An investigation of Montanas Public High School Physics Program During the 1972-73 School Year
by Alexander Kane Dickison

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
DOCTOR OF EDUCATION
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Abstract:
It was the purpose of the study to determine the status of physics teaching in the public high schools of Montana during the 1972-73 school year. The results of this investigation were compared to earlier studies to determine the progress that had been made in physics since 1959. The study concentrated on teaching objectives and "external factors". "External factors" included the enrollment in physics, teaching assignments, teacher preparation in physics, and laboratory and supplemental materials available.

Data were collected from three main sources. These were: 1)the Fall Reports submitted by the school districts to the State Department of Public Instruction; 2)questionnaires sent to all Montana high school physics teachers; 3)a visitation to twenty-two randomly selected high schools in Montana. The return of the "High School Physics Questionnaire" which emphasized the "external factors" was 81 percent. The return of the "Teachers' Objectives Questionnaire" was 84 percent. The major conclusions of the study were: 1)high school physics in Montana was mainly for the better students. Mathematics and problem solving were emphasized; 2)the teaching objectives of Montana physics teachers could be generalized to have been "traditional"; 3)"traditional" textbooks were used most often. P.S.S.C. Physics and Project Physics were used by some teachers as supplementary textbooks. P.S.S.C. Physics had greatly influenced the laboratory; 4) the academic preparation of Montana physics teachers had improved in the sciences and mathematics.

There were still many teachers, however, with 15 or less quarter hour credits in physics; 5)on the average the laboratory facilities had improved, but there were still many schools with inadequate physics laboratories.

The recommendations of the study were; 1)Montana colleges and universities should offer in-service and summer courses for high school physics teachers; 2)A program designed to increase communications between all physics teachers should be implemented. A State Coordinator of High School Physics should be created; 3)The undergraduate program in preparing physics teachers should be examined; 4) Programs such as summer physics institutes and the Science Curriculum Center, at Montana State University, should not only continue, but expand their services.

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A.K.D.

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ABSTRACT

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CHAPTER I

THE PROBLEM

Introduction

In the mid 1950's, the United States was in a position to think about its future. World War II and the Korean War were over. With the death of Stalin in 1953, the fear of Communism, which was displayed in the McCarthy hearings, had dissipated to a rational level. This was a time for planning for the future, even though well defined goals were not yet established.

In 1950, Congress established the National Science Foundation (NSF). By charter, this Foundation was expected to develop "a national policy for the promotion of basic research and education in the sciences."[1] World War II and the Korean War had convinced Congress that a strong science program in the United States was necessary for the national defense.[2]

During the early years of the Foundation, most money

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[1] Paul E. Marsh, and R.A. Gartner, Federal Aid to Science Education: Two Programs, Syracuse University Press, New York, 1963, p. 15.

[2] Ibid., p. 17.

received from Congress went to support basic scientific research.[3] It was not until 1956, that the Foundation became concerned about the quality of science education in the nation's high schools. It felt that in order to encourage youngsters to prepare for a scientific career, it was necessary to have challenging, modern high school science courses taught by first-rate teachers.[4] The National Science Foundation felt that both of these ingredients were lacking in many of the high schools in the United States. NSF prepared to tackle the problem of teacher preparation first. It sponsored summer and academic year institutes for university study in science and mathematics for high school teachers.[5] This program was intended to up-date and build onto the science preparation the high school teachers already had.

Independently in 1956, the Physical Science Study Commission (P.S.S.C.) was formed at the Massachusetts Institute of Technology. This group applied to NSF for a grant to develop a high-quality physics curricula that could be

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[3] *Ibid.*, p. 18.

[4] *Ibid.*, p. 18.

[5] *Ibid.*, p. 18.

taught by a teacher with a poor physics background.[6] They were awarded the grant, and started their work unaware of the importance physics would have in the American educational system in the very near future.

On October 4, 1957, Sputnik I was launched by the U.S.S.R. It was not until February 1, 1958, that the United States' space program was able to put a satellite into orbit. This Russian achievement created a strong feeling of competitiveness among the American people. The United States was going to try to be the first to land a man on the moon. The goals now had been set for the next ten years. The United States had entered the Space Race.

