become increasingly onerous. More and more, he teaches a subject that he himself does not recognize as science. If the brighter student is momentarily challanged to look upon the wider aspects of science, the syllabus is too hurried and too episodic to enable him to grasp any phase of it.

Several surveys were recently taken by educational groups all over the country. A special survey of physics textbooks was carried out by the American Institute of Physics, the American Association of Physics Teachers, and the National Science Teachers Association. All surveys reached the conclusion that high school physics courses present too much

---

[17] Ibid, pp. 316-317.

material, and choose that material unwisely.

In the report of a conference sponsored by the American Association of Physics Teachers[18] the following statement was made;

> The conference felt most strongly that physics teachers must reduce drastically the number of topics discussed in introductory physics courses. A more critical and parsimonious selection of content would permit a pace that encourages both reflection on the part of the student and a proper regard for depth and intellectual vigor. Physics as a body of knowledge, is now too extensive to receive adequate general coverage in an introductory course. The instructor must not sacrifice depth and understanding to cover too many topics in encyclopedic fashion.

Granting that the high school physics course contains much more than can be effectively taught, the physics teacher is then faced with the problem of determining what parts of the traditional course can be eliminated. Here he receives little help from the conventional textbook. He must therefore determine what parts of the course are basic to the understanding of the field. A conclusion reached by many writers seems to be that it is much better to teach a limited amount of material well, than to try to cover a larger amount less rigorously.

The importance of the individual teacher cannot be over emphasized. In any analysis of the effectiveness of a course it must be concluded that any course can be no better than the individual that teaches it.

In an attempt to summarize the concensus of opinion regarding the course content of high school physics we can make the following statements: The amount of accumulated physical knowledge has grown rapidly, but the time available for teaching it in high school has remained the same. The attempt to continue to survey the entire field of physics in

---

[18] Conference sponsored by the American Association of Physics Teachers, "Improving the Quality and Effectiveness of Introductory Physics Courses," American Journal of Physics, October, 1957. pp. 420-421.

a one-year course has resulted in a loss of depth and coherence. Since the course cannot illustrate the development of ideas for shortage of time, it is filled only with results of physics and laws to be learned by rote or through mathematical formulas. It becomes hard to understand and of limited interest. To enliven it, technological applications are often added and thus the bulk of material to be learned is further increased. The tendency to dress up science with the applications of its developments may stress its practical value, but further dims its cultural aspect. It fails to show science as a human activity, as the product of human thought. All the results surveyed in physics were obtained through the mental process of human beings; all the laws expressed by dry words and mathematical symbols were arrived at by men who possessed in high degree such human attributes as vivid imagination, power of abstraction and synthesis, perseverance and patience. Many critics believe that much of this is now lost in a high school course.

CHAPTER VI

THE PHYSICS TEACHER

The shortage of well-qualified science teachers in secondary education has been an acknowledged fact for some time and concern has been increasing in recent years over this situation. The reasons for this shortage are obvious, the chief reason being that other occupations are much more financially rewarding to those well-qualified in science. The National Science Teachers Association[19] has reported that in 1955 the number of new teachers prepared and available to teach physics was 50 per cent of the number who could have been employed. In addition to this they reported that only 56 per cent of the newly certified science teachers graduating in June of that year actually accepted jobs in September. Of those who did not enter teaching, many took jobs in industry; some entered military service; and a few continued with graduate studies.

The fact that a great many of the individuals who are now teaching high school physics have inadequate preparation in that field must also be considered. One of the reasons for this can be seen in the fact that in most schools the physics teacher must also teach a variety of other subjects. In preparing for a career as a science teacher, the college student is obliged to spread courses over a variety of broad

---

[19] Board of Directors of the National Science Teachers Association, "On the Target," The Science Teacher, April, 1957.

fields. The future physics teacher must take several courses in physics, chemistry and mathematics. In addition to these it is desirable that he have at least a minimum of knowledge of biology, geology and astronomy. As a result of this diversity the student ends up with little more than the introductory course in each field. While the future history or English teacher can concentrate on a particular field, the science teacher finds this impossible.

