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Survey of teaching methods of physics in the third class high schools of Montana

Joseph Robert Wolpert

The University of Montana

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A SURVEY OF TEACHING METHODS OF PHYSICS
IN THE THIRD CLASS HIGH SCHOOLS
OF MONTANA
by
JOSEPH WOLPERT
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Approved by:

[Signatures]
Chairman, Board of Examiners
Dean, Graduate School

Aug 15 1955
Date

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CHAPTER I

THE PROBLEM AND METHOD OF RESEARCH

Teachers are always confronted with various kinds of problems. The physics teacher of the small high school is handicapped by a lack of information on teaching methods. Relatively little has been written on the methods of teaching physics and most of this is for the large and well equipped high school.

The Problem

Statement of problem. The purposes of this survey were (1) to determine the primary and secondary objectives of the general physics course and how they can be adapted to meet the needs of the small high school, (2) to make a survey of teaching methods used in physics classes of third class high school in Montana\(^1\), (3) to summarize the teaching techniques in physics from related materials, and (4) to summarize the methods of teaching physics most widely used by Montana teachers.

Importance of the study. With the advance of the atomic age the role of physics has gained increased importance. Students that show ability and interest in science

\(^1\) Montana School Law (School Laws of the State of Montana, State Department of Public Instruction, 1949, p. 67) defines a third class high school as "A high school in a school district having a population of less than one thousand and with a school board of three members."
should be encouraged to enroll in the high school physics classes and secure a broader background in science. This should stimulate some of the students to continue in physics or related fields and take an active part of this atomic development. Carleton has this to say on the subject:

The job of trying to discover science-talented boys and girls should be started during the junior high school years if possible, and then offer these potential scientists the kind of educational attention and opportunities their talents deserve. A frightening shortage of engineers and scientifically trained personnel is upon us this very moment.²

With this added emphasis on science, physics is playing an important role in the high school curriculum and the physics teachers are becoming aware of this. This survey can be used as a guide for the beginning teacher of physics and also as an aid to those teachers already in the field. The high school physics teachers may find some answers to the questions that they were unable to find elsewhere. A wealth of related materials in the teaching of physics are available to the teacher but some of the material is of little value. Most teachers find that it is better to have a few good materials that are frequently used than a lot of poor materials that are seldom used by either the teacher or students.

Limitations of the study. Due to the large number of science courses offered in the high schools of Montana it was necessary to limit this survey to include only those

courses listed as general physics. Excluded were such courses as physical science, senior science and other courses that might be a combination of physics with other courses such as chemistry, astronomy and geology. The problems of physics teachers in the various sizes of Montana high schools are different so this survey includes only those schools that are listed as third class districts by the State Department of Public Instruction. With these delimitations a more homogeneous survey was made possible.

Methodology of Research

The primary source of information and data for this study was a questionnaire sent out to the physics teachers in the third class high schools of Montana. Secondary sources of information were related literature on the subject and the course of study provided by the State Department of Public Instruction.

Preparation of questionnaire. The first step in the preparation of the questionnaire was an interview with physics teachers who were on the campus for Summer Session at Montana State University in 1953. From the ideas and opinions expressed during these interviews a preliminary questionnaire was made up. This questionnaire was then given to these same teachers to fill out and make any changes or

3 "Course of Study in General Science, Biology, Chemistry, and Physics for Montana High Schools," The State Department of Public Instruction, 1928 (Helena, Montana) 92 pp.
comments on how the questionnaire could be improved. From this information the questionnaires were made out in its final form to be sent out to teachers the following school term. Six physics teachers gave their assistance in the preparation of the questionnaire used in this survey.

Distribution and return of questionnaire. The Part-A High School Reports were used to determine which third class high schools were teaching physics. Twenty-four schools were teaching physics, twenty-seven were teaching chemistry, and forty-three schools were teaching neither physics nor chemistry. Twenty-eight and four-fifths percent of the third class high schools were teaching physics, thirty-two and one-tenth percent were teaching chemistry, and forty-nine and one-tenth percent were teaching neither physics nor chemistry. To find that such a small percentage of the small high schools were teaching chemistry and physics was discouraging. However, an Office of Education survey showed that less than half of the high schools in the United States offered physics sometime in their curriculum.

After determining the schools in which physics was taught, the Part-A Reports were used to secure the names of

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4 An annual autumn report of all Montana secondary schools sent to the State High School Supervisor, State Department of Public Instruction, Helena, Montana.

the teachers. The questionnaires (see Appendix A) were then mailed to physics teachers in the third class high schools of Montana. Twenty-one were returned representing seventy-two and four-tenths percent of those mailed.

The Questionnaire

The questionnaire, Appendix A, was divided into two categories: curriculum and materials, and teaching methods. Teaching methods were broken into four subdivisions: laboratory, classroom, testing and evaluation, and assignments. The purpose of each of these divisions was to determine if there were some definite trends toward uniformity in the methods of teaching used.

Curriculum and materials. The section on curriculum and materials was further broken down into smaller sections: how often physics was taught, how many years the teacher has taught physics, the amount of time used for classroom and laboratory work, use of the State Course of Study, title and author of basic textbooks and laboratory manuals, and the primary and secondary objectives of physics. From this section it was hoped to get an insight into the place of physics in the curriculum, the objectives of physics as taught in the small high schools of Montana, and those reference materials that were most helpful to the teacher.

Teaching methods. The section on teaching methods was further divided into the following sections: method of
handling the laboratory, teacher demonstration versus student experiments, laboratory facilities and equipment, the use of films, methods of evaluation, use of assignments, and handling of individual differences in the classroom. These sections were considered to be the most important and an attempt was made to show some of the trends in the methods of teaching physics in the third class high schools of Montana.
CHAPTER II

REVIEW OF RELATED INFORMATION

A wealth of information on the methods of teaching science is available to the teacher, but a vast amount of this material is directed at the elementary and general science teacher. There is a limited amount of material available to the chemistry and physics teacher on his specific subject. This is primarily due to the fact that the physics course has been the least affected by the educators' attempt for reorganization. The National Society for the Study of Education put out a Yearbook in 1932 entitled "A Program for Teaching Science" and had the following to say about the trends and objectives of physics:

The traditional support for physics has been stated in terms of (1) formal discipline, (2) knowledge, and (3) college preparation; and the offerings in these fields have been least affected by the movement initiated by educators for reorganization. These courses in science secured a place in the program of studies in competition with traditional college-preparatory subjects at a time in the history of education when the major support of all subjects was given in terms of formal discipline. This support had such general recognition and gained such complete acceptance that it has held a place in the minds of teachers of these subjects, even though the philosophical and psychological tenets which were the basis of the support have now been greatly modified and, in large part, denied.¹

Fifteen years later the National Society for the Study of Education put out another Yearbook entitled "Science

Education in American Schools." The opinion this time was:

The picture we get is of a subject, physics, gone stale through adherence to a set and largely nonfunctional pattern of organization. A thorough overhauling both as to the content and organization seems in order.2

Several suggestions have been offered on how the physics program should be reorganized, but physics today is still taught in almost the same manner as it was many years ago. Hurd said about physics:

The type of physics being taught in many high school for 1952-1953 has slight resemblance to the type of course suggested by the various committees. Physics courses and their organization are about the same as fifty years ago.3

The objectives of physics are about the same today as they were a century ago and physics remains the most traditional course in the high school program. The objectives of the general physics course will be discussed in a later chapter.

Curriculum

Several educators are of the opinion that physics as a separate subject has lost its place in our modern educational system and that it should be combined with other courses and be made more functional. Hurd in his article


"The Case Against High School Physics" had this to say:

As a science physics has played an important and dynamic part 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.4

In support of the above statement, fewer students are taking physics each year and fewer schools are offering physics in their curriculum. The Office of Education made a survey of schools in the United States teaching physics and also the percent of students taking physics. They found that 5.49 percent of the total high school enrollment were taking physics. This compared with 19.04 percent of students taking physics in 1900 and 14.23 percent in 1915.5 The survey also pointed out that there were three times as many boys as girls in the physics classes.

Regardless of the declining enrollment and traditional methods of teaching, the majority of educators believe that physics is here to stay in our curriculum. Mallinson said, "The emerging curriculum does have a place for physics—a bigger one than ever before."6 Ephron wrote a book on the teaching of science in the secondary schools and had some good information on trends, course content and place of

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4 Ibid., p. 439.