The American people were demanding to know why the American Space Program was not first, and one area which came under close scrutiny was the field of Education. A total re-evaluation of the American educational system was undertaken.[7] One of the first, and perhaps most important, aspect to be studied was the different kind of teaching methods used in the classroom. Leading educators began criticizing the "traditional" methods employed by most class-

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[6]Gilbert C. Finley, "Secondary School Physics: P.S.S.C.", American Journal of Physics, 28:286-93, March, 1960.

[7]Marsh and Gartner, op. cit., p. 44.

room teachers. These "traditional methods" emphasized the teaching of facts rather than processes. They felt that if this could be changed, an improved American educational system would follow. As a result of this movement, a number of new teaching programs were developed.

It soon became apparent that in order to have a successful space program, a strong physics program was also needed.[8] With this new public attitude, the National Science Foundation and the Physical Science Study Commission gained momentum. The Physical Science Study Commission planned and wrote the P.S.S.C. physics curriculum. Since that time, a number of new programs in physics have been written by various agencies. These programs vary in grade level from elementary school through the college level. Among these programs developed were Introductory Physical Science, Harvard Project Physics, Berkeley Physics, Physical Science for Nonscientists, Science Curriculum Improvement Study, and Elementary Science Study.

The development of these new programs in physics was made possible in many cases by NSF grants. These grants allowed many of the leading scientists and educators in the field of physics to be assembled together to work on the

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[8] Ibid., p. 45.

curricula. They arrived at many new ideas and techniques on how to teach physics students at the high school and also the college level.

Statement of the Problem

During the 1958-59 school year, two studies were conducted on science teaching in Montana at the secondary school level. Orlich's study[9] concentrated on the methods of teaching science. He prepared and administered a questionnaire covering six areas of emphasis. These divisions were: 1) administrative factors, 2) methods and procedures of the science teachers, 3) audio-visual aids, 4) library and related facilities, 5) testing and evaluation, and 6) recommendations of the Montana senior high school science teachers. Gebhart[10] concentrated his study more on "external factors" rather than classroom methods. He determined sizes of schools, sciences taught, enrollment in the

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[9]Donald C. Orlich, "An Appraisal of the Methods of Teaching Science In the Senior High Schools of Montana," (unpublished Master's thesis, University of Utah, Salt Lake City, 1959).

[10]James W. Gebhart, "The Teaching of Science In the Secondary Schools of Montana", (unpublished Doctorate thesis, Ohio State University, 1960).

various sciences, teaching assignments, teacher preparation in the sciences, and teacher salaries.

Both of these studies were done soon after the initial impact of Sputnik. They, therefore, served as a basis for what physics teaching in the secondary schools of Montana was like before the development of the new curricula and the renewed emphasis on the upgrading of the educational system.

This dissertation deals with the status of teaching physics in the public high schools of Montana during the 1972-73 school year. The results of this investigation were compared to earlier studies to determine the progress that has been made in physics education during the past fourteen years. An analysis was made of the new programs in physics to determine which have been of the most benefit, and have been used by the most high school physics teachers in Montana. This study concentrated on the teaching methods and the "external factors" now being used in the high schools.

"External factors" included the enrollment in physics, teaching assignments, teacher preparation in physics, and laboratory equipment available. Programs were developed and carried out during the 1960's to try to influence these statistics. Institutes such as the National Science Foundation Teacher Institutes were conducted throughout the United

States to upgrade the teacher's preparation in physics. New curricula were developed, such as Harvard Project Physics, which had as one of their major goals, to increase the number of high school students enrolled in physics. The National Defense Educational Act (NDEA) provided money for science equipment in the public schools. By comparing the data developed by this study with those compiled by Gebhart, it can be determined if there has been any significant change in these factors in Montana.

The second area investigated was the teaching methods employed by the high school teachers of Montana. These methods included course objectives, laboratory use, and organization of subject material. Although the techniques to be used by this investigator were not the same as Orlich used in his study, it was still possible to compare these findings. Changes should have occurred if the goals of NSF, NDEA, and curricula written since 1956 have had any impact on the physics teaching in Montana.