Individual teachers who might like to improve the physics course are usually prevented from doing so by the existing conditions; science teachers are usually overloaded with work; they must not only teach, but also plan, set up, and dismantle classroom demonstrations; take care of laboratory equipment; counsel students; talk with parents; attend several kinds of meetings, and often sponsor science clubs and special science activities such as fairs, exhibits, etc. If they wish to keep up with science and further their own studies, they must do so in the summer, renouncing summer employment, which they usually need to supplement inadequate salaries. Great load, low salary, and poor status in the community all contribute to general dissatisfaction. If, despite these conditions, teachers find time and energy to plan new teaching procedures, they usually meet with administrators' resistance to innovations and with lack of funds for purchasing the necessary materials. At the same time textbooks are generally based on the traditional pattern of a physics course, and books deviating from this pattern are not likely to be accepted by either publishers or school systems. Thus the traditional pattern becomes more and more firmly established.

Three methods by which the development of increasing numbers of science teachers can be encouraged have been listed by the National Science Teachers Association.[20] They are as follows:

1. The supply of teachers available to local school systems can be increased by efforts of school boards and citizens' groups to improve salaries so as to provide effective economic competition with the salaries now offered by industry and business.

2. The retention of science teachers can be enhanced by improving their conditions of employment. Science teachers lack equipment and instructional materials; they lack time to plan for laboratory teaching and to work with superior students; many want refresher courses during the year and in the summer; some could make effective use of laboratory assistants.

3. A more intensive effort is needed to increase the number of high school and college students who are planning to prepare for science teaching. This effort should be aided and encouraged by high school science teachers, counselors, industry, and college professors in science as well as in science education.

[20]Ibid, p. 3.

CHAPTER VII

SUGGESTIONS FOR IMPROVEMENT

Suggestions for improving the course content and instruction in high school physics have been both many and varied. The most obvious and basic need for improvement is in securing and keeping better teachers. Any suggested revision in course content cannot be effective if physics instruction is inadequate. Since the previous chapter was concerned with the physics teacher, this chapter will consider chiefly some of the proposed changes in curriculum and course content.

One of the most recent innovations in the secondary school curriculum has been the introduction of a course in general physical science. This has been introduced at various levels and with varied content. In most cases it has consisted of a survey of physics, chemistry, astronomy and geology, with the purpose of providing students who do not intend to pursue scientific careers with at least a basic understanding in those fields. A properly constructed course of this nature is considered by some to be the answer to one of the more pressing problems, providing a background in physical science for the student who does not plan to attend college and take further work in science.

Several difficulties in introducing a course of this nature are immediately evident. In the first place, it introduces another course into the already crowded schedule of the science department. Another difficulty lies in finding teachers adequately prepared in the variety of fields covered in a course of this type. It might be suggested that it would result in the "watering down" of the material to the point where it would be of little value to the student. Another danger frequently mentioned is the idea that a course of this type would cause students looking for an easier course to further avoid chemistry and physics. Some have suggested that a general physical science course be made a prerequisite to high school chemistry and physics courses. In this way it would serve two purposes, enrich the program of science interested students and serve as a terminal course for the rest. Mallinson in discussing the use of the general physical science course has said;[21]

> General physical science is designed to stand on its own feet as a general education course in physical science for all students. It is designed to serve as a terminal course for those who do not desire to take the more specialized courses in physics and chemistry in the junior and senior years of high school, and to serve as a prerequisite for physics and chemistry for those who desire to take them. The students who do take chemistry and physics will thus be better prepared. Where such a plan for general physical science has been followed, enrollments in physics have increased, which is heartily to be commended.

In November, 1956, the National Science Foundation made a grant to the Massachusetts Institute of Technology, in support of an effort to improve the teaching of physics in secondary schools. The Physical Science Study Committee, established under this grant, consists of scientists from various universities, colleges, and industrial laboratories, and of high school teachers and educators. The work of this group has resulted in the development of a new and revolutionary type of physics course. The program is aimed at the same section of student population that is now taking physics in high school. The program

---

[21] Mallinson, p. 214.

does not aim specifically at preparing students for college physics.