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No discussion on the content of the physics course is necessary, as almost all courses in physics can be easily classified under the headings: mechanics, heat, magnetism and electricity, sound, and light. The Forty-Sixty Yearbook even criticized the unchanging order of teaching the various units.\footnote{Forty-Sixth Yearbook, N.S.S.E., \textit{op. cit.}, p. 209.}

\section*{Teaching Methods}

Several methods of teaching have been developed and have acquired various descriptive names over a period of time. Among the most commonly used methods are the lecture, laboratory, demonstration, question and answer, textbook, unit-problem, and project. As no method can be used completely by itself, many combination of the above methods are found. There are many less common methods, but only those above are discussed in this paper. Related literature on all methods is available and some of that literature is presented in the following paragraphs. Each method is treated separately and comparisons are made in the final analysis of this paper.

\textbf{Laboratory.} The laboratory method is not one that can be used exclusively by itself. When used with other
methods it can be used as an effective method of collecting evidence in the solution of problems. However, the laboratory needs to be handled properly if the students are to gain the full benefit of its educational value. Sometimes the objectives of the use of the laboratory are lost in over-emphasis. As Preston, who had a chapter on the use of the laboratory in his book, said:

Most of the evils in present laboratory work have arisen through its rapid growth and extension. Hence, there has resulted in very many schools and school systems the practice of doing laboratory work for the sake of complying with some such set of artificial requirements and paying little regard to the effects on the students.9

Preston said regarding the place of the laboratory, "The right and only natural time to go to the laboratory is when a problem has arisen that can be settled here better than anywhere else."10

The role of the laboratory method in teaching science courses was summed up by the National Society for the Study of Education in the 46th Yearbook:

1. Use laboratory work to give the pupils practice in raising and defining worth-while problems.
2. Conduct laboratory work in such a way that pupils will learn the meaning and use of controls in experiments.
3. Use laboratory work to test hypothesis and interpret data.
4. Maintain a proper balance between student exploration and teacher guidance.11

10 Ibid., p. 167.
11 N.S.S.E., Forty-Sixth Yearbook, op. cit., p. 209.
The comments on laboratory teaching within the last decade, as revealed by periodical literature, may be summarized as follows:

(1) extensive use of individual laboratory experiments should be continued; (2) demonstration experiments should be widely used in conjunction with class discussions; (3) more experiments should be of a practical nature; (4) an effort should be made to increase the number of controlled experiments; and (5) students should have some opportunity to develop their own experiments.12

The laboratory method was found to be a very effective method of teaching physics in the secondary school, and seemed to be the one method that was recommended by all authors on methods of teaching science. The physics and chemistry classes were the two subjects of the science curriculum where the laboratory method of teaching was considered to be an absolute necessity. Yet, many small high schools of Montana lack good laboratory facilities and equipment, which forces the teacher to substitute other methods for the laboratory method.

Lecture method. The lecture method was the primary and sometimes only method of teaching used during the first century of American education. This method has been losing popularity in our public schools during the 20th century. Most teachers still make use of this method in combination with other methods and the lecture method will continue to

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be one of the more widely used methods. Today the lecture method is usually accompanied by recitation, demonstrations, and visual aids.

According to some authorities the lecture method still has a definite place in our science classes. Hoff had this to say:

Many authorities in the field of teaching tend to advocate an increased use of the lecture method in the upper secondary school grades, especially for those students who are planning to attend college. The obvious reason for this is that it may tend to orient pupils better for college because this method is predominant in the college of today.13

Several advantages are listed for the lecture method and it can be used to advantage if used with other methods. Heiss, Obourn, and Hoffman14 in their recent book on science teaching claim that the lecture method provides an efficient means of covering subject matter and more or less insures that the pupils will receive the material in a concise and logically organized manner. It can be used in opening up a new unit for study or in summarizing principles at the close of the unit.

The lecture method is not considered one of our better methods of teaching. It has numerous disadvantages and these weak points were listed by Preston:


1. No assurance that audience is attentive and is receiving what is given.
2. No assurance that what is received is understood.
3. Rate may be too rapid to allow hearers to get necessary connection of thought.
4. Pupils are unskilled as listeners.
5. Pupils are passive recipients, not active participants.
6. Minimum stimulation to critical evaluation; emphasis on content retention above all else.  

Because of the above criticisms the lecture method of teaching is losing popularity in our secondary schools.

**Demonstration method.** Many studies have been made on the effectiveness of the demonstration method and almost all of them agree that it can be the best method of teaching when conditions are present for its use. As Noll said:

> One of the most effective methods of bringing home to a class the meaning and importance of scientific law or generalization is through the use of a suitable and well-prepared demonstration.... one earmark of an effective teacher of science is the ability to "put on" a good demonstration.

Of the science courses physics is the best adapted for the demonstration method. It is usually used in the following ways: to introduce an unit, to accompany the lecture, to aid student projects, and to present materials that can be best presented in this manner. During the period when the laboratory experienced its tremendous growth the emphasis was on individual experiments. However, experience has proved

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that the demonstration method can be used partly to replace this over-emphasis on individual work. Downing concluded that:

The lecture-demonstration method of instruction yields better results than the laboratory method in imparting essential knowledge and is more economical of time and expense. This is true for both bright and dull pupils and for all types of experiments. The lecture-demonstration method appears to be the better method for imparting skill in laboratory technique in its initial stages and for developing ability to solve new problems.17

The demonstration method has been attacked on the grounds that pupils are often passive when it is used, rather than active as they would be in the laboratory. This disadvantage can be overcome to some degree if the teacher assigns demonstrations to be done by the pupils.18

Question and answer method. The question and answer method is a device by means of which the teacher attempts to find out what information the student already possesses and to organize this information in the pupil's mind to serve as a basis for understanding new knowledge. Questioning must be skillfully done in order to be effective. Hoff said regarding the importance of the teacher in the question and answer method:

Questioning is an art and usually requires many years of experience to effect its perfection... It may be wise for the beginning teacher to bring

to class a written copy of well-planned set of questions during a discussion period. At times, this plan is acceptable also for the experienced teacher. Nevertheless, the teacher should attempt to get along as much as possible without referring to a set of questions because constant use of such a prepared worksheet tends to slow up the classwork, makes the discussion too rigid, and may cause pupils to feel that the teacher lacks mastery.  

Most authors on the use of various teaching methods agree that the sciences, including physics, offer the best opportunity for the use of the question and answer method. The students have an opportunity to use their past experiences to stimulate the discussion and to find the solutions to their problems. However, the success of this method depends on the mastery of the teacher to lead the discussion. As Preston said:

As class leader, he (the teacher) is responsible for holding the group to the subject and for so directing the thought that the attention shall constantly be focused on the goal to be achieved. At times, taking the lead completely, he must so frame his questions and so arrange their order that he will eventually bring the class to see what he wants then to see, yet make them feel that they have arrived by virtue of their own efforts.  

**Textbook method.** The textbook method as defined by Downing is as follows:

The textbook method, in its purest form, presents to the pupil the knowledge to be acquired in print or manuscript without illustrations or diagrams. From the text he learns his assignments and in the

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19 Hoff, op. cit., p. 155.

20 Preston, op. cit., p. 149.
recitation gives proof of his accomplishment.\textsuperscript{21} The textbook has always been an essential aid to learning. Even today, in many places the textbook is the course in physics, and learning consists largely of reading the text and reciting its contents back to the teacher. This is a definite abuse of the textbook method, but in spite of these recognized abuses there is no doubt the textbook will continue to be an important adjunct to learning in science classes for many years to come.\textsuperscript{22} Heiss, Obourn, and Hoffman had this to say on the textbook:

Properly used, the textbook may become a very important part of a course in science. When a single basal text is the only reference source, there is, of course, the danger that the pupils will come to think of the text as the only source of material and will thus have a distorted conception of its true value.\textsuperscript{23}

\textbf{Project method.} The project method consists chiefly of building a unit of study around an activity which may be carried on in the school room or outside. The physics course does not give a good opportunity for the use of this method as too much specialized equipment is necessary that only can be found in the laboratory. Since the emphasis on the laboratory, the laboratory method has chiefly replaced the

\begin{itemize}
\item \textsuperscript{21} Elliot Rowland Downing, \textit{Teaching Science in the Schools}, (Chicago: The University of Chicago Press, 1925) p. 111.
\item \textsuperscript{22} Heiss, Obourn, and Hoffman, \textit{op. cit.}, p. 122.
\item \textsuperscript{23} \textit{Loc. cit.}
\end{itemize}
method. The project method is usually used along with other methods, otherwise it has several disadvantages. The two major disadvantages as listed by Hoff were:

A disadvantage in the exclusive use of this method is the difficulty in achieving efficient organization of instructional materials which will eliminate confusion and time-wasting on the part of the pupil. A second disadvantage is the difficulty and inconvenience resulting from the care and maintenance of these projects. If often ties down the teacher to the ultimate completion of the project as pupils frequently lose interest and neglect to fulfill their responsibilities as the unit is extended.24

Unit-problem method. Hoff25 defines the unit in secondary school science "as a series of group-planned, related, and unifying experiences or activities in which secondary pupils participate in order to achieve an adaptation to, or control over, an area of living." Grizzell26 defines the unit as "a series of activities or experiences, vicarious or personal, the performance of which develop the ability of level of mastery indicated in the central objective."

