GRADUATE PREPARATION OF PHYSICS INSTRUCTORS
FOR LIBERAL ARTS COLLEGES

DISSERTATION
Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
GEORGE WILLIAM CRAWFORD, B. S., M. S.

* * * * * *

The Ohio State University
1959

Approved by:

John S. Richardson
Adviser
Department of Education
ACKNOWLEDGMENTS

The writer wishes to thank the members of his committee, Dr. Wave H. Shaffer and Dr. Everett J. Kircher for much valuable assistance and advice concerning this study. To Dr. John S. Richardson, chairman of the committee, under whose inspiration and guidance this study was initiated and completed, the writer is deeply grateful.

In such a study involving the time and energy of hundreds of one's fellow-workers it seems only fitting to express appreciation and thanks for their cooperation. Without the kind and sincere responses from cooperating educational institutions and individual physics instructors this study could not have been made. The writer wishes especially to express his appreciation to the many physics instructors, chairmen of physics departments, and college deans who so enthusiastically responded to the questionnaires upon which this study was based. The writer is also very grateful to the many individuals who so kindly arranged for personal interviews. This was one of the most gratifying phases of the study.
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>II. THE PROBLEM</td>
<td>7</td>
</tr>
<tr>
<td>Nature of the Problem</td>
<td>7</td>
</tr>
<tr>
<td>Graduate Physics Courses Emphasize Research</td>
<td>9</td>
</tr>
<tr>
<td>Effect of Increased Enrollment on the Problem</td>
<td>10</td>
</tr>
<tr>
<td>Purpose and Restrictions of the Study</td>
<td>10</td>
</tr>
<tr>
<td>General Plan of the Study</td>
<td>12</td>
</tr>
<tr>
<td>Evidence of the Problem</td>
<td>13</td>
</tr>
<tr>
<td>Lack of Professional Preparation for College Teaching</td>
<td>13</td>
</tr>
<tr>
<td>Emphasis on Research in the Graduate School</td>
<td>17</td>
</tr>
<tr>
<td>Quantitative Nature of the Problem</td>
<td>19</td>
</tr>
<tr>
<td>Anticipated Shortage of Qualified Physics Teachers</td>
<td>21</td>
</tr>
<tr>
<td>Major Source of College Physics Instructors</td>
<td>26</td>
</tr>
<tr>
<td>Brief Survey of the Development of Doctoral Training in the United States</td>
<td>28</td>
</tr>
<tr>
<td>Factors Which Influenced Early Graduate Study</td>
<td>28</td>
</tr>
<tr>
<td>Establishment of Graduate Instruction and Standardization of the Ph.D. Degree</td>
<td>33</td>
</tr>
<tr>
<td>Factors Which Have Altered the Purpose of the Ph.D. Degree</td>
<td>37</td>
</tr>
<tr>
<td>Need for Distinction in the Training of Prospective Teachers and Other Graduate Students</td>
<td>40</td>
</tr>
<tr>
<td>III. ATTEMPTED SOLUTIONS OF THE PROBLEM</td>
<td>45</td>
</tr>
<tr>
<td>Programs for College Teachers</td>
<td>45</td>
</tr>
<tr>
<td>General Programs</td>
<td>45</td>
</tr>
<tr>
<td>Specific Institutional Programs</td>
<td>53</td>
</tr>
<tr>
<td>Departmental Programs</td>
<td>58</td>
</tr>
<tr>
<td>Internship Programs</td>
<td>59</td>
</tr>
<tr>
<td>Fellowships and Institute Programs</td>
<td>60</td>
</tr>
<tr>
<td>General Features of Present Programs</td>
<td>64</td>
</tr>
<tr>
<td>Specific Evidence of the Problem in Physics and Attempted Solutions</td>
<td>66</td>
</tr>
<tr>
<td>Present Status of Undergraduate Physics Instruction</td>
<td>66</td>
</tr>
<tr>
<td>Attempts to Improve the Quality of Undergraduate Physics Instruction</td>
<td>76</td>
</tr>
<tr>
<td>Summary</td>
<td></td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>IV. METHOD OF SOLVING THE PROBLEM</td>
<td>86</td>
</tr>
<tr>
<td>General Plan for Securing Information</td>
<td>86</td>
</tr>
<tr>
<td>Restrictions of the Study</td>
<td>89</td>
</tr>
<tr>
<td>Questionnaires and Interviews</td>
<td>91</td>
</tr>
<tr>
<td>Questionnaires to Deans and Chairmen of Physics Departments</td>
<td>96</td>
</tr>
<tr>
<td>Qualifications, Strengths and Weaknesses of Physics Instructors</td>
<td>96</td>
</tr>
<tr>
<td>Academic Preparation of Physics Instructors</td>
<td>100</td>
</tr>
<tr>
<td>Professional Preparation of Physics Instructors</td>
<td>107</td>
</tr>
<tr>
<td>Research and the Dissertation</td>
<td>112</td>
</tr>
<tr>
<td>Questionnaire to Physics Instructors</td>
<td>117</td>
</tr>
<tr>
<td>Summary</td>
<td>120</td>
</tr>
<tr>
<td>V. RESULTS OF THE STUDY</td>
<td>121</td>
</tr>
<tr>
<td>Consolidation of Replies from Questionnaires</td>
<td>121</td>
</tr>
<tr>
<td>Qualifications, Strengths and Weaknesses of Physics Instructors</td>
<td>124</td>
</tr>
<tr>
<td>Desired Qualifications of Physics Instructors</td>
<td>124</td>
</tr>
<tr>
<td>Strengths and Weaknesses of Beginning Physics Instructors</td>
<td>128</td>
</tr>
<tr>
<td>Difficulties Encountered by Beginning Physics Instructors</td>
<td>134</td>
</tr>
<tr>
<td>Academic Preparation of College Physics Teachers</td>
<td>139</td>
</tr>
<tr>
<td>Thorough Preparation in Physics and Mathematics</td>
<td>139</td>
</tr>
<tr>
<td>Interdepartmental Programs and Allied Courses</td>
<td>111</td>
</tr>
<tr>
<td>Programs Which Include Humanities, Social Studies or Philosophy</td>
<td>116</td>
</tr>
<tr>
<td>Nature of Graduate Programs of Physics Instructors</td>
<td>151</td>
</tr>
<tr>
<td>Courses Which Physics Instructors Should Be Prepared to Teach</td>
<td>157</td>
</tr>
<tr>
<td>Professional Preparation of College Physics Teachers</td>
<td>163</td>
</tr>
<tr>
<td>Seminars and Methods Courses</td>
<td>163</td>
</tr>
<tr>
<td>Teaching and Internship Training of College Physics Teachers</td>
<td>172</td>
</tr>
<tr>
<td>Research and the Dissertation</td>
<td>188</td>
</tr>
</tbody>
</table>
# Chapter 1: Miscellaneous Responses and Interviews

- General Topics of Research Study ........................................ 196
- Essentiality of the Ph.D. Degree for Undergraduate Teaching ............... 196
- Contributions of Graduate Training toward Preparation for Teaching .......... 202
- Suggestions for Improvement of Graduate Preparation for Teaching ............ 205

# VI. CONCLUSIONS AND RECOMMENDATIONS

- Conclusions .................................................. 213
- Recommendations ............................................. 230
- Recommendations for Further Study .................................. 246