According to Finlay[22] the program is not intended as an "advanced" secondary school course. He states that the program is intended not only for the physics training of the future scientists but also for the general education in science of students looking ahead to nonscientific careers.

This committee is not trying to revise the present physics course but is attempting to set up a new and different type of program which they hope will more adequately meet the needs of high school students. Among the materials which this committee is preparing for both teachers and students are a detailed syllabus and a textbook, films and film strips, manuals for teachers and for students, suggestions and equipment for classroom demonstrations and laboratory work, kits for students, monographs and selected bibliography, questions for tests and exams, and other material.

In summarizing what this course has tried to do, Friedman states;[23]

> In this course the logical unity of the subject is apparent. This integration of knowledge makes it possible for understanding to aid memory far more than usual. In addition, the integration of ideas gives the student the sense of continuing development which in itself is intellectually exciting. The repeated appearance of certain concepts, such as submicroscopic particles, is essential. So also is the patient and detailed treatment of certain subjects. We explore parts of optics, mechanics, and atomic physics more deeply than usual in order to show how we develop a field of thought. The price is the subordination and even omission of many subjects commonly covered in high school courses. Heat and sound are not treated as independent subjects, but more nearly as examples; sound as an example of waves, heat as related to kinetic theory and to the conservation of energy. Hydrostatics and hydrodynamics are out. Technological applications are cut far back at all points.

---

[22]Gilbert Finlay, "What are the Questions?", <u>The Science Teacher</u>, November, 1957. pp. 327-329.

[23]Friedman, p. 322.

> Such radical omissions are necessary. In fact, the committee's deliberations began with pleas from science teachers to reduce substantially the sheer bulk of the current physics course in order to fulfill its purposes within the time allotted to the subject. The material that remains in our selection still leaves a one-year course more crowded than the teacher would like. In the next phase of our work, we may learn where to cut still further.

The Physical Science Study Committee realizes that a course as new and different as the one they are trying to set up will need much study and revision. They do not propose that they have all the answers. The improtant point is that a group of people interested in improving science education have developed a definite proposal for its improvement. The true worth of their program can be seen only after it has been actually used and fully tested.

One of the difficulties in establishing a program of this type is that many physics teachers will not have the training necessary for the proper use of it. The committee hopes to remedy this situation by providing special instruction for those who will teach the course. The program involves a sufficient departure from the content and approach of standard secondary school courses in physics that, in the opinion of those who have worked closely with it, it cannot be adopted as one would adopt a new text. To help meet this need, the National Science Foundation has established five institute programs for the summer of 1958 to enable selected secondary school physics teachers to study and evaluate the new approach. They hope to expand this summer institute program in the future.

The introduction of the general physical science course and the work of the Physical Science Study Committee have been the two most definite suggestions which have been made in an attempt to solve some of the problems which face science education. Neither of these supplies all the answers, but they seem to be a step in the right direction.

Another suggestion which has often been made is that physics courses should be more practical. Others have said that it should be more closely related to daily living and be concerned more with social problems as they are related to science. Hurd[24] has suggested that all science courses should work for the development of an appreciation of science and its methods, its attitude in approach to problems, its significance in present day society and its potentialities in improving modern living.

The physics laboratory has been subjected to much criticism. The laboratory is of major importance as a tool of instruction in high school physics. Only through the laboratory does the student come into direct contact with physical phenomena that will give him an adequate basis for understanding physics. There is much room for improvement in the quality and effectiveness of the introductory physics laboratory. In particular, the use of stereotyped reports fails to make use of the students initiative and curiosity. The recent gain in use of the science project and the science fair have done much to stimulate students to do original and exploratory laboratory work. They have also served the valuable purpose of creating public interest in the work of science. Their continued use and popularity is one of the surest signs that progress is being made in getting more and better students into secondary school science classes.

---

[24]Hurd, p. 449.

CHAPTER VIII

CONCLUSION

The problems which face high school physics are many and complex. The improtance of good secondary school science instruction cannot be too strongly emphasized. We are living in an age which is becoming more and more dependent on science and the future of America as a world power will depend largely on her scientific man-power. We must not only produce more scientists and engineers, but perhaps even more important, educate all Americans to an understanding of science and its importance.