The unit method of teaching has become very popular in recent years as indicated by the many courses of study and textbooks which use it. Studies have failed to prove objectively that the unit plan is superior to other specific plans such as the question and answer, project, lecture, and

24 Hoff, op. cit., p. 159.
25 Ibid., p. 117.
the like as far as measurable learning products are concerned. Nevertheless, critical evaluation on the basis of modern philosophies of education gives the unit plan advantages over other methods of teaching. Following are some of those advantages.

1. Caring for individual differences is possible to a greater degree.
2. Pupil activity instead of teacher activity may be emphasized.
3. It affords challenges to brighter pupils.
4. It permits more complete mastery according to individual capacity.
5. It procures individual pupil effort to a greater degree.
6. It permits the use of a wide variety of learning activities such as extensive reading, problems, individual experiments, projects, oral reports, written reports, and the like.
7. It facilitates remedial work.

The success of the unit plan depends on the skill of the teacher. Regarding the role of the teacher, Walters said:

The unit plan depends on the teacher for its inception, direction, and completion. This demands that the teacher be one who has a definite philosophy of life and a wide background of experience as well as a technique of teaching. The teacher must provide suitable situations for promoting these activities and experiences through the pupil or the community. The teacher must also see that individual differences are considered.

There is no one best method of teaching science, but

27 Hoff, op. cit., p. 119.
28 Loc. cit.
the teacher should use the best parts of each method and the ones that best fits his personality. A method of teaching that has proved very satisfactory to one teacher may not for another. A teacher should be aware of the advantages and disadvantages of each method and then decide on the methods that she finds most effective.

Testing and Evaluation

Many types of devices may be used for evaluation of the achievement and progress of the student. The Forty-Sixth Yearbook gave the following list of evaluation devices:

1. Evaluation by paper-and-pencil devices: (verbal tests, either "objective" or "essay" in form, Diagrams, pictures, charts, etc., Rating scales and check lists.
2. Analysis of work products according to acceptable criteria (apparatus set-ups, notebooks, student collections, committee reports, etc.)
3. Classroom questioning and discussion.
4. Observation and recognition of significant behavior, either informal, as in day-by-day classroom or laboratory activities, or,
5. Conferences and interviews with individuals or with small groups.

The purpose here is not to judge which method is the best to use. However, the trends in testing and evaluation as expressed by science teachers are as follows: (in order of decreasing frequency)

1. More objective tests should be used in science teaching.
2. Standardized tests have many values for science teaching, particularly for diagnostic purposes.

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30 N.S.S.E., Forty-Sixth Yearbook, op. cit., pp. 252-3.
3. All the objectives of science teaching should be evaluated.
4. Science examinations should contain questions which require students to apply principals of science to life situations.
5. Test results should function in the guidance of students.  

CHAPTER III

ANALYSIS OF QUESTIONNAIRE

The purposes of this chapter are to present the information received on the questionnaire and to determine whether or not this information indicated any trends in the teaching of physics in the third class high schools of Montana. Each question from the questionnaire is analyzed separately and in the same order as it appeared in the questionnaire, Appendix A.

Curriculum and Materials

How often does the school offer physics? Of the twenty-one schools from which questionnaires were received, nineteen were teaching physics once every two years, one school taught physics every year, and one school taught physics only on demand. The Part-A report indicated that almost all of the schools alternated chemistry and physics in the school program. Seventeen teachers were currently teaching physics the year that this survey was made, while four had taught it sometime previous to that year.

How many years have you taught physics? As shown in Table I one teacher had more than six years of teaching experience in physics. Eighty-six percent of the teachers had three years or less experience in teaching physics. The average number of years of experience was two and
two-tenths years and the median was three years. The returns of this questionnaire included seventeen out of a total of twenty-four schools that offered physics in the third class high schools of Montana in 1953-1954. The questionnaires returned indicated that most of the teachers in the third class high schools of Montana had had relatively little experience in the teaching of physics and were teaching physics for the first or second time.

In how many different schools have you taught physics? Nine teachers had done all of their physics teaching in one school while nine more had taught physics in two different schools. Two teachers had teaching experience in three different schools and one teacher had taught physics in five schools. Considering the small number of years of teaching experience for physics teachers and the number of different schools in which they taught physics would indicate considerable amount of shifting of physics teachers in the small high schools.

How much time is scheduled for physics class each week? Over half of the school reported that they had 315 minutes for physics classes each week. This was divided into three 45 minute periods each week for classwork and two 90 minute periods for laboratory work. A survey made by the Office of Education\(^1\) showed that most of the schools over the

TABLE I

PERCENTAGE BAR GRAPH ON NUMBER OF YEARS TEACHING PHYSICS AS REPORTED BY 21 MONTANA PHYSICS TEACHERS

<table>
<thead>
<tr>
<th>Years</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 YEAR</td>
<td>29%</td>
</tr>
<tr>
<td>2 YEARS</td>
<td>29%</td>
</tr>
<tr>
<td>3 YEARS</td>
<td>29%</td>
</tr>
<tr>
<td>4 YEARS</td>
<td>5%</td>
</tr>
<tr>
<td>5 YEARS</td>
<td>0%</td>
</tr>
<tr>
<td>6 YEARS</td>
<td>5%</td>
</tr>
<tr>
<td>OVER 7 YEARS</td>
<td>5%</td>
</tr>
</tbody>
</table>

MEAN 3.0

TABLE II

PERCENTAGE BAR GRAPH ON USE OF STATE COURSE OF STUDY AS REPORTED BY 21 MONTANA PHYSICS TEACHERS

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>FREQUENTLY</td>
<td>9%</td>
</tr>
<tr>
<td>SOMETIMES</td>
<td>21%</td>
</tr>
<tr>
<td>SELDOM</td>
<td>9%</td>
</tr>
<tr>
<td>NOT AT ALL</td>
<td>57%</td>
</tr>
</tbody>
</table>
nation had either five 60 minute periods or seven 45 minute periods each week for physics. Two schools in Montana had as much as 450 minutes per week, while three schools had but 225 minutes of time. The majority of schools had from 135 to 180 minutes of laboratory time per week with two days set aside for laboratory work. The general length of the laboratory period was 90 minutes. The Forty-Sixth Yearbook\textsuperscript{2} does not recommend that laboratory work be confined to regularly scheduled periods each week. Modern authorities recommend that each physics class be approximately sixty minutes in length and that experiments or laboratory work be done as the need arises.

To what extent is the State Course of Study\textsuperscript{3} used? As Table II indicates, fifty-seven percent of the teachers made no use of the State Course of Study for physics. Only two teachers used the course of study frequently, and two more teachers made seldom use of it. The present State Course of Study for Physics was prepared in 1928 and its method of presentation is outmoded. This probably accounts for its limited use by teachers today.

What is the title and author of the basic textbook? Two physics textbooks were generally used by the teachers.

\begin{itemize}
\item \textsuperscript{3} "Course of Study in General Science, Biology, Chemistry and Physics for Montana High Schools," The State Department of Public Instruction, 1928 (Helena, Montana) 92 pp.
\end{itemize}
Eight teachers used *Elements of Physics* by Fuller, Brownlee, and Baker and seven teachers used *High School Physics* by Blackwood, Herron, and Kelly. No other textbook was used by more than two teachers. Following is a complete list of textbooks used by 21 teachers of physics in the third class high schools of Montana:

- Fuller, Baker, and Brownlee, *Elements of Physics* (Boston: Allyn and Bacon, 1952)

What is the title and author of the laboratory manual? Most teachers reported using laboratory manuals that accompanied the textbooks that they were using. As a result the laboratory manuals by Blackwood, Herron, and Kelly and by Fuller, Brownlee, and Baker proved to be the most popular. Over half of the teachers were using one or the other of these two manuals. No other laboratory book was reported being used by more than two teachers. One teacher did not use a laboratory manual because of no laboratory equipment and facilities.