# Bibliography

- BIBLIOGRAPHY .................................................. 248
- APPENDIX A .................................................. 256
- APPENDIX B .................................................. 285
- AUTOBIOGRAPHY .............................................. 298
<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Chronological Comparison of Some Important Scientific Discoveries, Inventions, or Periods in World History</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>Graduate Degrees Awarded, 1955-58, by Institutions in Ohio and Adjoining States with Percentage of Recipients of Degrees who Entered College Teaching</td>
<td>72</td>
</tr>
<tr>
<td>3.</td>
<td>Geographical Distribution of Colleges and College Instructors Included in the Study</td>
<td>92</td>
</tr>
<tr>
<td>4.</td>
<td>Rating Conversion Scale</td>
<td>123</td>
</tr>
<tr>
<td>5.</td>
<td>Qualifications of Undergraduate Physics Instructors Which Are Particularly Desired by Deans and Chairmen of Physics Departments in Seventy-One Colleges</td>
<td>125</td>
</tr>
<tr>
<td>6.</td>
<td>Strengths of Beginning Physics Instructors As Reported by Deans and Chairmen of Physics Departments in Seventy-One Colleges</td>
<td>129</td>
</tr>
<tr>
<td>7.</td>
<td>Weaknesses of Beginning Physics Instructors As Reported by Deans and Chairmen of Physics Departments in Seventy-One Colleges</td>
<td>132</td>
</tr>
<tr>
<td>8.</td>
<td>Areas in Which Undergraduate Physics Instructors Encountered Problems or Difficulties after They Had Attained Their Highest Degree</td>
<td>136</td>
</tr>
<tr>
<td>9.</td>
<td>Desirability of a Thorough Preparation in Fundamental Fields of Physics and Mathematics with Specialization in a Particular Field of Physics</td>
<td>140</td>
</tr>
<tr>
<td>10.</td>
<td>Desirability of an Interdepartmental Program with Major Area in Physics and Minor Areas in Mathematics, Chemistry and/or Other Sciences</td>
<td>142</td>
</tr>
<tr>
<td>11.</td>
<td>Preference of a Thorough Preparation in Fundamental Fields of Physics and Mathematics with Inclusion of Courses in the Allied Areas Listed</td>
<td>144</td>
</tr>
<tr>
<td>12.</td>
<td>Desirability of an Interdepartmental Program with a Major Area in Physics, Minor Area in Mathematics, a Minor Area in Chemistry and/or Other Science and a Minor Area in the Economic, Historical and Social Implications of Developments in Science</td>
<td>147</td>
</tr>
</tbody>
</table>
Table | Page
--- | ---
13. Desirability of an Interdepartmental Program with a Major Area in Physics, a Minor Area in Mathematics, a Minor Area in Chemistry and/or Other Science and a Minor Area in Philosophy with Particular Emphasis on Its Relation to Physics | 148
14. Desirability of an Interdepartmental Program with a Major Area in Physics, a Minor Area in Mathematics, a Minor Area in Chemistry and/or Other Sciences and a Minor Area in the Humanities | 149
15. Desirability of an Interdepartmental Program with a Major Area in Physics, a Minor Area in Mathematics, a Minor Area in Chemistry and/or Other Sciences and a Minor Area in the Social Studies | 150
16. Major and Minor Areas of Study Pursued by Eighty-eight Physics Instructors for Their Highest Degree | 152
17. Courses in Physics and Allied Sciences Which College Physics Instructors Did Not Have but Which, in Their Judgment, Would Have Helped Them in Their Preparation for Undergraduate Teaching | 154
18. Judgment of Respondents Regarding the Value of Graduate Courses, Which Deal with the Historical and Social Implications of Science for Prospective Undergraduate Instructors | 155
19. Judgment of Respondents Regarding Graduate Courses They Had Which Were of Little Value in Preparing Them to Teach Undergraduate Physics | 158
20. Undergraduate Physics Courses Offered by Seventy-One Liberal Arts and Teachers Colleges Located in Ohio and Adjoining States | 159
21. Courses in Physics, Mathematics and Allied Sciences Which Ninety Physics Instructors Reported They Had Taught on the Undergraduate Level | 160
22. Desirability of Seminars or Method Courses Taught by Well Qualified Physics Professors and Devoted to the Improvement of Class and Laboratory Instruction | 165
<table>
<thead>
<tr>
<th>Table</th>
<th>Desirability of Seminars or Methods Courses Taught by Well Qualified Professors of Science Education As Well As Physics Professors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Desirability of Methods Courses or Seminars Which Are Devoted to General Methods of Teaching Other Sciences As Well As Physics at the College Level</td>
<td>168</td>
</tr>
<tr>
<td>24</td>
<td>Desirability of Courses or Seminars in Which a Study Is Made of the Administration, Organization and Purposes of Higher Education</td>
<td>169</td>
</tr>
<tr>
<td>25</td>
<td>Desirability of Experience in Which the Prospective College Physics Instructor Teaches Class and Laboratory Sections With Little or No Supervision</td>
<td>170</td>
</tr>
<tr>
<td>26</td>
<td>Desirability of Experience in Which the Prospective Physics Instructor Teaches Class and Laboratory Sections under the Supervision of Well Qualified Physics Professors</td>
<td>171</td>
</tr>
<tr>
<td>27</td>
<td>Desirability of Experience in Which the Prospective Physics Instructor Observes the Teaching of Well Qualified Physics Professors with the Primary Motive of Learning Methods of Instruction</td>
<td>173</td>
</tr>
<tr>
<td>28</td>
<td>Desirability of Experience in Which the Prospective Physics Instructor Teaches Class and Laboratory Sections under the Supervision of Well Qualified Professors of Science Education As Well As Physics Professors</td>
<td>175</td>
</tr>
<tr>
<td>29</td>
<td>Desirability of Experience in Which the Prospective Physics Instructor Teaches Class and Laboratory Sections under the Supervision of Well Qualified Physics Professors</td>
<td>176</td>
</tr>
<tr>
<td>30</td>
<td>Desirability of Experience in Which the Prospective Physics Instructor Attends Seminars Devoted to Discussions of Techniques and Special Methods Applicable to a Class the Prospective Instructor Is Teaching</td>
<td>178</td>
</tr>
<tr>
<td>31</td>
<td>Desirability of Experience in Which the Prospective Physics Instructor Works in an Industrial or Research Plant</td>
<td>179</td>
</tr>
<tr>
<td>32</td>
<td>Combinations of Teaching and Internship Training Methods for Prospective College Physics Instructors, Desired by Some Deans, Chairmen of Physics Departments and Instructors in Colleges</td>
<td>181</td>
</tr>
<tr>
<td>33</td>
<td>Teaching Experience of Respondents Prior to Obtaining Their Highest Degree and the Value of This Experience in Preparation for College Physics Teaching</td>
<td>183</td>
</tr>
<tr>
<td>Table</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>34.</td>
<td>Total Years of Teaching Experience and Years Taught at the Present Location As Reported by Ninety Instructors</td>
<td>187</td>
</tr>
<tr>
<td>35.</td>
<td>Desirability of a Dissertation Which Emphasizes Original Research in a Restricted Phase of Pure or Applied Physics As Indicated by Respondents</td>
<td>190</td>
</tr>
<tr>
<td>36.</td>
<td>Desirability of a Dissertation Which Overlaps Other Sciences and Broadens the Student's Knowledge of Experimental Procedures in Related Sciences As Well As Physics</td>
<td>191</td>
</tr>
<tr>
<td>37.</td>
<td>Desirability of a Dissertation Which Is Devoted to Original Research but Is Planned to Meet the Specific Needs of a Person Who Is Preparing for College Teaching Rather Than for Research and/or Graduate Teaching</td>
<td>192</td>
</tr>
<tr>
<td>38.</td>
<td>Desirability of a Dissertation Which Is Devoted to the Study of a Problem Concerned with the Social Effects of Scientific Developments, the Teaching of College Physics or a Problem of an Interpretive Nature</td>
<td>194</td>
</tr>
<tr>
<td>39.</td>
<td>Nature of the Dissertation or the Thesis and Extent to Which It Has Been Utilized for Further Research and Publications</td>
<td>197</td>
</tr>
<tr>
<td>40.</td>
<td>Judgment of Respondents Regarding the Essentiality of the Ph.D. Degree in the Preparation for Undergraduate Physics Teaching</td>
<td>198</td>
</tr>
<tr>
<td>41.</td>
<td>Judgment of Respondents, Who Do Not Feel That the Ph.D. Degree Is Essential Preparation for Undergraduate Teaching, Regarding the Sufficiency of a Rigorous Master of Science Degree with an Experimental Thesis</td>
<td>200</td>
</tr>
<tr>
<td>42.</td>
<td>Aspects of Graduate Training Which Have Made the Greatest or the Least Contribution in the Preparation for Effective Teaching As Reported by Physics Instructors</td>
<td>203</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

Many physicists consider that the experimental method of science, as we now understand it, began during the first half of the seventeenth century. Galileo's work on falling bodies and other experiments which he performed in his search for scientific truth marked the beginning of a method in the study of our physical phenomena that was quite different from the methods which had been employed. This is not to imply that the experimental method had not previously been used. On the contrary, there are numerous isolated cases where it was quite effective in resolving problems. For example, Archimedes (287-212 B.C.), an early physicist and mathematician, experimentally determined the purity of a king's crown and in the process discovered the law of flotation which today bears his name.\(^1\) Roger Bacon (1214-1292), a British scientist and philosopher and a monk of the Franciscan Order, taught that one must observe in order to learn the secrets of nature.\(^2\) A Swedish astronomer, Tycho Brahe (1546-1601), spent twenty years making systematic observations of the motions of the planets and accumulating data of the highest degree of accuracy possible without a telescope.\(^3\) These data were later

---


\(^2\) Ibid., p. 10.  
\(^3\) Ibid., p. 16.
used by Johann Kepler (1571-1630), a brilliant young mathematician who was a student of Brahe for a year, in formulating Kepler's laws of planetary motion. If Kepler had not possessed the accurate observations of Brahe his theoretical calculations would have not been possible, or had Brahe's observations not been used by a brilliant theoretician such as Kepler, they would have been of little value. It is essential for theory and experiment to accompany each other in order for science to progress. Sometimes experiment precedes theory, sometimes theory precedes experiment. One is just as important as the other. Galileo did so much more than any of his predecessors to establish the experimental method that his name is synonymous with the beginning of experimental physics, or one could go so far as to say the beginning of physics. Even though he was forced in later life to renounce many of his observations, his writings had a pronounced influence on the development of physics during the three centuries following his death in 1642.

Prior to the time of Galileo the predominant influence on science and scientific thought was the writings of Aristotle (384-332 B.C.), a pupil of the philosopher Plato. Aristotle adhered to the philosophy that problems which result from the phenomena of man's surroundings may be solved by reasoning. His intellectual brilliance, as exhibited in his writings, had a tremendous influence on scientific development for centuries after his death. Although Aristotle based his writings in science on reasoning rather than on accurate observations, he at times indicated the observed facts were in agreement with the conclusions he

---

4 Ibid., p. 16. 5 Ibid., p. 6.
had deduced. As shown by Richtmyer and Kennard, the philosopher after proving by a more or less abstract argument that the earth is spherical says in "De Caelo" (Book II, Cap XIV):

> The evidence of all the senses corroborates this. How else would eclipses of the moon show segments as we see them? ....since it is the interposition of the earth that makes the eclipse, the form of the line (i.e., the earth's shadow on the moon) will be caused by the form of the earth's surface, which is therefore spherical. ⁶

Many of Aristotle's writings, however, were not even related to the observed facts and, according to one author, when viewed from the vantage point of the twentieth century not a little of his reasoning on the physical universe sounds like piffle. ⁷ It is little wonder that from the third century B.C. until the time of Galileo, little progress was made in scientific development. The authority of Aristotle's writings was not questioned. Even though observations did not agree with his statements, his writings were referred to for the final answer and were followed blindly. Any one who dared to disagree subjected himself to possible punishment or even death. As one writer has stated:

> The power of Aristotle's logic was immense. His writings were so persuasive that for centuries after his time his books constituted the final authority in all things scientific. This fact was strikingly true in the case of astronomy; when observations began to tell new facts about the planets and other heavenly bodies savants merely shook their heads -- it was not according to Aristotle. ⁸

> The importance of Galileo's work lies not so much in the discoveries he made as in the fact that he was able through his experiments

---

and observations to throw off the medieval shackles of Aristotle’s writings, which had dominated scientific thought for nearly twenty centuries, and gain for us greater freedom in the search for truth. It marked the turning point from the philosophy of science in which observations were interpreted to agree with the observer’s preconceived and prejudiced ideas, to a period in which the scientist seeks to obtain scientific facts by unbiased observations and accepts new ideas on the basis of scientific principles.

About three and a half centuries have elapsed since the time of Galileo, but during this period the progress made in science has been far greater than it was in all previous centuries combined. In fact, practically all progress in physics has been made within the past three centuries. A large number of the discoveries and developments have occurred during the present century, and to a great extent within the past twenty-five years. If one starts with the estimated age of the earth and tabulates a few of the important events and discoveries up to the present time, a table such as is shown on page 5 is obtained. One year on the table represents an elapsed time of one million years. It will be noted that on this comparative basis the uranium age would have occurred about 5000 years ago. This is the earliest period of time scientists are able to determine with any degree of accuracy. On this tabulated scale man appeared on the earth perhaps one month ago. The pyramids of Egypt were constructed less than two days ago. Less than a minute has elapsed since the first artificial satellite was launched.