The most important factor in improving science instruction is the development of understanding by the public. When the American public can be made to see the need for better education in science and is willing to provide it, the greater part of the battle will have been won.

This report has been concerned with physics teaching in the high school. However, it must be remembered that much of a students education is received before he enters the physics classroom. Perhaps more emphasis should be placed on the students science education at this level. Teachers at the elementary and junior high levels can do a great deal to stimulate interest and provide basic knowledge in science. This is an area which must not be neglected in any attempt to improve the science program. Colleges could help a great deal in this area by providing more descriptive and qualitative courses in the field of science for elementary teachers. Many elementary and junior high teachers now avoid the introductory course in college physics because it has little or no application to their work.

In the final analysis the heart of the problem lies in the physics teacher. No amount of curriculum revision, visual aids or laboratory equipment can be effective without a well-prepared, dedicated and enthusiastic teacher. The improvement of teacher preparation is an area which should certainly be considered.

Physics has been an important part of the high school curriculum for a long time and will probably continue for some time to come. Its content and form may have to be changed but the world has changed a great deal too since the beginning of the ninteenth century. If a student is to live in an age of earth satellites, jet airplanes and space travel his education must be adapted to fit his environment. Education can only keep up with the world by constant inspection and improvement.

This report has tried to inspect the state of physics teaching today, to see what seems to be wrong and what might be done about it. In the end, the individual teacher must decide for himself what his aims and objectives are, what is good and what is bad and how he can do the most effective job. It is hoped that this report has provided enough of a glance at high school physics to help the individual teacher to form a philosophy which can help him better understand his work.

BIBLIOGRAPHY

Board of Directors of the National Science Teachers Association, "On the Target," The Science Teacher, XXIV (April, 1957).

Conference sponsored by the American Association of Physics Teachers, "Improving the Quality and Effectiveness of Introductory Physics Courses," American Journal of Physics, XXV (October, 1957), 420-421.

Dees, Bowden C., "Some Current Problems and Needs in Science Education," American Journal of Physics, XXIV (December, 1956), 616-623.

Finlay, Gilbert, "What are the Questions?" The Science Teacher, XXIV (November, 1957), 327-329.

Friedman, Francis L., "A Blueprint," The Science Teacher, XXIV (November, 1957), 320-332.

Heiss, Elwood D., Obourn, Ellsworth S., and Hoffman, C. Wesley, Modern Methods and Materials for Teaching Science, (New York, 1940).

Hurd, Paul DeH., "The Case Against High School Physics," School Science and Mathematics, LIII (June, 1953), 439-449.

Little, Elbert P., "From these Beginnings," The Science Teacher, XXIV (November, 1957), 316-319.

Mallinson, George Greisen, "The Role of Physics in the Emerging High School Curriculum," School Science and Mathematics, LV (March, 1955), 211-216.

Richardson, John S., Science Teaching in Secondary School, (Englewood Cliffs, N. J., 1957).

Summerer, Kenneth H., "Some Suggestions for Unifying High School Physics Around the Concept of Energy," School Science and Mathematics, LVII (October, 1957), 536-540.

VITA

Willard William Korth

Candidate for the Degree of

Master of Science

Thesis: THE PLACE OF PHYSICS IN SECONDARY EDUCATION

Major Field: Natural Science

Biographical:

Personal data: Born in Pierce, Nebraska, December 29, 1927, the son of Elmer A. and Esther Korth.

Education: Attended rural grade school in District #46, Pierce County, Nebraska; graduated from Pierce High School, Pierce, Nebraska, in 1945; received the Bachelor of Arts degree from Wayne State Teachers College, Wayne, Nebraska, with majors in education and physical science, in August, 1950; attended Stanford University, Stanford, California in summer of 1957; completed the requirements for the Master of Science degree in May, 1958.

Professional experience: Employed by the Wynot Public Schools, Wynot, Nebraska, September 1950 to May, 1953, as science and mathematics teacher; employed by the Butte Public Schools, Butte, Nebraska, September, 1953, to May, 1954, as principal, science and mathematics teacher; employed by the Madison Public Schools, Madison, Nebraska, September, 1954, to May, 1957, as science teacher.