Other books or reference used in the course. Of the
twenty-one teachers reporting, five did not give any "Other references used". The use of other physics textbooks and encyclopedias was listed by most of the teachers. Five teachers used the Handbook of Chemistry and Physics. Following is a list of the periodicals that were used by the teachers:

Scientific American
Science Digest
Science News Letter
Popular Science
Science Illustrated
Current Science and Aviation
Life Magazine (some issues)

The Science Digest was the periodical that was most used as a reference by teachers.

In the teaching of physics, what objectives are kept in mind: most important objectives, secondary importance? Instead of trying to summarize all of the different objectives of the reporting teachers, a list of some of the more common objectives are listed. No distinction is made between the most important and the secondary objectives because of the overlapping of them in the opinions of the different teachers. Following is a list of those that were listed most often by teachers:

To gain an understanding of the social significance of science.

To stimulate individual experimentation and practical application

---

To give students a working knowledge of the physical world in which he is to make a living.

To understand the laws of matter and energy and their application.

To cultivate the inquiring mind.

To logical analyze the situations based on evidence and not prejudiced reactions.

To appreciate the place of physics in their environment.

To teach students to think objectively and analyze all sides of a problem.

These objectives have about the same basic ideas as those objectives expressed by authorities in the teaching of science in the secondary school. These were summarized adequately in the Forty-Sixth Yearbook on the major objectives of science teaching:

A. Providing opportunities for the growth in the understanding of facts.
B. Providing for development of functional concepts.
C. Providing for growth in the functional understanding of principles.
D. Providing opportunity for growth in basic instrumental skills.
E. Providing opportunity for growth of skill in the use of elements of scientific method.
F. Providing for growth in the development of scientific attitudes.
G. Providing for growth in the development of appreciations.
H. Providing for growth in the development of interests

Croxton has set up the following as general objectives to the teaching of science:

(1) To cultivate scientific attitudes and methods of procedure.
(2) To tend to broaden concepts, generalizations and outlooks.

5 N.S.S.E., Forty-Sixth Yearbook, op. cit., p. 209.
(3) To open new avenues of interest and satisfaction.  
(4) To enable the individual to meet the problems of existence with the available knowledge and requisite skills.  
(5) To develop social attitudes and appreciations.  

Teaching Methods

As pointed out in Chapter I, twenty-four third class schools were teaching physics the year that this survey was made. Questionnaires were returned from seventeen of these schools representing seventy-one percent of the schools teaching physics. The conclusions from the following questions will represent the seventy-one percent of the third class school returning questionnaires and from four more schools that taught physics the year preceding this survey.

Approximately what percent of the laboratory work was teacher demonstration? Table III points out that five percent of the school returning questionnaires had more than fifty percent of the laboratory work done as teacher demonstration. In eighty-five percent of the schools more than seventy-five percent of the laboratory work was student done. This indicates that the students in the third class high schools have a sufficient opportunity to do individual laboratory work.

Approximately what percent of teacher experiments

**TABLE III**

PERCENTAGE BAR GRAPH ON PERCENT OF LABORATORY WORK WAS TEACHER DEMONSTRATION AS REPORTED BY 21 PHYSICS TEACHERS

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10%</td>
<td>38%</td>
</tr>
<tr>
<td>15%</td>
<td>21%</td>
</tr>
<tr>
<td>25%</td>
<td>14%</td>
</tr>
<tr>
<td>33%</td>
<td>10%</td>
</tr>
<tr>
<td>Over 50%</td>
<td>5%</td>
</tr>
</tbody>
</table>

**TABLE IV**

PERCENTAGE BAR GRAPH ON PERCENT OF TEACHER DEMONSTRATIONS TAKEN FROM LABORATORY MANUAL AS REPORTED BY 20 PHYSICS TEACHERS

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 25%</td>
<td>50%</td>
</tr>
<tr>
<td>33%</td>
<td>15%</td>
</tr>
<tr>
<td>50%</td>
<td>15%</td>
</tr>
<tr>
<td>66%</td>
<td>15%</td>
</tr>
<tr>
<td>Over 75%</td>
<td>15%</td>
</tr>
</tbody>
</table>
were from laboratory manual? As indicated by Table IV most of the teacher demonstrations were not taken from the laboratory manual, but from some other reference. Seventy percent of the teachers took more than half of their experiments from the textbooks or reference materials. Only fifteen percent of the teachers relied mainly on the laboratory manual for their demonstration exercises.

During teacher experiments from laboratory manual were students required to follow manual and record results? The teachers indicated that they expected their students to record the results of the experiments in their laboratory manual as they were done by the teacher. Seventy-nine percent of the teachers always or usually required students to record results, while the remaining twenty-one percent sometimes or never required students to record the results of the teacher demonstrations and experiments.

Were some of the experiments in the laboratory manual performed as student demonstrations rather than teacher? Fifty-two percent of the teachers reported that some of the laboratory experiments were performed as student demonstrations rather than by the teacher. An additional twenty-four percent frequently used student demonstrations, while less than twenty-four percent of the teachers never or very seldom used student demonstrations. This method of teaching appears to be very popular with physics teachers in small Montana high schools.
According to authorities, as mentioned in Chapter II, this device is recommended to stimulate interest and avoid passive learning that might come from too much teacher demonstration.

**How often were teacher demonstrations used to accompany lectures or discussions?** The questionnaires indicated that fifty-three percent of the teachers frequently used demonstrations to accompany lectures or discussions and another forty-two percent made some use of this method. Only five percent of the teachers made no use of demonstrations in the classroom discussions.

**How effective was the above method?** As indicated by Table V more than half of the teachers found the use of demonstrations to accompany lectures and discussions a very effective method of teaching. Twenty-six percent found demonstrations moderately helpful, sixteen percent somewhat helpful, and no teacher found this method of little value.

**How often were teacher demonstrations used to introduce units?** This method was only moderately used as indicated by the teachers returning questionnaires. Twenty-nine percent of the teachers used teacher demonstrations very little or not at all to introduce new units of study, while thirty-seven percent made general or frequent use of this method. One-third of the teachers used it some. However, as the next paragraph points out, the teachers that used this method found it a very effective method of introducing the new unit.
### TABLE V

**PERCENTAGE BAR GRAPH ON EFFECTIVENESS OF THE USE OF TEACHER DEMONSTRATIONS AS REPORTED BY 19 MONTANA PHYSICS TEACHERS**

<table>
<thead>
<tr>
<th></th>
<th>Percentage Bar Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO ACCOMPANY LECTURES</td>
<td></td>
</tr>
<tr>
<td>Very Effective</td>
<td>83%</td>
</tr>
<tr>
<td>Moderately Helpful</td>
<td>26%</td>
</tr>
<tr>
<td>Somewhat Helpful</td>
<td>17%</td>
</tr>
<tr>
<td>Little Value</td>
<td>0%</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TO INTRODUCE UNITS</td>
<td></td>
</tr>
<tr>
<td>Very Effective</td>
<td>50%</td>
</tr>
<tr>
<td>Moderately Helpful</td>
<td>33%</td>
</tr>
<tr>
<td>Somewhat Helpful</td>
<td>17%</td>
</tr>
<tr>
<td>Little Value</td>
<td>0%</td>
</tr>
</tbody>
</table>

### TABLE VI

**PERCENTAGE BAR GRAPH ON TIME OF CHECKING LABORATORY MANUAL AS REPORTED BY 19 MONTANA PHYSICS TEACHERS**

<table>
<thead>
<tr>
<th></th>
<th>Percentage Bar Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each Six Weeks Period</td>
<td>63%</td>
</tr>
<tr>
<td>After Each Unit</td>
<td>26%</td>
</tr>
<tr>
<td>After Each Experiment</td>
<td>26%</td>
</tr>
<tr>
<td>After Each Chapter</td>
<td>0%</td>
</tr>
<tr>
<td>Not At All</td>
<td>0%</td>
</tr>
</tbody>
</table>
of study.

How effective was the demonstration as a method of introducing a new unit? Table V shows that half of the teachers found teacher demonstrations a very effective method of introducing new units and another one-third found it moderately helpful. No teacher reported the demonstration as having little value.

What percent of the student experiments were taken from the laboratory manual? Forty-two percent of the teachers took all the student experiments directly from the laboratory manual. Seventy-four percent of the physics classes had more than three-fourths of their experiments taken from their own laboratory manual. Only two teachers reported using the laboratory manual for less than half of the student experiments. This indicated that the laboratory manual is an important aid to the physics laboratory and almost all of the experiments done by the students followed the manual.