---

### TABLE 1

**CHRONOLOGICAL COMPARISON OF SOME IMPORTANT SCIENTIFIC DISCOVERIES, INVENTIONS OR PERIODS IN WORLD HISTORY**

<table>
<thead>
<tr>
<th>Period or Event</th>
<th>Elapsed Time 1 : 1,000,000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Years</td>
</tr>
<tr>
<td>Age of uranium</td>
<td>5000</td>
</tr>
<tr>
<td>Beginning of abundant life</td>
<td>500</td>
</tr>
<tr>
<td>Evidence of early man</td>
<td>37-218</td>
</tr>
<tr>
<td>Pyramids of Egypt</td>
<td>3.7-37</td>
</tr>
<tr>
<td>Archimedes' discoveries</td>
<td>19</td>
</tr>
<tr>
<td>Copernican solar system; America discovered</td>
<td>4</td>
</tr>
<tr>
<td>Galileo and the experimental method</td>
<td>3</td>
</tr>
<tr>
<td>Newton's laws of mechanics</td>
<td>2</td>
</tr>
<tr>
<td>Steam engine; industrial revolution</td>
<td>1</td>
</tr>
<tr>
<td>Faraday and electricity</td>
<td>1</td>
</tr>
<tr>
<td>Telephone</td>
<td>42</td>
</tr>
<tr>
<td>Radio</td>
<td>37</td>
</tr>
<tr>
<td>X-ray</td>
<td>33</td>
</tr>
<tr>
<td>Airplane; motion pictures</td>
<td>29</td>
</tr>
<tr>
<td>Cyclotron; atomic fission</td>
<td>10</td>
</tr>
<tr>
<td>Television</td>
<td>4</td>
</tr>
<tr>
<td>First artificial satellite</td>
<td>40</td>
</tr>
<tr>
<td>Atomic submarine crosses artic</td>
<td>25</td>
</tr>
</tbody>
</table>
The significant observation to be made from this comparative study is that we are living in a scientific age which has developed in very recent years. One has merely to pause for a moment of reflection to realize that pioneers in the development of electronics, nuclear physics, atomic energy, aviation, electricity, moving pictures, the automobile, radio, television, and many other fields of science or technology are still living or have died within recent years. The progress of scientific development is constantly accelerating. At the present time we are merely on the threshold of development in many areas of science. Gordon B. Carson, formerly Dean of the College of Engineering, The Ohio State University, stated in an address to a group of graduate students in the summer of 1955 that in the field of engineering we are merely on the threshold of automation and that the field of electronics has hardly been touched. Recent developments in electronics strengthen his statement. Experiments are being conducted which it is hoped will eventually lead to space travel and the exploration of other heavenly bodies. Mankind stands on the threshold of scientific discovery and development and in infancy looks out upon a vista of scientific exploration which is so vast he cannot mentally visualize all that lies before him. Advances during the next ten years will probably far exceed those made in any decade of the past.
CHAPTER II
THE PROBLEM

Nature of the Problem

The rapid development of science in recent years has done much to advance civilization. In fact it would appear that industrial, economic, social, and educational progress have paralleled scientific progress. Along with the advantages which have resulted from scientific and technological developments there are many problems which have accompanied these developments or resulted from them. Some of these problems are social; some are industrial; and some are in the realm of education, since the problems of education are in many cases related either directly or indirectly to other problems. One of these problems is concerned with the preparation of college physics teachers for small, liberal arts colleges. With the rapid development of science and technology during and since World War II there has been such a demand for scientists and persons trained in technology that the supply has been insufficient to meet the demand. The greater remuneration offered by industry and research has captured many physicists who otherwise might have entered college teaching. The emphasis which is now placed on research has caused many physicists who have entered college teaching in recent years to be attracted to university positions where research facilities were available, rather than to the small college where few if any research
facilities were provided, and where the salary the small college could offer the young Ph.D. graduate was much less than graduates with the M.S. degree would get in industry.

The shortage of physics instructors in liberal arts colleges is but a single phase of the problem. The preparation which prospective college physics teachers receive in obtaining the Ph.D. degree is seldom planned to prepare the candidate for teaching undergraduate physics in a small liberal arts college. The objectives of the small college are quite different from those of the large university. As stated in the Report of the Harvard Committee:

Taken as a whole education seeks to do two things: help young persons fulfill the unique particular functions in life which it is in them to fulfill, and fit them so far as it can for those common spheres which, as citizens and heirs of a joint culture, they will share with others.\(^{10}\)

One of the major objectives of the small liberal arts college is to prepare young people to lead well adjusted lives as citizens of their communities and of the nation. The problems which confront the beginning physics instructor in the small college are not concerned entirely with the preparation of future physicists although that is one of his duties. He must also provide physics courses for the non-physics major who plans on a career in another scientific field such as engineering, chemistry, or medicine. A third very important function which the physics instructor must perform in the small liberal arts college is that of making provision for a course in physics which is planned to meet the needs of the non-science major. Thus the physics instructor in a small college

is faced with a triple instructional problem. At the same time he is expected to be able to teach all physics courses which may be offered on the undergraduate level. The physics staff is generally limited to three or less instructors. In many cases it consists of only one person. The small college physics professor has little time for doing research even though facilities for such research may be available.

**Graduate Physics Courses Emphasize Research**

Courses of study in graduate physics departments in recent years have generally been planned to meet the needs of the prospective research worker or the person who plans to enter university teaching. Very little emphasis has been placed on the professional preparation of the prospective undergraduate physics teacher. The President's Commission on Higher Education stated in its report:

> To knowledge of subject matter and research ability must be added the mastery of teaching techniques. The young instructor frequently lacks this essential skill through no fault of his own, but because the institution did not provide for his acquiring it. Too often graduate schools provide training for research and not for teaching, though a high percentage of their graduates go into college teaching. \(^{11}\)

The greater emphasis on preparation for research is the outgrowth of several factors. Research work has been encouraged in universities by research grants and grants-in-aid to worthy students. The demands of private industry and research organizations have further accentuated the emphasis on research training rather than on the preparation for teaching at the college level. It is true that a few schools have recognized

---

to this weakness and are offering programs which stress the preparation for college teaching to a limited extent. However, very few of these institutions offer specific programs for the prospective physics teacher.

Effect of Increased Enrollment on the Problem

The magnitude of the problem of providing adequately prepared physics instructors in sufficient numbers to meet the needs of our colleges becomes all the more evident when one considers the expected increase in college enrollments within the next few years and the increased emphasis which is being placed on science and technology. According to a study made by the Fund for the Advancement of Education college enrollments are expected to increase by 1971 from a minimum of 103 percent to a possible maximum of 192 percent of the 1954 enrollment. The higher percentage of college age youth who seek a college education will place greater emphasis on the need for general education programs at the undergraduate level. Already some institutions are planning the utilisation of television and other teaching media to help meet the need for instructors in general education programs. Thus a problem which is now acute may be expected to become extremely critical within the next decade unless drastic remedial action is taken.

Purpose and Restrictions of the Study

This study has been made to show that some of the problems which have been cited briefly above may be partially overcome by a concerted effort to provide a program on the Ph.D. level which gives specific em-

---

phasis to the preparation of physics instructors for undergraduate teaching in liberal arts colleges and teachers colleges which also offer a liberal arts curriculum. Such a program should emphasize (1) a thorough foundation in the fundamental courses in physics, (2) an adequate amount of research in experimental physics, and (3) allied courses which emphasize social implications of scientific developments and broaden the prospective teacher's general background.\footnote{Bernard B. Watson, "Current Trends in the Training of College Teachers," \textit{American Journal of Physics}, XVII (December, 1950), 554.} In addition, the program should provide the prospective physics teacher with a knowledge of those techniques and skills which are essential for effective teaching. It should also make provision for him to gain experience in college physics teaching under the counsel of well qualified physics instructors.

The study has been restricted to programs which lead to the acquisition of the Ph.D. degree, although other programs were included indirectly where it was evident that it would be advantageous to include a study of such programs to the extent that they had a bearing on the Ph.D. degree programs. The study was made with the assumption that prospective physics teachers who plan to teach in a liberal arts college or a teachers college which prepares secondary school science teachers will benefit from a program that differs somewhat from the program which is followed by the prospective physicist who intends to teach at the graduate level, where the direction of research work is one of his primary duties. The study has not been concerned with graduate programs for the preparation of secondary school physics teachers except in those
cases where the degree programs overlapped. The study was made in an endeavor to determine the desired preparation of a college physics instructor on the basis of (1) his expected teaching duties, (2) the needs or desires of the employing institution, (3) the expected needs of physicists in the future, and other factors. The study was not made with any intention to minimize the importance of present programs for the acquisition of the Ph.D. degree in physics but to indicate means by which present programs may be improved.

General Plan of the Study

The remainder of this chapter is devoted to a study of the Evidence of the Problem and a Brief Survey of the Development of Doctoral Training in the United States. In Chapter III a study is made of programs for the preparation of college teachers in general and of specific attempts to improve the preparation of college physics instructors. A description is given in Chapter IV of the questionnaire which was used in the study to obtain additional information, the area and institutions included in the study, and the procedure followed in obtaining information. Chapter V includes tabulated results of the study with a discussion of the significant features of the information which was obtained. Chapter VI is devoted to a summary of the entire study. Conclusions which were based on the interpretation of the results are included in this chapter. Recommendations are made for the improvement of present doctoral programs and suggestions offered for future studies.
Evidence of the Problem

Lack of Professional Preparation for College Teaching

The President's Commission on Higher Education made a thorough study of all phases of higher education including the graduate preparation of prospective college teachers and, as a result of the study, the Commission made some very definite recommendations for improvement of graduate programs then in existence. One striking condition which was found is described rather poignantly in the following statement:

The most conspicuous weakness of the current graduate programs is the failure to provide potential faculty members with the basic skills and the art necessary to impart knowledge to others. College teaching is the only major learned profession for which there does not exist a well-defined program of preparation directed toward developing the skills which it is essential for the practitioner to possess. The objectives which higher education seeks to achieve cannot be reached unless there is realism in the programs for preparing college teachers.

When it is realized that college teaching is one of the most essential of our professions the gravity of the above statement becomes increasingly obvious. Our public schools have realized the value of teacher preparation for prospective public school teachers whom they may employ. The curricula in colleges which train a number of teachers have been modified to meet the needs of prospective teachers. With the advent of mushrooming scientific developments during and since World War II Science programs have been included in the required preparation of public school teachers, not only to help those who may teach the more or less formalized courses of physics, chemistry, or biology in the high

---

\[11\] President's Commission on Higher Education, IV, 16.
school but also to provide an appreciation of science for those who may teach in the elementary grades.