Need for and Benefit of the Study

Due to the increased pressure on education to account for its role and mission in society, it is important that studies be made of the current practices in specific subject areas. These studies can then serve as a basis to determine if an upgrading and reformation would be needed for any methods and standards now used in the classrooms. It is important that if any changes are made, that they be based on factual information and not speculation. This research project provides data on Montana's current physics program in the secondary schools.

This study provides a standard of comparison for secondary level physics programs in Montana. The results are stratified according to high school population. Individual teachers or entire school districts can compare their own programs with schools similar to theirs throughout the state.

Institutions that train physics teachers for the secondary level should also benefit from this study. It is important that they know the current state of the physics programs in the secondary schools. This is necessary so that future teachers can be taught what to expect out on the job, and how these present conditions can be improved. The teacher-training schools have also been given the responsibility of updating and retraining the experienced teacher. Federal funding is available to support programs such as in-service institutes and instructional resource centers. If these programs are going to be of maximum benefit, a knowledge of the current state of physics teaching should be obtained in order to gear them to the proper level.

Another reason for undertaking this research project was to determine the effect of past attempts in changing the physics program. A great deal of money, talent, and energy was expended in the United States during the past fourteen years to change the direction of the physics program at the secondary level. Perhaps by studying the present state of the physics program in Montana, it can be determined which of these changing forces have succeeded, and which have not.

In summary, the most important function of this study was to serve as a basis for initiating change. This study will, hopefully, serve as a basis for determining what, if any changes should be undertaken to improve the overall physics program in Montana.

General Questions to be Answered

This study will answer a number of questions about the physics program in the high schools in the state of Montana. A list of these questions include:

1. What was the enrollment in physics in Montana high schools during 1972-73? How does this enrollment compare to that of 1958-59?

2. What formal training in physics (and other disciplines) did the physics teachers in the secondary schools of Montana during 1972-73? How did this compare to the 1958-59 school year?

3. What were the teaching assignments of the high school physics teachers in Montana during 1972-73? How did this compare to 1958-59?

4. To what extent had Federal monies been used in Montana for updating high school physics facilities, or in upgrading the teacher's knowledge of physics?

5. What was the number and availability of courses in physics in the high schools of Montana during 1972-73?

6. What was the availability of physics laboratory equipment in the high schools of Montana?

7. What was the extent of library facilities related to physics in the high schools in Montana?

8. What were the audio-visual facilities related to physics that were available to the physics teachers and students in Montana?

9. What were the prerequisites that a student must fulfill in order to enroll in a physics course in the high schools of Montana?
10. What type of courses (i.e. P.S.S.C., Harvard Project Physics, "traditonal", etc.) were being taught in the high schools of Montana?
11. What course objectives did the physics teachers in Montana hold to be most important?
12. Were the objectives of the physics teachers of Montana in harmony with the type of courses being taught?
13. What was the academic ability of the students enrolled in physics courses in the high schools of Montana?
14. What, if anything, could be done to improve the high school physics being taught in Montana within the resources available?

General Procedures

In order to answer these questions, data had to be collected from three main sources. These were: 1) the fall reports submitted by the school districts to the State Department of Public Instruction; 2) a questionnaire sent to all high school physics teachers in Montana; and 3) a visitation to twenty-two randomly selected high schools in Montana. (List in Appendix A, page 247).

Initially a visit was made to the State Department of Public Instruction. This was done so the fall reports for 1971-72 could be examined. These reports contained information on school enrollment, sciences taught, enrollment in the sciences, teaching loads of the physics teacher, and the college hours of preparation the physics teacher had in various subject areas. The 1970-71 fall reports had to be used for the college preparation of physics teachers due to a change in form of the fall reports starting with the 1971-72 school year. Because this data was older and perhaps, less reliable, this information was asked for again in the questionnaire.