How many of the experiments were absent students required to make-up? Most teachers required the students to make up the largest part of the experiments that were missed through absence. Thirty-five percent of the teachers had students make up all experiments missed and forty percent had students make up those experiments that were considered by the teacher to be the most important ones. One fourth of the teachers didn't have the students make up any of the missed laboratory work.
What method of supervision of experiments was used? The method of supervision of experiments preferred by fifty-eight percent of the teachers was having the students follow the directions from the manual while the teacher kept the class working together as much as possible. Twenty-six percent of the teachers allowed the students to progress at their own rate, while sixteen percent of the teachers gave the directions from the manual and kept the class working at the same rate.

How often was the laboratory manual checked by the teacher? As shown by Table VI most of the teachers preferred to check the laboratory manuals each six-weeks period. Twenty-six percent of the teachers checked them after each experiment, the same percent after the completion of each unit. The remaining forty-eight percent checked the laboratory manual after the end of each six-weeks period. All the teachers indicated that they checked the manual at some time.

What reasons prevented the use of more laboratory experiments by students? As indicated by Table VII sixty-three percent of the schools reported that lack of time was a minor reason for not having more individual laboratory work, while twenty-one percent gave lack of time as a major reason. However, lack of equipment was listed as the major reason by seventy-six percent of the teachers and another ten percent gave it as a secondary reason. Lack of facilities was another major reason for limited individual laboratory work.
<table>
<thead>
<tr>
<th></th>
<th>LACK OF TIME</th>
<th></th>
<th>LACK OF EQUIPMENT</th>
<th></th>
<th>LACK OF FACILITIES</th>
<th></th>
<th>CLASS TOO LARGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAJOR</strong></td>
<td>21%</td>
<td><strong>MAJOR</strong></td>
<td>76%</td>
<td><strong>MAJOR</strong></td>
<td>53%</td>
<td><strong>MAJOR</strong></td>
<td>0%</td>
</tr>
<tr>
<td><strong>SECONDARY</strong></td>
<td>16%</td>
<td><strong>SECONDARY</strong></td>
<td>10%</td>
<td><strong>SECONDARY</strong></td>
<td>28%</td>
<td><strong>SECONDARY</strong></td>
<td>0%</td>
</tr>
<tr>
<td><strong>MINOR</strong></td>
<td>37%</td>
<td><strong>MINOR</strong></td>
<td>0%</td>
<td><strong>MINOR</strong></td>
<td>5%</td>
<td><strong>MINOR</strong></td>
<td>10%</td>
</tr>
<tr>
<td><strong>NOT SIGNIFICANT</strong></td>
<td>26%</td>
<td><strong>NOT SIGNIFICANT</strong></td>
<td>4%</td>
<td><strong>NOT SIGNIFICANT</strong></td>
<td>14%</td>
<td><strong>NOT SIGNIFICANT</strong></td>
<td>90%</td>
</tr>
</tbody>
</table>
work. The size of the class was not an influence on the amount of individual laboratory work done by the students. The physics students of the third class high schools of Montana were apparently handicapped in their laboratory work because of the lack of equipment and facilities. Most schools have enough time for laboratory work and none of the classes were too large to hinder the laboratory program.

Were students allowed to carry on experiments of their own interest? As pointed out in Table VIII almost half of the schools regularly allowed the students to carry on experiments of their own choosing outside of the scheduled class time. Only nineteen percent of the schools did not permit the students to do laboratory work in line with their own interest. To schools reported that the students were allowed to do the experiments, but the students had no interest in doing them.

Were many experiments more effective if teacher done rather than student done? More than half of the teachers reported that several of the experiments were more effective if performed by the teacher. Nineteen percent of the teachers said that a good many should be teacher done. This indicates that teachers should perform some of the laboratory experiments; however, only through experience can the teacher determine which experiments are more effective if performed by the teacher.
TABLE VIII

PERCENTAGE BAR GRAPH INDICATING IF STUDENTS WERE ALLOWED TO CARRY ON EXPERIMENTS OF OWN INTEREST AS REPORTED BY 21 MONTANA PHYSICS TEACHERS

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regularly</td>
<td>48%</td>
</tr>
<tr>
<td>Seldom</td>
<td>9%</td>
</tr>
<tr>
<td>Very Little</td>
<td>24%</td>
</tr>
<tr>
<td>None</td>
<td>19%</td>
</tr>
</tbody>
</table>

TABLE IX

PERCENTAGE BAR GRAPH ON RATING OF LABORATORY MANUALS BY 19 MONTANA PHYSICS TEACHERS

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>0%</td>
</tr>
<tr>
<td>Very Good</td>
<td>67%</td>
</tr>
<tr>
<td>Good</td>
<td>12%</td>
</tr>
<tr>
<td>Fair</td>
<td>5.5%</td>
</tr>
<tr>
<td>Poor</td>
<td>5.5%</td>
</tr>
</tbody>
</table>
How do you rate your laboratory manual? Table IX gives the percentage breakdown on how teachers rated their laboratory manual. Eighty-nine percent of the teachers either rated their manual very good or good and eleven percent rated them fair or poor. This indicates that most teachers were satisfied with their laboratory manual. The teacher using the laboratory manual to accompany Whitman and Peck's textbook gave the manual a poor rating. The most favorable rating was given to the manual that accompanies Fuller, Baker, and Brownlee's textbook *Elements of Physics* (see page 26).

Classroom

What extent was the lecture method used to present material to the class? Table X points out that the lecture method was commonly used in seventy-one percent of the classrooms. Only one teacher reported not using this method to present material to the class. One teacher used it very little. This indicates that the lecture is a very common method of teaching in the third class high schools of Montana.

How often were student panels used to present material? Sixty-three percent of the teachers made no use of student panels to present new material to the class (see Table X). No teacher reported using this method frequently and eleven percent used it some. Using the student panel to present material to the class evidently is not a common method of teaching physics.
How many field trips are taken each year? No school reported taking more than two field trips each year in the physics class. One-third of the classes did not take any trips and approximately another one-third had only one. Twenty-nine percent had two field trips. The small community does not offer the opportunity of the larger communities for field trips, but the good physics teacher will take advantage of all the community resources possible to improve the physics program.

To what extent do students do oral reading in class? Physics teachers of the small high school reported that they have the students do very little oral reading in class. Ninety percent of the teachers had none or very little oral reading in the classroom. As pointed out in Table X only one teacher used this method frequently. Evidently the teachers preferred to use the class time for lectures, demonstrations, and recitation.

How many oral reports are given? The use of oral reports by the students is another teaching device that is not often used by the teachers. Table X indicates that two-thirds of the teachers either did not or seldom used this method. One teacher reported using oral reports by the students frequently in his classroom. Oral reports given by the students is a method of having new ideas and applications in physics presented to the entire class.
### TABLE X

PERCENTAGE BAR GRAPH ON USE OF SOME TEACHING METHODS AS REPORTED BY 21 TEACHERS

<table>
<thead>
<tr>
<th></th>
<th>LECTURE</th>
<th>STUDENT PANELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequently</td>
<td>74%</td>
<td>0%</td>
</tr>
<tr>
<td>Sometimes</td>
<td>19%</td>
<td>11%</td>
</tr>
<tr>
<td>Very little</td>
<td>5%</td>
<td>26%</td>
</tr>
<tr>
<td>Not used</td>
<td>5%</td>
<td>63%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>ORAL READING</th>
<th>ORAL REPORTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequently</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Sometimes</td>
<td>5%</td>
<td>29%</td>
</tr>
<tr>
<td>Very little</td>
<td>52%</td>
<td>43%</td>
</tr>
<tr>
<td>Not used</td>
<td>38%</td>
<td>19%</td>
</tr>
</tbody>
</table>

### TABLE XI

PERCENTAGE BAR GRAPH ON NUMBER OF FILMS USED BY 21 MONTANA SCHOOL TEACHERS

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Two or more per week</td>
<td>0%</td>
</tr>
<tr>
<td>One per week</td>
<td>5%</td>
</tr>
<tr>
<td>One every two weeks</td>
<td>5%</td>
</tr>
<tr>
<td>One every three weeks</td>
<td>19%</td>
</tr>
<tr>
<td>One every month</td>
<td>9%</td>
</tr>
<tr>
<td>Less than one a month</td>
<td>62%</td>
</tr>
</tbody>
</table>
What portion of the class time is recitation? The majority of teachers used approximately one-half of the class time for recitation. Ten percent of the teachers used three-fourths of the class period and five percent used the entire class period for recitation. All teachers reported having some recitation in their class. The questionnaire indicated that the physics class time is about equally divided between lecture and recitation with other methods of teaching used very infrequently.