The growth of the population in the United States and the demands of educational reformers led to the establishment of certification procedures and the growth of teachers colleges. By 1870 there were more than 6,871,000 pupils in the public schools of America. Of this number 6,791,000 were in the elementary grades. State normal schools were established to enable teachers to meet the certification requirements. By 1890 there were 92 state supported normal schools, offering courses of two to three years and in some cases four years. The establishment of teachers colleges was a result also of the failure of liberal arts colleges to make provision for public school teachers who desired training which would enable them to meet the certification requirements. In many cases it was not possible to maintain standards at the same level as was the case in liberal arts colleges. Many teachers colleges suffered because of the resulting reputation, although in a number of cases the reputation was unfounded. Standards have now been raised in many of these institutions and a number of them have expanded and strengthened their liberal arts programs. The training of our public school teachers is generally at a much higher level than it has been in previous years. It may be expected that this improvement will continue at an accelerated rate with the present awareness of the public for the need of better schools and better teachers.

---

No such change as that which occurred in the normal schools and teachers colleges has taken place in the graduate schools where our college teachers generally get their final academic preparation. It is true that there have been some spasmodic movements toward the improvement of the preparation of college teachers, but generally these movements have not been widely accepted by the graduate schools. According to McCutcheon, there have been three periods when the improvement of college instruction has been stressed. The first of these occurred in the late 1920's when the Association of American Colleges through a committee, headed by President Wilkins of Oberlin College, brought in a long report charging that the training by graduate schools, important though it was to sound research, after all had very little to do with the main job that the Ph.D. candidate would presently be doing. The second period occurred during World War II when great emphasis was being placed on instruction as a part of the war effort. The most significant influence at this time was perhaps the publication in 1945 of a study of current Ph.D. programs. One investigator was classed by some in the liberal arts colleges as a professional educationist and was under the cloud of having been attached to the United States Office of Education. With the return of veterans to college campuses after World War II a

---


third attack was made on the state of college teaching. There were two factors which influenced this attack. The returning veteran was more mature than the average college student and was in a position to be more critical of the instruction he received. Furthermore the flood of students to the campuses overtaxed practically all institutions of higher education to provide qualified instructors. Many instructors were so overloaded they were unable to work at their maximum efficiency. These forces caused a number of institutions to become much concerned about the preparation of college teachers and to initiate programs for the improvement of their training. A description of some of these programs will be given in a later chapter. Current predictions on expected future enrollments in our colleges have caused a revival of the concern for improving the quality of college instruction.

 Complaints which are made by the critics of the present training provided by our graduate schools fall in two classifications. One complaint is that the emphasis in the graduate school is almost entirely on research. The result of this overemphasis is that the young graduate student has a very narrow academic outlook and limited future cultural interests. Another complaint is that graduate schools make little or no provision for preparing their products for the job of college teaching in a liberal arts college where the chief objectives of students may be quite different from those of students in a large university or professional school. Other evidence of growing concern for the preparation which is given by graduate schools to prospective college teachers may be found in articles recently appearing in such publications as the Journal of Higher Education, the Educational Record, School and Society,
and others. A recent publication entitled *Improving College and University Teaching* was started in 1953 by the Graduate School of Oregon State College. It is devoted to various problems primarily in the realm of improving instruction. Grants and fellowships have been established in recent months and some of those already in existence have been expanded. The Carnegie Foundation has made a grant of $300,000 to the American Association for the Advancement of Science for improvement of instruction. The National Science Foundation, the Fund for the Advancement of Education which was established by the Ford Foundation, the Danforth Foundation, the Woodrow Wilson Fellowship Program and other programs or foundations have indicated considerable concern for the problem. The National Defense Education Act provides graduate fellowships in an amount not to exceed $2500 to help students pursue graduate study. Preference in awarding the fellowships will be given to those graduate students who have expressed a desire to enter college teaching. Several reports have been made of conferences or committee studies which were primarily concerned with problems pertaining to college teaching.

**Emphasis on Research in the Graduate School**

When graduate schools were first established they were patterned after the German university in which research was one of the predominant influences. During the hundred years since their establishment they have fostered the development of research work. The result is that today this nation ranks as a world leader in research activity and tech-

---

nology. Government sponsored research has expanded enormously during and since World War II. The proposed appropriation for research for the next fiscal year amounts to five and one-half billion dollars. The 1940 appropriation amounted to approximately one-tenth of a billion dollars; in 1950 it was slightly over one billion dollars. The greater portion of this appropriation will go to the universities proper, but a large part will be designated for a comparatively new kind of institution, the research center, which is owned by the government but is operated by one or more universities or industrial concerns. Of the forty-seven centers in operation in 1958 twenty-eight were university controlled. There has been an equal expansion in privately sponsored research. In 1953 over five billion dollars was spent in the United States on research and development, 18 percent of which was carried on by governmental agencies, 72 percent by industrial organizations, and 9 percent by colleges and universities.

The increase in the emphasis on research and particularly applied research by the Federal Government and industry has resulted in an expansion of and an increased emphasis on research activities at university campuses. While the results of this emphasis have generally been good

---

20 "Federal Budget Sets Research and Development Funds at $5.5 Billion with Emphasis on Space Activities," Science, CXXIX (February 6, 1959), 315.


and have been of immense value in the advancement of science and technology they have, in some instances, caused the neglect of efforts to improve the art and science of college teaching. One writer in commenting on the situation has this to say:

One must conclude from the criticisms and from the abundance of the literature that something has been amiss in the last half century and that probably the art and science of teaching have been neglected. It is not surprising that this is true when one considers the almost complete dedication to specialization and to scientific research in American higher education during the last half century. 23

There is considerable evidence to indicate that this neglect has been recognized and that some attempts are being made to correct the situation. This is true not only in educational institutions but also in agencies, foundations, and industry. In 1945 Vannevar Bush, the wartime director of the Office of Scientific Research and Development, proposed the establishment of a National Research Foundation to support research and education in the sciences and to disseminate scientific information. 24 His proposal was later adopted with the establishment of the National Science Foundation in 1950.

Quantitative Nature of the Problem

The problem is quantitative as well as qualitative. In a study made by the Fund for the Advancement of Education it was predicted that the total college enrollment may increase by 1973 from 103 percent to


192 percent over what it was in 1951.\footnote{25} This estimate is based on several factors. Persons born during the post-war years, when there was a sharp rise in the total number of births per year, will be of college age between 1965 and 1973. The study shows that in 1900 there were 5,931,000 persons in the United States in the age group of 18-21 years.\footnote{26} In 1951 there were 8,489,000 persons in this same age group. On the basis of actual births it is estimated that there will be 15,065,000 persons in the 18-21 year age group in 1973. This is an increase of approximately 250 percent over the figure for 1951. In 1951 there were 2,478,000 students enrolled in our colleges, or a total of approximately 35 percent of those persons who were of college age were enrolled in college. For the past fifteen years the ratio of college enrollments to the total number of youth in the 18-21 age group has been increasing on the average of 1 percent each year. In 1900 only about 4 percent of the youth between eighteen and twenty-one years of age were enrolled in college; in 1951 almost 30 percent of this age group were enrolled. If this present trend continues it is estimated that by 1973 there will be over seven million persons between the ages of 18-21 years who are enrolled in our colleges. If the percentage of the total number of this age group who attend college remains constant it is estimated that there will be over five million young people enrolled in our colleges in 1973. It would seem, however, that the greater demands for college trained personnel, the rapid advancement of technology, and the increased empha-

\footnote{25}The Fund for the Advancement of Education, Teachers for Tomorrow, p. 15.

\footnote{26}Ibid., p. 49.
sis on education for a scientific age would cause the present trend to continue or even to accelerate. On the basis of conclusions arrived at by the President's Commission on Higher Education it is certainly possible for the total college enrollment to expand enormously within the next decade. From information on Army General Classification Test Scores made on tests administered to almost ten million men during World War II, the Commission estimated that at least 49 percent of the population has the ability to complete fourteen years of education and that at least 32 percent of our population has the ability to complete an advanced degree. While there may be some disagreement with this conclusion it does give food for thought and suggests a possible source of supply to partially provide needed college teachers, as well as other college trained personnel.

**Anticipated Shortage of Qualified Physics Instructors**

In addition to the predicted increase in college enrollments within the next decade, which will present college administrators with many problems, there will be a shortage of qualified teachers. This will result partially from the increase in college enrollments and partially from a growing shortage of teachers to meet present college demands. The National Education Association has stated in a recent bulletin:

---

27President's Commission on Higher Education, I, 40-41.
Where to obtain and how to retain qualified instructional staff in the required numbers may well be the greatest single problem to confront him [college administrator] in the next decade.  

A study conducted by the Research Division of the National Education Association in 1957 on teacher supply and demand is quite revealing. One portion of the study requested information from all types of institutions of higher education on unfilled teaching positions in 1955-56 or 1956-57. Of 761 institutions which responded, 383 had one or more unfilled positions. There were a total of 1,196 unfilled positions reported. Slightly over one-half of the vacancies reported were in the fields of engineering, mathematics, and the physical sciences. Specifically, there were 226 vacancies in engineering, 225 in the physical sciences, and 148 in mathematics. The study further reveals that 658 of 749 reporting institutions indicated shortages of one or more qualified teachers. Here again the greatest shortages were physical sciences, 413 institutions, mathematics, 392 institutions, and engineering, 141 institutions.