From the fall reports it was ascertained which high schools offered a physics course during the past three years. All of these schools were sent a "High School Physics Questionnaire". (copy in Appendix D, page 250). A randomly selected stratified group of physics teachers received, in addition, a "Teachers' Objectives Questionnaire". (copy in Appendix E, page 256). Three weeks after mailing these questionnaires, they were mailed again to the teachers who did not respond. Six weeks after the initial mailing phone calls were made to the non-respondent schools to determine if anyone at the school was qualified to fill out the questionnaire. At some schools there was no physical sicence teacher employed during the year, and they were eliminated from this study.

From the questionnaires retured, information about the teachers' objectives in teaching physics, the teachers' college preparation, the teachers' opinions about how various agencies could help their physics program, and finally factual information about their physics programs was obtained. The factual information included prerequisites needed for a student to take physics, text used, extent new curricula were used, adequacy of laboratory, library, and audio-visual facilities, and whether or not their school had participated in any Federal Aid to high school physics.

Finally, due to the researcher's opinion that the most reliable method of obtaining data was through personal visits to the schools and with the teachers, as many of these trips were undertaken as resources permitted. Altogether twenty-two randomly selected schools were visited. For each visit, a uniform interviewing procedure was used. (copy in Appendix F, page 260).

The results of this study were broken down into four categories. These were: schools with student enrollment over 800; schools with enrollment between 300 and 800; schools with enrollment between 100 and 300; and schools with enrollment under 100. For this reason, the random selection of schools to be visited was also stratified. The stratification was based on the number of students enrolled in each of the above catagories.

The data resulting from this investigation was analyzed and presented, utilizing descriptive statistical analyses.

Definition of Terms

P.S.S.C. Physics Curricula. A physics curriculum developed by the Physical Science Study Committee after a thorough analysis of the physics being taught in the high schools during the late 1950's. Included is a textbook, special laboratory equipment, and films. The P.S.S.C. objectives are explained below.

P.S.S.C. Objectives. The Physical Science Study Committee never formulated objectives for the P.S.S.C. course besides those of trying to develop a better curricula. The P.S.S.C. objectives will therefore be taken as

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Limitation

It was the purpose of this study to determine the status of physics teaching in the public high schools of Montana during the 1972-73 school year. In order to completely understand why students take or do not take high school physics or how much knowledge the students learn about physics in a high school class, information should be gathered from the high school students. This study, however, concentrated on teaching objectives and "external" factors. "External factors" included the enrollment in physics, teaching assignments, teacher preparation in physics, and laboratory and supplemental materials available.

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P.S.S.C. Objectives. The Physical Science Study Committee never formulated objectives for the P.S.S.C. course besides those of trying to develop a better curricula. The P.S.S.C. objectives will therefore be taken as those which were developed by Trowbridge.[11] These objectives are listed on pages 149, 150 and 151.

"Traditional" Physics Course. The "traditional" physics curricula is a composite of high school courses made from a variety of textbooks, workbooks, laboratories, and supplementary material usually written during the 1940's or the early 1950's. The "traditional" course is defined by this researcher as having the objectives described next.

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[11] Leslie W. Trowbridge, "A Comparison of the Objectives and Instructional Materials in Two Types of High School Physics Courses," Science Education, 49:117-119, March, 1965.

"Traditional" Physics Course Objectives. The objectives of the "traditional" physics course are those determined by "Trowbridge."[12] These objectives are listed on page 149.

Harvard Project Physics. A physics curriculum developed by a team of physicists and educators at Harvard University beginning in 1964.

Harvard Project Physics Objectives. The long term objectives of Harvard Project Physics as described by Holton[13] and Rutherford.[14] The four main objectives were:

1. to create a coherent, tested course for use on a national scale alongside the others that have been developed previously. This course accentuates those aspects of physics not prominently incorporated into high school physics, although they are widely held desirable.
2. to help stem the decline in proportionate enrollment in physics at the high school level - a decline which is now reaching into the college years.

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[12] *Ibid.*, pp. 118-119.

[13] Gerald Holton, "Project Physics: A Report on Its Aims and Current Status", *The Physics Teacher*, 5:198-211, May, 1967.

[14] F. James Rutherford, "Flexibility and Variety in Physics," *The Physics Teacher*, 5:215-221, May, 1967.