How many films are used in the physics classroom? The teachers reported that few films were used in the physics classes. Sixty-two percent of the teachers used less than one film per month. As indicated in Table XI no teacher used more than one film per week and only one teacher used as many as one per week. The average number of films used by 21 Montana physics teachers was about eight films during the school year. The use of motion pictures should be an important aid in the teaching of physics. The Forty-Sixth Yearbook devoted several pages to the use of films in science:

Motion pictures and slidefilms may be used to achieve many of the objectives of science teaching. Motion pictures and slidefilms are in most cases the next best thing to direct experience when such experience is impossible. They have two special values. They may depict excellent instruction, thus serving as a sample for the effective use of equipment and materials in teaching science, as well as illustrating good method and content. Also, they may, by virtue of their unique characteristics, illustrate scientific phenomena which cannot be seen by the naked eye.7

7 N.S.S.E., Forty-Sixth Yearbook, op. cit., p. 111.
Approximately what percent of the films are from the State Film Library? Over half of the teachers received less than forty-five percent of their films in physics from the State Film Library at Helena, Montana. Fourteen percent of the schools got all of their physics films from the State Library and another fourteen percent received three-fourths of the films from the State Library, but the rest of the schools got most of their films from other sources. A large number of films are available to the teacher of physics. The State Film Library lists in its catalog 75 films on physics. Heiss, Obourn, and Hoffman in their book Modern Science Teaching have prepared a list with addresses of over 140 corporation, government agencies, and service organizations that have films on physics and closely related topics available rent-free to high schools.

How effective is the use of films in the teaching of physics? As indicated by Table XII twenty-five percent of the teachers reported that films were very effective in the teaching of physics. Another forty percent said that films were moderately helpful while only ten percent said they were of little value. This indicates that films are considered

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8 Catalog of Films, Montana State Library of Visual Aids in Education (Helena, Montana, State Department of Public Instruction, 1954) p. 44.

moderately helpful as a teaching aid in physics by twenty-one Montana teachers.

How many projects does each student have during the year? Nineteen percent of the teachers had the students do more than four projects during the year. Sixty-two percent required one or two projects, while nineteen percent of the teachers reported not requiring the students to do any projects. The average number of projects done by the students was two.

Testing and Evaluation

How often are major (full period) tests given? Table XIII points out that one-fourth of the teachers gave a major examination to the students every two weeks; another forty-five percent gave tests every three weeks; while the remaining thirty percent gave a major test once every six weeks. No teacher reported giving a major examination oftener than every two weeks or less often than every six weeks with an average of one major examination every three weeks.

How often are minor (partial period) tests given? Table XIII also indicates that the majority of physics teachers reported giving a partial period test every week. One teacher gave more than one minor test a week and seven reported giving less than one per week.

Is time allowed in class for reviewing for major and minor tests? Eighty percent of the teachers usually or always spent class time to review for the major examinations.
### TABLE XII

PERCENTAGE BAR GRAPH ON EFFECTIVENESS OF THE USE OF FILMS AS REPORTED BY 20 PHYSICS TEACHERS

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Effective</td>
<td>25%</td>
</tr>
<tr>
<td>Moderately Helpful</td>
<td>10%</td>
</tr>
<tr>
<td>Somewhat Helpful</td>
<td>25%</td>
</tr>
<tr>
<td>Little Value</td>
<td>10%</td>
</tr>
</tbody>
</table>

### TABLE XIII

PERCENTAGE BAR GRAPH ON TEST-GIVING BY 20 MONTANA PHYSICS TEACHERS

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FULL PERIOD TEST</strong></td>
<td></td>
</tr>
<tr>
<td>Once a Week</td>
<td>0%</td>
</tr>
<tr>
<td>Bi-Weekly</td>
<td>25%</td>
</tr>
<tr>
<td>Tri-Weekly</td>
<td>15%</td>
</tr>
<tr>
<td>Every Six Weeks</td>
<td>30%</td>
</tr>
<tr>
<td>Once a Semester</td>
<td>0%</td>
</tr>
<tr>
<td><strong>PARTIAL PERIOD TEST</strong></td>
<td></td>
</tr>
<tr>
<td>2-4 Times a Week</td>
<td>5%</td>
</tr>
<tr>
<td>Once a Week</td>
<td>10%</td>
</tr>
<tr>
<td>Bi-Weekly</td>
<td>10%</td>
</tr>
<tr>
<td>Tri-Weekly</td>
<td>20%</td>
</tr>
<tr>
<td>Every Six Weeks</td>
<td>5%</td>
</tr>
</tbody>
</table>
Only one teacher seldom reviewed for the full period tests and fifteen percent reviewed sometimes. This indicates that the teachers usually reviewed for their major tests. However, most teachers reported spending no or little time reviewing for the minor tests. Five percent of the teachers always reviewed for these tests and another fifteen percent usually spent some time reviewing for the partial period test.

Approximately what portion of the major tests were made up of problems? Mathematical problems still play an important part in the physics examination. All teachers reported using problems in the tests. Sixty-two percent of the teachers had approximately one-fourth of the test made up of problems, while the rest of the teachers had about one-half of the test made up of problems.

What methods were used in determining the grades of the students? As indicated in Tables XIV and XV several methods were used by various teachers to determine the grades received by the students in physics. Teacher-made tests were the major factor used by the teachers in grading. Ninety-six percent of the teachers used teacher-made tests and eighty-one percent made them an important part of grading. The five factors that most influenced the student grades were in order the following: (1) teacher-made tests, (2) class participation, (3) laboratory manual, (4) attitude in class, and (5) laboratory technique. The five factors least used in grades were
### Table XIV

**Percentage Bar Graph Rating Importance of Various Methods of Grading as Used by 21 Montana Physics Teachers**

<table>
<thead>
<tr>
<th>Method</th>
<th>Major</th>
<th>Secondary</th>
<th>Minor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Participation</td>
<td>33%</td>
<td>29%</td>
<td>19%</td>
</tr>
<tr>
<td>Tests from Workbook</td>
<td>15%</td>
<td>21%</td>
<td>5%</td>
</tr>
<tr>
<td>Standardized Tests</td>
<td>10%</td>
<td>21%</td>
<td>5%</td>
</tr>
<tr>
<td>Class Attitude</td>
<td>25%</td>
<td>21%</td>
<td>10%</td>
</tr>
<tr>
<td>Laboratory Technique</td>
<td>15%</td>
<td>21%</td>
<td>5%</td>
</tr>
<tr>
<td>Class Discipline</td>
<td>15%</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Tests from Textbook</td>
<td>15%</td>
<td>21%</td>
<td>5%</td>
</tr>
<tr>
<td>Teacher Made Tests</td>
<td>81%</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Grading of Reports</td>
<td>19%</td>
<td>21%</td>
<td>11%</td>
</tr>
<tr>
<td>Laboratory Manual</td>
<td>19%</td>
<td>21%</td>
<td>11%</td>
</tr>
</tbody>
</table>

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TABLE XV

PERCENTAGE BAR GRAPH OF METHODS USED TO DETERMINE GRADES AS REPORTED BY 21 MONTANA PHYSICS TEACHERS

<table>
<thead>
<tr>
<th>Method</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Made Tests</td>
<td>96%</td>
</tr>
<tr>
<td>Class Participation</td>
<td>81%</td>
</tr>
<tr>
<td>Laboratory Manual</td>
<td>77%</td>
</tr>
<tr>
<td>Class Attitude</td>
<td>72%</td>
</tr>
<tr>
<td>Laboratory Technique</td>
<td>71%</td>
</tr>
<tr>
<td>Class Discipline</td>
<td>62%</td>
</tr>
<tr>
<td>Tests from Textbook</td>
<td>57%</td>
</tr>
<tr>
<td>Grading of Reports</td>
<td>57%</td>
</tr>
<tr>
<td>Standardized Tests</td>
<td>41%</td>
</tr>
<tr>
<td>Grading of Projects</td>
<td>33%</td>
</tr>
<tr>
<td>Tests from Workbook</td>
<td>25%</td>
</tr>
</tbody>
</table>

TABLE XVI

PERCENTAGE BAR GRAPH PERCENT OF FINAL GRADE BASED ON DAILY ASSIGNMENTS AS USED BY 21 MONTANA PHYSICS TEACHERS

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 75%</td>
<td>15%</td>
</tr>
<tr>
<td>66%</td>
<td>11%</td>
</tr>
<tr>
<td>50%</td>
<td>18%</td>
</tr>
<tr>
<td>33%</td>
<td>21%</td>
</tr>
<tr>
<td>25%</td>
<td>14%</td>
</tr>
<tr>
<td>Less than 25%</td>
<td>5%</td>
</tr>
</tbody>
</table>
in order as follows: (1) tests from workbooks, (2) grading of projects, (3) standardized tests, (4) grading of reports, and (5) tests from textbook. Discipline of the student in the classroom was a factor in determining the grades as reported by sixty-two percent of the teachers. However, it was usually considered a minor factor.