In 1930 there were approximately eighty-two thousand teachers in our institutions of higher learning. By 1954 the number had increased to one hundred and ninety thousand. The Fund for the Advancement of

---


Education has estimated that by 1970, at least 377,310 teachers will be required to staff our colleges and universities. If the percentage of college age youth who attend college continues to accelerate, the required number of teachers may total almost one-half million. Furthermore, a minimum of approximately 168,000 new college teachers will be needed for replacement of teachers now in service and another minimum of approximately 168,000 will be needed to provide for increases in college enrollments during the years 1956-1970. These numbers may range as high as 185,000 for replacements and 300,000 for additional teachers to meet the demands of the increased enrollments if the present student-teacher ratio of 13:1 is maintained. This means that during the fifteen years from 1955-1970 a total of at least 336,915 new teachers will be needed for our colleges, according to present estimates. This number may range as high as 483,960 or nearly one-half million new teachers for our colleges. At the same time it is estimated that during the years 1955-1970 from 120,000 to 135,000 doctorates will be conferred. It is doubtful if more than half of this number will enter educational work. Statistics released by the National Education Association indicate that approximately 57 percent of the recipients of doctor's degrees in 1955 and 1956 entered educational work. In such fields as engineering and the physical sciences only a little more than 30 percent entered educational work. If this trend continues throughout the period from 1955 to 1970

---

31 Fund for the Advancement of Education, Teachers for Tomorrow, pp. 55-57.

32 National Education Association, Teacher Supply and Demand in Colleges and Universities, pp. 29-31.
there will be at most approximately seventy-five thousand recipients of
the doctorate who enter educational work to partially supply the need of
from 336,945 to 483,960 new teachers in our colleges during this pe-
period.\(^\text{33}\)

Thus, if the acquisition of the Ph.D. degree, which in recent
years has become one of the essentials in the preparation of the pros-
ppective college teacher, is to continue to be the basis on which the
qualification of beginning instructors is judged, there will be a marked
decline in the quality of instruction provided by our colleges at a time
when it is most needed. In 1953-54, the levels of preparation of college
teachers were as follows:

<table>
<thead>
<tr>
<th>Level of Preparation</th>
<th>Percent of total full-time staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor's degree</td>
<td>40.5</td>
</tr>
<tr>
<td>Master's degree plus at least one year of advanced study</td>
<td>20.9</td>
</tr>
<tr>
<td>Master's degree</td>
<td>28.2</td>
</tr>
<tr>
<td>Less than Master's degree</td>
<td>10.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0(\text{34})</strong></td>
</tr>
</tbody>
</table>

During the period from 1954 to 1957 holders of the doctor's degree among
newly employed full-time teachers decreased 25.2 percent and those with
the Master's degree increased 26.9 percent. The results of this trend
are indicated by the following statement: "It seems inevitable that the

\(^{33}\) The number of doctorates expected to enter educational work
represents 57 percent of the maximum number of doctorates which it has
been estimated will be graduated during the period 1955-1970, namely

\(^{34}\) National Education Association, Teacher Supply and Demand in
Colleges and Universities, p. 17.
quality of instruction has already been seriously impaired."

A study of the National Education Association in 1954-55, revealed that a shortage of teachers for general education programs was already being felt by some institutions. From 33.3 to 44.4 percent of the liberal arts colleges which had attempted to find faculty members for the teaching of general education courses did not find satisfactory candidates available. Nearly 70 percent of these same institutions indicated that they felt the general education movement in undergraduate colleges justified an organized effort by graduate schools to provide doctoral programs of broader than the traditional pattern. The Committee of Fifteen found that "the two epithets thrown most often and with the greatest bitterness at Ph.D. programs are 'over-specialization' and 'narrowness'". At the beginning of the present century when the elective system had been widely adopted "a freshman might be permitted to enter at once the department of his choice and devote ....almost all his time to the study of one subject". The development of general education programs and the greater stress on liberal arts education has created the need for broader preparation in the graduate school of prospective college instructors. Such training can hardly be obtained by a continuation of the general education program of the undergraduate school into the graduate institution. The Committee recommended an "inter-depart-

---

36 National Education Association, Teacher Supply and Demand in Degree-Granting Institutions, p. 160.
mental program with a philosophical point and purpose". The field of physics has expanded to such an extent in recent years that it is difficult for the prospective physics instructor, who has been given highly specialized training without an orientation in the objectives of the liberal arts college, to adjust his goals for a course in general physics to the needs of students who are not science majors.

Major Source of Qualified Physics Instructors

One of the major sources of new full-time teachers in our colleges is the graduate school. In fact it has been the major source of supply of college teachers for the past several decades. In 1953-54, over 51 percent of all newly appointed teachers came from the graduate schools. Liberal arts colleges with an enrollment of less than one thousand students drew the largest percentage, specifically 56.2. It would seem that the most logical region for raising the quality of college instruction is in the graduate program of study. This is not to imply that the employing college does not have a responsibility for improving the quality of instruction within its own institution. On the contrary, it has a very vital part in this phase of higher education. In the final analysis, however, it is the graduate school that sets the standards for the qualifications of prospective college teachers and during the next decade the institutions can do much to maintain high standards of quality.


38 National Education Association, Teacher Supply and Demand in Degree-Granting Institutions, p. 149.
in college instruction. It is a responsibility which they cannot shirk. It is true that one of their functions is to expand the frontiers of knowledge through research. At the same time these institutions must assume their responsibility of passing the "torch of knowledge" on to succeeding generations as well as advancing knowledge through research.

A recent publication on the role of the graduate school stated:

The fact remains, however, that only one agency can be regarded as an original source of supply. That agency is the graduate school. It alone can perform the one essential function -- the well-rounded development of the scholar -- which undergirds the teaching profession. Only the graduate school can provide the organized program of instruction and research necessary to the full mastery of a field of instruction. Self-made teachers there may be, but such exceptions only strengthen the realization that the formalized program of preparation carries the burden of future supply [italics in original].

In view of this importance in supplying qualified teachers for our small colleges a review of the development and objectives of graduate instruction in the United States is quite appropriate before any recommendations are made for improvements or changes to meet current demands for qualified teachers of physics in our liberal arts colleges.

---

39 National Education Association, Teacher Supply and Demand in Colleges and Universities, p. 37.
Factors Which Have Influenced Early Graduate Study

While the Master's degree was awarded as early as 1642 by Harvard College graduate education, with the award of the Ph.D. degree after a period of study, did not begin in America until about the middle of the nineteenth century. Since this study is restricted to graduate programs which lead to the acquisition of the Ph.D. degree it would be superfluous to go into a study of graduate programs on the master's level, except in those cases where it is necessary to consider the programs for the lower degree in order to get an understanding of the doctoral program.

One writer considers the Morrill Act as one of the most important single events in the progress of higher education in the United States.\(^{10}\) In 1857 Justin C. Morrill, of Vermont, introduced a bill in Congress which would provide for the donation of public lands to support at least one college in each state and promote the liberal and practical education of the industrial classes. The bill was passed by Congress but was vetoed by President Buchanan. It was introduced again at a later date, passed by Congress and approved by President Lincoln on July 2, 1862.\(^{11}\)

Perhaps nothing before or since has so powerfully molded American higher education. The current conception at the time was that all essential educational problems had been solved and that educators needed only to


resort to the wisdom of antiquity. It was a situation somewhat analogous to medieval education in Europe, when it was considered that Aristotle had answered the problems of natural philosophy. As indicated earlier Galileo showed, although with only limited immediate success, that Aristotle's writings were in many cases erroneous.\textsuperscript{42} According to Cowley the Morrill Act broke the log jam that had prevented educational progress in higher education since the founding of the Nation.\textsuperscript{43} The Act provided for the establishment of at least one college in each state where the leading object should be without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such a manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.\textsuperscript{44}

This marked the beginning of government subsidization of higher education. One of the most significant immediate results was that it opened the door of higher education to the industrial classes and initiated the start of professional and technical education which was to become increasingly important for scientific and technological progress. Both graduate and undergraduate education were given a stimulus by the Act.

When one begins a study of early graduate programs for the Ph.D. degree one immediately thinks of Johns Hopkins University. In fact, the

\textsuperscript{42}Supra, pp. 3-4.

\textsuperscript{43}Cowley, \textit{Educational Record}, XXXIX, 312.

beginning of graduate study in America may be thought to be synonymous
with the founding of Johns Hopkins in 1876. It is true that other
schools, such as Yale University, Pennsylvania State University, Columbia
University, the University of Michigan, and others had made sporadic at­
tempts to establish programs of graduate study before 1876 but their at­
tempts had met with little success. The founding of Johns Hopkins Uni­
versity marks the first successful attempt in America of graduate study
which was patterned after the European Universities.

There are several reasons for the success of the graduate educa­
tion program at Johns Hopkins. Since the founding of higher education
in America over three hundred years ago two antithetical educational
traditions have developed. The colonial college was patterned after
English colleges and particularly after Oxford. The liberal arts col­
leges in America developed in the tradition of the aristocratic colonial
college. At least up until the nineteenth century these schools were
under secterian control. Early attempts at graduate education were out­
growths of the liberal arts college, which was patterned after Oxford
and Cambridge but which was similar to these institutions only in name.
The faculty in the American college had little control over educational
policies, and the students were less well prepared than students in Eng­
land. Also, Oxford and Cambridge were each made up of several colleges.
The American College was a single unit. The early liberal arts colleges
relieved upon secterian authority and mental discipline to achieve their
goals. A fixed curriculum which was based on the fundamentals of knowl­
edge was prescribed. In recent years the dominant pattern of college
education has been one that emphasizes a major subject or area of study,
supported by a minor area. With few exceptions our graduate schools were patterned after the liberal arts college traditions. Early attempts to establish graduate programs met with failure because of this sectarian control and the opposition on the part of alumni to the introduction of so-called European tradition. Furthermore, early graduate programs were staffed by faculty members who, in addition to graduate teaching, taught on the undergraduate level. The faculty members were generally graduates of the institutions where they taught. Students were not admitted to the graduate school unless they held the bachelor's degree from the undergraduate division of the same institution. Exceptions were made in some cases but generally this was the policy. The result was that early graduate departments were largely an extension of the undergraduate departments of the school.

Up to the end of the eighteenth century the American colleges met the educational needs of the Nation at least adequately. During the nineteenth century science, literature, and the arts were developing rather rapidly in Europe. The American liberal arts college failed to keep pace with the times. Men on the faculties who sensed the need were unable to get administrators to recognize this. Many faculty members went to Europe to study and brought back the philosophy of the European and particularly the German university. The nineteenth-century German university ideals of freedom in learning, teaching, research and the publication of findings, constitute a second element in the traditions of higher education; a factor which is antithetical to the traditions of the colonial, sectarian controlled college. By 1850 men in science began to press for adequate representation of the sciences in the college cur-
ricula. One of the earliest and most successful of these attempts was made by Professor Sillman and his associates at Yale University. On their own responsibility, and without financial help from Yale University, they started graduate instruction in science at that institution in 1848. The graduate division at Yale University was established in 1858.\textsuperscript{145} Two early members of the faculty were J. Willard Gibbs, an outstanding theoretical physicist, and Daniel C. Gilman who later became the first president of Johns Hopkins University.