Assignments

How often were written assignments required? Almost one-half of the teachers reported that they gave the students one written assignment a week. No teacher gave a written assignment every day, but nineteen percent had three assignments a week. Fourteen percent of the teachers gave less than one assignment per week, but the average assignments were one and one-half per week.

How many of the written assignments were corrected by the teacher? Most of the physics teachers of the third class high schools of Montana corrected the majority or all of the written assignments turned in by the students. Forty-three percent (see Table XVII) of the teachers checked all the written assignments and another forty-three percent checked most of the assignments. One teacher reported not correcting any of the written assignments turned in by students.

Is the same assignment given to all students? As pointed out in Table XVIII all of the teachers returning questionnaires either always or usually gave the same
### Table XVII

**Percentage Bar Graph on Written Assignments Corrected by the Teacher as Reported by 21 Montana Physics Teachers**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>14%</td>
</tr>
<tr>
<td>Most</td>
<td>14%</td>
</tr>
<tr>
<td>Some</td>
<td>10%</td>
</tr>
<tr>
<td>Very Few</td>
<td>0%</td>
</tr>
<tr>
<td>None</td>
<td>5%</td>
</tr>
</tbody>
</table>

### Table XVIII

**Percentage Bar Graph on Number of Same Assignments Given to All Students as Reported by 21 Physics Teacher**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td>57%</td>
</tr>
<tr>
<td>Usually</td>
<td>13%</td>
</tr>
<tr>
<td>Sometimes</td>
<td>0%</td>
</tr>
<tr>
<td>Seldom</td>
<td>0%</td>
</tr>
<tr>
<td>Never</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Table XIX

**Percentage Bar Graph on Amount of Reference Book Reading Assignments Given by 21 Montana Physics Teachers**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usually</td>
<td>13%</td>
</tr>
<tr>
<td>Frequently</td>
<td>10%</td>
</tr>
<tr>
<td>Some</td>
<td>38%</td>
</tr>
<tr>
<td>Very Little</td>
<td>29%</td>
</tr>
<tr>
<td>Never</td>
<td>19%</td>
</tr>
</tbody>
</table>
assignments to all of the students. This indicates that the teachers made little effort to give differentiated assignments to the above average, average, and below average students.

How often is a written report required? The teachers required very few written reports from the students. Twenty-nine percent did not require any and forty-seven percent required very few written reports. Three teachers frequently required written reports as part of the assignments.

Are extra reading and reference book reading assignments given? According to Table XIX fifteen percent of the teachers frequently gave reference book reading assignments while about half of the teachers used reference reading very little or not at all. The remainder of the teachers used this method some. This indicates that the giving of extra reading and reference book reading assignments was not popular with physics teachers in the small Montana high schools.

Are students required to make-up assignments missed through absence? Sixty-one percent of the teachers always required all assignments missed through absence to be made up and turned in. Another twenty-nine percent usually required the assignments to be made up and ten percent sometimes had the assignments be made up. No teachers reported having none of the missed assignments being made up and handed in.
What percent do the daily assignments count on the final grade? Table XVI indicates that thirty-eight percent of the teachers returning questionnaires counted the daily assignments as half of the final grade in physics. One teacher based more than seventy-five percent of the final grade on daily work while another teacher counted the daily work as less than twenty-five percent of the grade. As reported by twenty-one teachers the daily assignment counted an average of forty-four percent of the final grade.

Questions number twenty-five, thirty-nine, forty-nine, and fifty-one of the questionnaire, Appendix A, were omitted from this analysis as they did not contain data pertinent to this paper, although at the time of making out the questionnaire they did seem to have some value.
CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purposes of this survey were (1) to determine the primary and secondary objectives of the general physics course as used by teachers in the small high school, (2) to make a survey of teaching methods used in physics classes of third class high schools in Montana, (3) to summarize the teaching techniques in physics as reported in related materials, and (4) to summarize the methods of teaching physics most widely used by Montana teachers.

A questionnaire sent to physics teachers was the primary source of data used for this study. Secondary sources of information were related literature and the state course of study. The questionnaire was prepared from information received during interviews with several physics teachers during the summer of 1953.

The Part-A High School Reports were used to determine the third class high schools that were teaching physics and also the names of the teachers. The questionnaires were mailed to twenty-nine teachers, and twenty-one were returned representing seventy-two and four-tenths of those mailed.

The questionnaire was divided into two categories: curriculum and materials, and teaching methods. The teaching methods were further broken down into four subdivisions:
laboratory, classroom, testing and evaluation, and assignments. The purpose of the questionnaire was to determine some trends in the methods of teaching physics in the third class high schools of Montana.

The data were then tabulated and used as a basis for Chapter III, Analysis of Questionnaire.

Conclusions and Recommendations

Curriculum and materials. One-fourth of the third class high schools of Montana offered physics in their curriculum on alternating years. Two-thirds of the teachers teaching physics in the third class high schools returned questionnaires and these teachers had an average of two years of experience teaching physics. There is variation between schools on the length of class periods and time devoted for laboratory work, but this variation seems to be common all over the country.

The lack of the use of the State Course of Study is probably due to the fact that it has not been revised since 1928. This is a poor situation considering the advances made in the field the past few years. A new course of study should be developed.

Physics is losing popularity in the school curriculum. Fewer students are taking physics and fewer schools are offering physics. The chief cause of this is that physics had undergone very little reorganization in the past fifty years and physics has gone stale as a subject.
Two textbooks were in general use by the teachers: *Elements of Physics* by Fuller, Brownlee, and Baker and *High School Physics* by Blackwood, Herron, and Kelly. The laboratory manuals that accompany these textbooks were recommended by the teachers as being satisfactory. Few teachers reported using reference books, but several periodicals were in frequent use. Since new ideas and theories are continually being developed in physics, up-to-date reference material is a "must" for a complete course in physics.

The objectives as listed by Montana physics teachers were about the same as those objectives expressed by authorities in the teaching of science in the secondary school.

**Teaching Methods**

Four methods of teaching were found to be very common in the small Montana high schools. These methods were: laboratory, demonstration, lecture, and question and answer. Approximately three-fourths of the laboratory work was done by the student with the remaining one-fourth being done as student or teacher demonstration. Most of the experiments performed by the students were taken from the laboratory manual, while the teacher demonstrations were taken from the textbook or reference materials. Teachers found the use of demonstrations an excellent method of introducing new units and very effective when used to accompany lectures or discussions.

Montana physics teachers in the third class districts
were handicapped by a lack of laboratory equipment and facilities. Time and size of the class were not important factors in determining the amount of laboratory work performed by the students. The teachers and administrators should put forth all the effort possible to secure proper laboratory equipment and facilities for their physics program. The teachers generally allowed the students to do experiments of their own interest.

The following methods of teaching were not often used by the teachers taking part in this survey: student panels, oral reading, oral reports, outside or reference reading, and projects. The physics classroom time was largely taken up with lectures and discussion with other methods of teaching used very little. This indicates that the physics classes were teacher dominated, which was the trend in teaching physics over the country.

Few motion pictures or slidefilms were used by the physics teachers. Most of the films were secured from sources other than the State Film Library, because many of the teachers were dissatisfied with the service of the state library. Many principles of physics are presented in an excellent manner by films and their use should be an important aid the teaching of physics.

The teachers seemed to use the traditional types of tests and tried to add the students' class attitude and class participation to the test results. The sum of these along with the laboratory techniques seemed to make the basis for
the students' grades.

Written assignments played an important part in the teaching of physics. Most teachers still demanded that the students turn in several written assignments per week and a large percentage of their final grade was based on these assignments.

The methods of teaching physics in the small high schools of Montana were basically the same as those used by physics teachers over the country. They still rely on the traditional methods of teaching and have not allowed the progressive methods alter their pattern.
A. BOOKS


B. PERIODICAL ARTICLES


November 30, 1953

Dear Fellow Physics Teacher:

Once again you are being asked to fill out a questionnaire. As part of my work in the preparation of my thesis for a Masters degree, I need your help in securing information regarding your physics program and your method of teaching the subject.

I have tried to make this instrument as economical of your time as possible and have enlisted the aid of several physics teachers in the construction of a questionnaire in an effort to make it valid. I sincerely hope you will fill it in as accurately and completely as possible, since the survey's validity is completely dependent upon your information.

In the event that you have not taught physics at any school system in the past you should disregard this questionnaire, but even if you are not teaching physics at the present time and have taught it in the past please take the time to fill it out.

All information about any specific school system or teacher will be kept completely confidential and the final paper will not identify any school or teacher.

If you would like a copy of the findings, please indicate on the questionnaire and a copy will be mailed to you.

Joseph Wolpert
Physics teacher
Superior, Montana.
Physics Teaching

in the Third Class High Schools of Montana

Directions: Please fill out all blanks as accurately as possible or check the answer that most nearly agrees with your situation. Where your situation isn't fully covered by the questions, please feel free to add information on the margins or back of the page.

School ___________________ Town or City ___________________

Your name ________________________

Do you wish a copy of the findings?   Yes   No

A. Curriculum and Materials

1. How often is physics offered in your school?   Every year
   Every two years   Only on demand.

2. Are you teaching physics this year?   Yes   No

3. About how many years have you taught physics? ___________

4. In how many different schools have you taught physics? ___________

5. How many minutes do you have for both laboratory and classwork each week? ___________

6. About how much time per week is laboratory work? ___________

7. How long is each laboratory period? ___________

8. To what extent do you use the state course of study in physics?  
   Frequently,   Sometimes   Seldom   Not at all.

9. What is the title and author of your basic textbook(s)?

________________________________________________________________________

10. What is the title and author of your laboratory manual?

________________________________________________________________________

11. Other books or references used in course: (Include pamphlets, bulletins, magazines, encyclopedias and the like. List below.)

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

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12. In your teaching of physics, what objectives do you keep in mind?
Most important objectives: ____________________________
Of secondary importance: ____________________________

B: Teaching methods
I. Laboratory

13. Approximately what percent of laboratory work was teacher demonstration?
   _Less than 10%, ___15%, ___25%, ___33%, ___over 50%._

14. Approximately what percent of teacher experiments were from laboratory manual?
   _Less than 25%, ___33%, ___50%, ___66%, ___over 75%._

15. In teacher experiments from the laboratory manual were students required to follow manual and record results?
   _Always, ___Usually, ___Sometimes, ___Never._

16. Were some of the experiments in the laboratory manual performed as student demonstrations rather than teacher?
   _Frequently, ___Some, ___Very few, ___Never._

17. How often were teacher demonstrations used to accompany lectures or discussions?
   _Frequently, ___Some, ___Very few, ___Never._

18. How effective was the above method if used?
   _Very effective, ___Moderately helpful, ___Somewhat helpful, ___Little value._

19. How often were teacher demonstrations used to introduce units?
   _Not used, ___Very little, ___Some, ___Generally, ___Frequently._

20. How effective was the above method if used?
   _Very effective, ___Moderately helpful, ___Somewhat helpful, ___Little value._

21. What percent of the student experiments were taken from the laboratory manual?
   _100%, ___90%, ___75%, ___66%, ___Less than 50%._

22. How many of the experiments were absent students required to make up?
   _All, ___Only the more important ones, ___None._
23. What method of supervision of experiments were used?
   _ Students progress at own rate, _ Teacher gave directions from manual
   and kept class all working at same rate, _ Students followed directions
   from manual and teacher kept class working together as much as possible.

24. How often was laboratory manual checked by teacher?
   _ After each experiment, _ After completing of each chapter, _ After
   completion of each unit, _ Each six-weeks period, _ Not at all.

25. Approximately what percent of the experiments in laboratory manual were
   done by either students or teacher?
   _ Over 80%, _ 75%, _ 66%, _ 50%, _ Less than 50%.

26. In the following reasons why teacher experiments might have been done in
   place of student experiments, check whether it was a major, secondary,
   minor, or not significant reason.

   Lack of time _ Major _ Secondary, _ Minor, _ Not significant
   Lack of equipment _ Major _ Secondary, _ Minor, _ Not significant
   Lack of facilities _ Major _ Secondary, _ Minor, _ Not significant
   Class too large _ Major _ Secondary, _ Minor, _ Not significant

27. Were students allowed to carry on experiments of their own interest outside
   of class time?
   _ Regularly, _ Seldom, _ Very little, _ None.

28. In your opinion were many experiments more effective if teacher done rather
   than student done?
   _ Good many, _ Several, _ Very few, _ None.

29. How do you rate your laboratory manual?
   _ Superior, _ Very good, _ Good, _ Fair, _ Poor.

II. Classroom

30. To what extent do you use the lecture method of presenting material to your
    class?
    _ Always, _ Frequently, _ Sometimes, _ Very little, _ Not used.

31. How often do you use student panels to present material?
    _ Frequently, _ Some, _ Very little, _ Not used.

32. Approximately how many field trips do you take each school year?
    _ None, _ One, _ Two, _ Three or four, _ Five or more.

33. To what extent do you have students do oral reading in class from textbook
    or reference material.
    _ Frequently, _ Sometimes, _ Very little, _ Not used.

34. How much do you have students give oral reports?
    _ Frequently, _ Sometimes, _ Very little, _ Not used.
35. Approximately what portion of your classtime is given to recitation?
   None, One-fourth, One-third, One-half, Three-fourths, All.

36. On an average how many films do you use in physics?
   Two or more per week, One per week, One every two weeks, on every three weeks, One every month, Less than one a month.

37. Approximately what percent of the films you use from the state film library?
   100%, 75%, 66%, 50%, Less than 45%.

38. How effective do you find the use of films on the teaching of physics?
   Very effective, Moderately helpful, Somewhat helpful, Of little value.

39. What is the maximum size you would recommend for a physics class?
   Less than 10, 10-16, 17-25, 26-32, Over 32.

40. How many projects does each student have during the year?
   None, One, Two, Three, Four or more.

III. Testing and Evaluation

41. How often do you give major (full period) tests?
   Once a week, Bi-weekly, Tri-weekly, Once every six weeks, Once a semester.

42. Do you spend time in class reviewing for the major tests?
   Always, Usually, Sometimes, Seldom, Never.

43. How often do you give a minor (partial period) test?
   2 to 4 times a week, Once a week, Biweekly, Tri-weekly Once every six weeks.

44. Do you spend time in class reviewing for the minor tests?
   Always, Usually, Sometimes, Seldom, Never.

45. Approximately what portion of the major tests are made up of problems?
   None, One-fourth, One-half, Three-fourths, All.

46. Of the methods used in determining the grades of the students, check below with "1" if considered of major importance, with "2" if considered secondary in importance, with "3" if considered but not greatly, and leave blank if not considered at all.
   Class participation, tests from text and lab manual
   Tests from workbook, teacher made-tests
   Standardized tests, grading of reports
   Class attitude, laboratory manual
   Laboratory techniques, projects
   Class discipline, others: list below
IV. Assignments

47. How often do you require written assignments, either problems or questions over the reading assignments?
   - Every day, ___ Three times weekly, ___ Twice weekly, ___ once a week, ___ Less than once a week.

48. How many of the written assignments are corrected or checked by the teacher?
   - All, ___ Most, ___ Some, ___ Very few, ___ None.

49. Do you allow the students to check their own assignments and turn in their grades?
   - Frequently, ___ Sometimes, ___ Seldom, ___ Never.

50. Do you give the same assignments for all students?
   - Always, ___ Usually, ___ Sometimes, ___ Seldom, ___ Never.

51. How often do you give students a definite assignment, either written or reading?
   - Everyday, ___ Four times weekly, ___ Three times weekly, ___ Twice weekly, ___ Once a week.

52. How often do you require a written report of some type?
   - Frequently, ___ Some, ___ Very little, ___ Not used.

53. Do you give extra reading and reference book reading assignments?
   - Usually, ___ Frequently, ___ Some, ___ Very little, ___ Never.

54. Are students required to turn in assignments missed through absence?
   - Always, ___ Usually, ___ Sometimes, ___ Seldom, ___ Never.

55. Approximately what percent do the daily assignments count on the final grade?
   - More than 75%, ___ 66%, ___ 50%, ___ 33%, ___ 25%, ___ Less than 25%.