According to Cowley, a century ago there were no universities worthy of the name. Students at most universities were concerned with studying the wisdom which had been accumulated. Experimental science was even openly sneered at. Andrew Dickson White, a member of the Yale class of 1853, wrote:

\begin{quote}
One day in my senior year, looking from my window in North College, I saw a student \textsuperscript{[of the Sheffield Scientific School]} examining a colored liquid in a test tube. A feeling of wonder came over me! What could it all be about? Probably not a man among us in all the senior class had any idea of a chemical laboratory save as a small kitchen back of a lecture desk like that in which an assistant and a colored servant prepared oxygen, hydrogen, and carbonic acid for the lectures of Professor Sillman. I was told that this new laboratory was intended for experiment, and my wonder was succeeded by disgust that any human being should give his time to pursuits so futile. (Italics mine.)\textsuperscript{146}
\end{quote}

The above quotation gives some idea of the general feeling of persons in higher education toward innovations of science during the nineteenth century.


century. Governing bodies were even less sympathetic with new programs.

To summarize there were at least four conditions prior to the founding of Johns Hopkins University which were influential in preventing success in early attempts at establishment of graduate schools. One of these was the Aristocratic tradition of the liberal arts college under sectarian authority. A second factor was the lack of qualified faculty members for teaching in the newly formed graduate schools. Kraus states that when Johns Hopkins was founded in 1876 there were no faculty members in the United States qualified to do research except Professor Willard Gibbs of Yale University. A third factor was the unsympathetic attitude of governing bodies toward new innovations or changes in higher education. Alumni had considerable influence in maintaining the traditions of the past. A fourth factor which led to the failure of some early attempts at graduate programs was the influence of undergraduate divisions. The graduate department at Cornell University was started without sectarian control or alumni traditions, but it had difficulties because an undergraduate college was predominant and overshadowed the graduate research in the early history of the institution. The needs of vocational agriculture predominated over graduate research.

Establishment of Graduate Instruction and Standardization of the Ph.D. Degree

To avoid some of the difficulties other institutions had encountered, the founders of Johns Hopkins decided that the new university should offer only graduate work; that it should be privately sponsored;
and that it should be free from all religious and political control. The university would be patterned after the European universities. A handicap with which it was immediately faced was that the Ph.D. degree was being awarded not only as an earned degree but also as an honorary degree. A number of struggling undergraduate colleges annually awarded the honorary degree.

The success of Johns Hopkins University was due not only to the careful planning of its founders but also, to a great extent, to the careful selection of faculty members by President Gilman. He insisted that his faculty members do research and gave publicity to their work by subsidizing publication of the results of research work. Public grants were obtained for research which supported the medical school. In his inaugural address Gilman promised that Johns Hopkins would make for less misery among the poor, less ignorance in the schools, less suffering in the hospital, less folly in politics. It is interesting to note that he was emphatic in declaring that one of the functions of Johns Hopkins University was the graduate preparation of college teachers. To quote Gilman:

I can hardly doubt that such arrangements as we are maturing will cause this institution to be a place for the training of professors and teachers for the highest academic posts; and I hope in time to see arrangements made for unfolding the philosophy, principles, and methods of education in a way which will be of service to those who mean to devote their lives to the highest departments of instruction.  

Later developments in research to a great extent overshadowed the ful-

---

18 Addresses at the Inauguration of Daniel C. Gilman as President of The Johns Hopkins University (Baltimore: John Murphy and Company, 1876), p. 38ff.
fillment of this objective at Johns Hopkins University.

Other institutions which were established shortly after Johns Hopkins were Clark University at Worcester, Massachusetts in 1889, and the University of Chicago in 1892. Each of these, like Johns Hopkins, was founded "to meet what were conceived to be the needs of the day, rather than merely to follow a college and university tradition." While Johns Hopkins was founded by Gilman as a graduate institution, Clark, under G. Stanly Hall and the University of Chicago under William Rany Harper, had undergraduate college divisions as well as the graduate divisions. Hall had hoped to found Clark University solely as a graduate university but Clark provided in his will for the establishment of an undergraduate college. Rockefeller, in providing for the establishment of the University of Chicago, desired that a college be established. However, President Harper was instrumental in securing the establishment of both a college and a university.

The fact that the Ph.D. degree was awarded on an honorary basis as well as an earned degree led to attempts at standardization of the degree requirements. The first honorary Ph.D. degree was awarded in 1832 by Bucknell University. The last honorary Ph.D. degree was awarded in 1938. In 1876 there were eighteen earned Ph.D. degrees awarded by universities in the United States. At the same time there were twenty-six honorary doctoral degrees awarded. A number of factors have


worked toward the standardization of requirement for the degree. Prior to 1900 the Federation of Graduate Clubs was perhaps the most influential organization and made several recommendations which are included in current requirements. During the 1890's such men as Gilman at Johns Hopkins, Harper at Chicago, Hall at Clark, and Eliot at Harvard were influential in setting up requirements for the degree in individual institutions. Since 1900 four organizations have worked more or less independently for standardization. These are the Association of American Universities, the National Association of State Universities, the Association of Land-Grant Colleges and Universities, and the American Association of University Professors. During this same time philanthropic foundations, such as the Carnegie and the Rockefeller organizations, as well as regional accrediting associations, had considerable influence on graduate education. This influence was an indirect result of their efforts to raise the standards of undergraduate colleges and to increase the number of holders of the Ph.D. degree on the staffs of undergraduate institutions. Initially standardization efforts had proceeded on the assumption that

the purpose of the degree program was to train individuals who would either devote themselves to research directly, or who would combine individual study of an advanced character with the training of other research workers under university auspices.\(^{51}\)

One writer has divided the development of graduate instruction into three periods: first, the period of supremacy of the Master's degree, from 1642 to 1860; second, the period of the growth and the devel-

\(^{51}\) Hollis, *Toward Improving Ph.D. Programs*, p. 27.
opment of the Ph.D. degree, from 1860 to 1900; and third, the period of
the great diversification of degrees on both the master's and the doc­
tor's levels. The last period could also be classed as the period of
standardization of degrees. There is some evidence to indicate that we
may now be entering a fourth period in the development of graduate in­
struction. As previously indicated, the President's Commission on
Higher Education considered the preparation of college teachers one of
the most important functions of the graduate school and one that had
been largely neglected during the rapid growth of research. Howard
Mumford Jones has stated:

Undergraduate curriculums are subject to manipulation; but
the training of those who are to teach undergraduates -- that
is, the graduate students of today who become the professors
of tomorrow -- remains unaltered.

Factors Which Have Altered the Purpose of the Ph.D. Degree

Since 1918 several factors have tended to alter the purpose for
which the Ph.D. degree was initially established. One of these is the
enormous increase in graduate enrollments, and the number of graduate
degrees awarded. In 1920 only 562 doctors degrees were awarded by in­
stitutions in the United States. In 1940 there were 3,290 such degrees

52 John C. Walton, Graduate Study in Universities and Colleges in
the United States, United States Office of Education Bulletin 1934,

53 Supra, p. 9.

54 Education and World Tragedy (Cambridge, Mass.: Harvard Univer­
awarded. In 1954 the number had increased to 8,995. This represents an increase of almost 1500 percent in thirty-four years. Added to the burden of numbers was the greater diversity of interests. During this same period of time undergraduate colleges made a phenomenal expansion in enrollment and in the diversity of course offerings to meet the needs of the changing social pattern. The result was a demand for increased offerings in graduate work, such as sociology, home economics, audio-visual aids, and other fields of study which had recently developed.

Another factor which has worked to alter the nature or objectives of the Ph.D. degree is the change in the sponsorship of research. Before 1918 practically all research work was sponsored by the universities. The importance of this research is evidenced by the establishment of the National Research Council in 1918 to mobilize strategic facilities of the universities for the war effort. At that time, according to Hollis, there were fewer than three hundred private laboratories for industrial research in the country. The universities were clearly the leaders in fundamental research. Graduate school policies were influenced by this. By 1941 the country had 2,264 industrial research laboratories that employed 44,900 full-time workers. The chemical industries alone were setting aside an annual budget of $50,000,000 for research. During and since World War II, research under private as well as government sponsorship has burgeoned. By 1952 obligations and expenditures for research

55The Fund for the Advancement of Education, Teachers for Tomorrow, p. 59.

56Hollis, Toward Improving Ph.D. Programs, p. 33.
by Federal Agencies had reached almost two billion dollars.\textsuperscript{57} The government's budget for research and development for the fiscal year which ends June 30, 1960 amounts to five and one half billion dollars, which exceeds the 1940 expenditure by $5.1 billion.\textsuperscript{58} A rather sizable amount of this appropriation is available to colleges and universities through the Atomic Energy Commission. However, these appropriations, as well as appropriations from private organizations for university research, have a marked control over the goals to be achieved in graduate research. Because funds are more readily available for nuclear or atomic research or more recently in space travel, those institutions stressing graduate study in these fields find grants more easily obtained. The emphasis which is placed upon research by the Government and private industry has caused a greater emphasis to be placed upon this phase of graduate study by many of our universities.

The sponsorship of research in universities by the Government and private industry has led to a third factor which has influenced graduate policies in universities. This is the struggle for control of the outcomes of research. Future developments in business and industry are dependent to a great extent on research developments. This has caused many large companies, such as General Electric, to set up their own research organizations. In cases where private or Government research funds are allocated to universities it is generally under restrictions

\textsuperscript{57}"National Science Foundation Estimates for Scientific Research and Development," \textit{Science}, CXVII (May 29, 1953), 571.

\textsuperscript{58}"Federal Budget Sets Research and Development Funds at $5.5 Billion with Emphasis on Space Activities," \textit{Science}, CXXIX (February 6, 1959), 315.
in order that the sponsoring agency may maintain control of the outcomes of research work. The result has been an increase in the emphasis which is placed upon applied research at the sacrifice of pure research or the preparation for teaching. There are some indications that sponsoring agents realize the need for more emphasis on the preparations for teaching and are making specific allotments of funds to encourage this phase of graduate preparation.

Need for Distinction in the Training of Prospective Teachers

The emphasis which is being placed on research in recent years without a comparable emphasis on the preparation for teaching has led some authorities to advocate the introduction of a program for the prospective college teacher which differs materially from that pursued by the prospective research worker. Frederick W. Ness divides students enrolled in graduate schools into (1) those who will teach in college and secondary schools, (2) those preparing for work in industrial laboratories, research institutions, government agencies, and private business, and (3) those preparing for research careers in college and university departments.59 McGrath has advocated the establishment of what he calls an institute of higher studies for those students who have the desire and creative ability to become creative workers.60 On the other hand he


advocates the preparation of prospective college teachers in a division of the university just as prospective doctors are trained in the medical school, which is a professional division of the university. Such a division should provide for three advantages over the present system. First, it should permit the recruitment and better selection of prospective college teachers. Second, it could provide for the broadening of the present Ph.D. degree programs to meet present needs. In the third place, it would be possible with such a division of training to provide for the pedagogical needs of the prospective teacher, especially in equipping him to communicate knowledge to others.

In the training of college physics teachers research work is important because it fosters creativity which is essential for good teaching. But at the same time, effective teaching is equally important. It offers opportunity for creativity just as experimental research offers opportunity for creativity. If one does research in methods of communicating knowledge to others and as a result adds to the effectiveness of teaching science, this may well be the means of indirectly adding more to our store of knowledge than would be added by an equal amount of experimental research. Cowley divides teachers into three classes: the logidemic, or teachers who have contributed little to the advancement of knowledge but who ferret out new knowledge and interpret it for others; the practidemic, or those who teach students how to do something; and the pandemic, or teachers who advance the frontiers of knowledge and interpret facts. Although all three types of teachers are needed the graduate schools make no distinction between them. To quote Cowley:
Unhappily the graduate schools do not distinguish between these three kinds of prospective teachers ....I must, however, say this: in my judgment the reform of the graduate school of arts and sciences toward the end of differentiating the preparation of logidemic, practidemic, and pandemic teachers constitutes the most urgent need of present-day American higher education.61

Some alert graduate schools have recognized the need for making this distinction and have taken steps to adjust their graduate programs to meet the needs of society. They realize that the social needs of higher education today are quite different from many of the needs which prompted the establishment of Johns Hopkins University. Steps which are being followed by some of these institutions to modify their graduate programs will be discussed in a later section.

61Cowley, Educational Record, XXXIX, 325.
Summary

During the period from the establishment of graduate schools in this country until the present time there has been a rapid expansion of research phases of graduate study. College enrollments have increased enormously and are expected to increase much more within the next decade. During this same time very little has been done to prepare college physics instructors professionally for teaching undergraduate physics in the liberal arts college. The greater emphasis has been on training for research and graduate teaching. This has led to criticism of the present degree programs and to the advocacy by some of a different degree for prospective college teachers.

The prospective physics instructor in the liberal arts college is faced with the problem of providing a physics course for (1) prospective physicists, (2) prospective scientists in other fields of science, and (3) non-science students. The growth of general education programs in the liberal arts college presents another problem. There is a need for a graduate program which, in addition to giving the prospective physics instructor (1) a good foundation in fundamental fields of physics and (2) competence in research, will give him (3) professional preparation for teaching undergraduate physics and (4) a broad liberal background.

It is the purpose of this study to determine what is being done to prepare prospective physics instructors for liberal arts colleges, what training liberal arts colleges desire in physics instructors, and
what modifications or changes should be made in the present degree programs to prepare prospective physics instructors more effectively for teaching in liberal arts colleges.
CHAPTER III

ATTEMPTED SOLUTIONS OF THE PROBLEM

Programs for College Teachers

Various steps have been taken by institutions of higher education in attempting to improve the quality as well as the quantity of college teachers. In some instances it has meant the addition of courses devoted to the study of higher education; in other cases specific programs have been planned in efforts to improve the graduate preparation of prospective teachers. Foundations have made sizable grants for fellowships to encourage students to enter the teaching profession and to improve the quality of college instruction. Some of the procedures currently being followed by various institutions in their efforts to improve the preparation of prospective college teachers will be considered in this chapter. No attempt will be made to describe all programs in detail. Instead, typical programs will be included. The results of studies which have been made will also be considered in an effort to isolate practices which have been found of value in the graduate training program of prospective college teachers.

General Programs

A study made in 1949 of fifty leading American universities indicated that 78 percent of the institutions were offering one or more courses which dealt with college teaching, the organization of higher
education, and problems pertaining to higher education.¹ Among the thirty-nine institutions which made some formal course provisions, only eighteen offered fewer than four courses; thirteen offered from four to nine courses; and eight described fairly complete programs. Nearly three-fifths of all course offerings listed in the catalogues which were reviewed could be classified into areas dealing with the junior college, the general field of higher education, or problems dealing with the college curriculum and college instruction. The remaining courses dealt with student personnel work, teacher education, and the organization, administration, and financing of higher education. The study further revealed that 58 percent of the courses which pertained to the junior college appeared to be quite general in nature, and were designed to acquaint the student with the history, present status, and trends in the junior college. Only about one third of the courses dealt specifically with problems of teaching in the junior college. Seven institutions included in the study reported that they made formal provision for internship or practice teaching. The same situation was found generally to exist in other areas of higher education. The following includes some of the observations of the study:

1. Leading American universities show considerable awareness of the need to prepare students for service in colleges and universities, indicated by the fact that nearly four-fifths of those included in the survey make some curricular provisions for this training.

3. The problems of the junior or community college are receiving considerable attention — .... But there seems to be a serious lack of attention to the particular problems of the liberal arts college and of professional and graduate education.

4. Courses dealing specifically with problems of college teaching are found in the majority of institutions offering any courses in the field of higher education. Since only one course of this type is usually provided, it is not focused on teaching problems in one particular type of institution or in one subject field. Hence the prospective teacher .... seldom get sic specialized help on problems associated with teaching in his major field.

5. Local programs apparently have developed in response to demands for specific offerings or particular interests of faculty members rather than from sustained study of the needs that American graduate schools should be meeting in this field. ....

6. Course descriptions obviously do not reveal much concerning the nature of the learning experiences provided. But this brief survey at least suggests that many of these courses are chiefly designed to provide information about college teaching and other faculty responsibilities. .... To be highly useful, the courses must be developed around carefully selected teaching problems; they must themselves illustrate good teaching practice; they must, above all, stimulate the students who enroll to participate creatively in study, discussion, and experimentation centered around these recurrent teaching problems [italics not in original].

Perhaps one of the earliest attempts to develop a program for the improvement of college teaching was at the University of Michigan. This program was initially begun in 1932 with the establishment of fellowships for graduate students who had exhibited both research capacity and teaching ability. When the program was started the graduate school assumed a supervisory function with respect to the in-service teacher training which each department, by appointing teaching fellows, obli-

\[\text{\textcopyright{\textnormal{Ibid.}, pp. 111-12.}}\]

gated itself to perform. In 1947 there was such an increase in the number of fellows that it became necessary to revise the program to meet current needs. For example, when the number of fellows in the Mathematics Department increased to forty-five the program was revised to include regular group lecture and discussion meetings, consultation service with a member of the department, and classroom visitation by a member of the staff followed by a conference. During the group conferences such topics as administrative details, classroom teaching hints, methods of teaching, suggestions for planning a class hour, and the nature and source of supplementary teaching materials are topics for discussion. The present program calls for at least two visits to a teaching fellow's classroom by a senior faculty member. Each visit is supplemented by a conference with the observing faculty member. The Department of Higher Education offers a course entitled "Current Problems in Higher Education" in an effort to make prospective college teachers aware of some of the problems of the profession.

At the University of Chicago the Committee on the Preparation of Teachers, which is an all-university committee that is appointed annually by the Chancellor, is charged with shaping policies and programs for the preparation of teachers at all levels. The committee was first appointed in 1933 but did not give serious consideration to the preparation of college teachers until 1938. In 1948 a statement of policies and plans, which was formulated by the committee after a year of intensive study, was adopted by the university. The essential features of the program

---

Blegen and Cooper (eds.), The Preparation of College Teachers, p. 147.
are embodied in the nine principles contained in the adopted statement:

(1) The prospective college teacher should have training in research of such a character as to give him the experience of making a contribution to understanding; (2) the research training of the prospective teacher should be acquired whenever feasible in connection with a problem of such scope and significance as will lead him to employ a considerable variety of the principles, materials, and techniques of his eventual teaching field; (3) the prospective college teacher should have, preferably before his graduate work begins, a well balanced general education in the major arts and sciences; (4) in addition to knowledge of the subject matter of his special field of concentration, the graduate study of the prospective college teacher should give him a command of the broader divisions of knowledge within which his field of concentration lies; (5) in addition to the techniques which he may learn to employ in solving his individual research problem, the prospective college teacher should be given a concrete acquaintance with the full range of basic research methods used in his division of studies; (6) in the prospective college teacher's academic preparation, the subject matter and methodology of any body of knowledge should be taught and learned together; (7) all candidates for advanced degrees who expect to become members of college faculties should have some knowledge of the inter-relationships of the various fields of knowledge and their methods and of the implications of these inter-relationships for educational theory and practice; (8) all candidates for advanced degrees who expect to become members of college faculties should learn something of the variety of relations which have obtained or which may obtain among (a) the college, (b) the college teacher, and (c) the society within which higher education is carried on; and (9) prospective college teachers should serve as teaching fellows for at least a year so that they may learn through discussion, observation, and actual practice how to do the various kinds of educational work expected of a teaching member of a college faculty.

The above principles, if adopted by all major graduate departments in the training of prospective college teachers should prove to be of immeasurable value in improving the teaching performance of beginning instructors. At the University of Chicago it is required that a student complete a program of general education in the major arts and sciences before he is admitted to a division or school at the University. To

5Ibid., pp. 147-148.
further implement the above principles, breadth of academic training is provided at the graduate level through special programs, such as the divisional master's degree. The Council on Teacher Education is charged with the formulation of varied, departmental programs. In the biological, physical, and social sciences committees on the preparation of college teachers help faculties translate the principles listed above into departmental and interdepartmental programs. For specialized training in teaching, students enroll in the Department of Education. A seminar on higher education and college teaching is offered for graduate students who have been admitted to candidacy for the degree. A limited number of fellowships are available for students to devote a substantial amount of time to the study of college teaching during one year under the general direction of a special committee and the immediate direction of a major professor. Fellows attend weekly sessions which are devoted to a study of problems dealing with college teaching.

Bentley has described a rather unique program for the preparation of college English teachers which is being promulgated by the National Council of Teachers of English. The writer gives the following characteristics of a good English teacher:

1. A wide and accurate knowledge of English and American literature and their development;
2. A notable zeal for the study of literature;
3. A sympathetic understanding of undergraduates; and
4. Pedagogical skill.

---


7 Gerald Eades Bentley, "The Graduate School as a Preparation for Teachers," *College English*, XII (March, 1951), 330-35.
On the basis of importance in the preparation of a college English teacher, the first of the above qualifications is given a rating of 70 percent. Each of the other three is given a rating of 10 percent. In an attempt to improve the pedagogical skill of a prospective college English teacher the National Council of Teachers of English has undertaken a detailed study of the problem of preparing college teachers.

The following are some of the suggestions which it is offering:

1. The student should be constantly reminded of aspects of his graduate study which have a direct bearing on undergraduate teaching.

2. Graduate seminars should stress enunciation, timing, delivery, correction of mannerisms, and speaking from notes.

3. Courses should include discussion of textbooks in the field as well as professional journals.

4. At least one question on pedagogy should be included on every examination to make students aware of some of the problems of college teaching.

5. Students should be required to conduct at least one recitation in a seminar made up of fellow graduate students and supervisory members of the faculty.

6. An apprenticeship program should be provided for advanced graduate students who have had no teaching experience.  

The writer describes a program in which graduate students in English conduct a recitation in a seminar composed of fellow graduate students. The student conducting the recitation prepares a statement in advance, outlining what he wishes to accomplish. This statement is distributed after the student has finished his recitation for comments on his success. In the apprenticeship program students are assigned to a well qualified instructor in a course in freshman English. They attend

---

8 Ibid., pp. 332-33.
all meetings of the department, help organize and administer examinations, and grade papers under the supervision of the regular instructor. For six weeks the student attends two recitations each week observing the teaching of the regular instructor. He meets with the regular instructor in a weekly conference in which methods, purposes, and shortcomings of the recitations for the week are discussed. During the seventh and eighth weeks the interné takes over part of the recitations with the regular instructor present in the classroom. A conference is held after each such recitation.

As pointed out earlier, a study made in 1949 indicated that 78 percent of fifty leading universities were offering one or more courses in higher education. A more recent study gives information which indicates that of 134 institutions in the United States which award the Ph.D. degree twenty-three reported having one or more courses on the problems of higher education and college teaching as well as supervised teaching. Eighteen reported having some form of supervised teaching and nine reported having one or more courses which dealt with the problems of higher education. Five institutions reported that they had established a doctoral program which was specifically planned for prospective college teachers. All of these institutions, except Oklahoma State University, offer a program which leads to the acquisition of the Ph.D. degree. At the latter institution a program is offered which leads to the acquisition of the Ed.D. degree with a major in higher education. The degree may be earned in any field which offers the Ph.D. degree.

9Supra, p. 145.

Specific Institutional Programs

Syracuse University offers three doctoral programs which are specifically designed for the training of prospective college teachers. These programs lead to the doctor of philosophy in humanities, the doctor of philosophy in science, and the doctor of social science.11 An integral part of the Syracuse plan is a close relationship between the new programs and a newly expanded series of courses in general education for undergraduates. These courses are used as a laboratory for the training of prospective college teachers. The courses are taught by distinguished professors. Seven departments participate in the social science program, eight departments participate in the humanities programs, and in the science program the departments of chemistry, physics, mathematics, geology, plant sciences, zoology, and experimental psychology participate. In the science program the academic preparation consists of approximately fifty-four semester hours in a major science area and one minor science area or a major science area and two minors in additional science departments. Seminars in higher education which are designed to give a perspective of some of the major issues and trends in higher education, and introduction to college teaching are made an integral part of the program. Students participate in seminars in the teaching of science and are given the opportunity to teach one or two general education courses in one or more departments. In addition, the following courses are required:

---

1. A one-year course in the History of Science
2. A one-semester course in the major issues and trends in Higher Education
3. A course in the teaching of science in higher education
   Supervision of practice teaching is included in this course.  

Additional general requirements for the degree of doctor of philosophy in science include --

Foreign Languages:
One is required.

Research:
The research may be in one science or
May involve more than one science field or
May be concerned with problems of instruction in science.

The other programs are planned to provide a broad field of training for the candidate. Coordination between academic departments and the all-university Graduate School of Education is made through the dual professor who holds rank equally in an academic department and in the School of Education. Close cooperation exists between the departments and the School of Education in all three programs.

A recent summer session bulletin had this to say in regard to the establishment of the college training programs:

During recent years there has been an increasing desire on the part of institutions of higher learning to provide more complete training at the graduate level for those individuals who are preparing to teach science in junior colleges and private schools. There has also been an increasing demand by liberal arts colleges and universities for staff members who are particularly qualified to teach lower division science courses.

Because there is a shortage of qualified teachers for these lower division areas, institutions have had difficulty in securing capable staff members who have the necessary background and experience to be good college teachers. Recognizing this

---

12"A Doctoral Program for the Preparation of College Science Teachers, Syracuse University" (folder distributed, 1958).
situation, Syracuse University has prepared a program for the preparation of college teachers of science leading to the Doctor of Philosophy degree.

There are five distinct features of the program:

1. A broad training in the sciences
2. A graduate program combining breadth, specialization, and integration in the sciences
3. Supervised experience in teaching courses in science and provision for teaching experience in more than one field of science
4. Professional education seminars in curriculum development, methods of teaching and evaluation
5. Provision for research in more than one field of science.\textsuperscript{13}

Michigan State University offers a program which leads to the acquisition of the degree of Doctor of Philosophy for college teachers.\textsuperscript{14} The candidate for the degree must, in addition to satisfying the requirement of an adequate foundation for scholarly activity in a special field, do advanced study in broader areas than is usually required in the conventional Ph.D. program. The degree may be earned in a department which is authorized to award the Ph.D. degree or in one of the divisional areas, Biological Sciences, Mathematical and Physical Sciences, or Social Sciences. The program is essentially interdepartmental in scope. The dissertation may be concerned with a problem which extends across departmental lines. Experience in a seminar in higher education of not more than three credits is required.

The candidate must teach and be fully responsible for one class in the Basic College in the general area of his study for at least one

\textsuperscript{13}Graduate Programs for the Science Teacher, School of Education, College of Liberal Arts, University Division of the Summer Sessions, Syracuse University, summer sessions 1957, p. 13.

\textsuperscript{14}Bulletin on Graduate Study, Michigan State University (East Lansing: Michigan State University, May, 1957), pp. 31-32.
quarter under the direction of a committee which consists of the head of the Basic College, an experienced teacher in the Basic College, and a representative from the College of Education. In addition to the regular diploma, the candidate is awarded a certificate indicating that he has completed the internship program.15

The Guidance Committee includes the director of the appropriate college division, heads of appropriate departments, the head of the Basic College department in which the candidate is doing his work or a representative from the department, and any other persons the student's program may require. At least three departments must be represented on the committee unless a department offers two or more recognized subject fields. Not more than 50 percent of the course credits beyond the bachelor's degree may be in one department.

The program at Michigan State University was begun in 1946 with the creation of the position of "professor of higher education." Two of the major responsibilities of the new position were the improvement of instruction on the campus and the development of a program for the preparation of college teachers. The distinctive features of the program are (1) the joint responsibility taken by the basic College and the School of Graduate Studies, and (2) the program of studies leading to the degree of doctor of Philosophy for college teachers.

At Vanderbilt University a special Ph.D. program for the preparation of college teachers has been established under a grant from the Fund for the Advancement of Education. Awards up to $3,500 are made over a year.

---

period of two years to persons who have completed at least two years of graduate study. The program requires a total of four years of graduate study for the Ph.D. degree. During the third and fourth years of study special courses for the preparation of college teachers and supervised teaching are added to the regular Ph.D. program. It is expected that the program will

(1) help to relate the specialized training of the candidate to a wider intellectual experience on the graduate level, (2) help to adapt the work of the Graduate School more directly to the needs of the American college in which its graduates will be employed, and (3) facilitate the completion of all requirements for the doctorate within the period of technical residence. 16

Two years of residence at Vanderbilt are required. The additional year which is required in the program makes it unnecessary to reduce or weaken the training in research. Two new courses are added to the usual program and provision is made for supervised teaching. During the third year of graduate study, one of the new courses, "The History and Organization of the American College," gives the student a general introduction to the institution in which he will pursue his career. A seminar on "Basic Ideas" is given in the fourth year. Each student in the program is required to do teaching under supervision. This supervision is in part the responsibility of the major department and in part the responsibility of the Director of the program. It is considered by the graduate faculty that responsibility for the adequate preparation of prospective college teachers is a problem of the entire faculty and not of the major department only.

Oregon State College offers a program for the Ph.D. degree in which a graduate minor is taken in conjunction with a subject-matter major. Included in the minor program are courses such as the College Student, College and University Teaching, American Higher Education, and a seminar on Teaching Procedures. Electives may be chosen in appropriate areas to form an integrated program in college teaching. Graduate students are also encouraged to join faculty groups which are engaged in studies dealing with problems in teaching. The Graduate School at Oregon State College publishes a periodical entitled Improving College and University Teaching, which is distributed quarterly and which features articles on teaching written by college and university faculty members.

Departmental Programs

Some institutions such as Pennsylvania State University, Kansas State College, Emory University, The Ohio State University, Stanford University, Northwestern University, The University of Minnesota, Harvard University, Princeton University, and the University of Wisconsin have programs which have been developed to a lesser degree than those described above, and are generally on a departmental basis. In most instances the departments concerned are in the humanities or social studies. However, at the Pennsylvania State University the Department of Physics sponsors a graduate seminar on college teaching in physics. The seminar seeks to (1) introduce prospective physics teachers to contemporary problems in higher education, with special reference to the possible contributions physics teachers can make, (2) consider the problems and obligations of the college physics teacher in college and community life,
(3) study effective teaching procedures, and (4) develop a professional attitude on the part of prospective college physics teachers.

Internship Programs

Another recent trend in the preparation of college teachers is the establishment of internship programs for beginning instructors. If properly conducted there is probably no phase of the prospective college teacher's training which will give him more immediate beneficial results than a well supervised period of apprenticeship. The President's Commission in its study of higher education made the following statement in regard to internship training of college teachers:

A carefully arranged period of supervised internship should become the very keystone of an effective preparatory program for college teachers.

This Commission recommends that each graduate school engaged in the preparation of individuals for careers in higher education take steps immediately to expand the supervision of their instructional and research fellowships into a program of real internship.17

College teaching is one of the few professions in which a period of internship is not required. Yet if properly conducted a year of internship should not only improve the quality of instruction of the beginning instructor but also it should materially decrease losses from the profession. It is admitted that the program would be costly if the intern taught a reduced load but the beneficial results should justify the salary drawn by the beginning instructor during his period of internship.

A number of colleges and universities are carrying out experiments in internship training to induct newcomers into the profession in such a way that they can arrive at their full potential as good teachers more quickly. More than twenty institutions have experimented with such programs under grants from the Fund for the Advancement of Education. While the programs differ in various institutions all have some features which are common. At Colgate University, for example, the intern takes fewer hours than is generally assigned to a beginning instructor. Each intern is a regular member of the college faculty. He is given an opportunity to engage in faculty discussions of teaching problems. He quite often audits a course for a year before he teaches it. His own teaching may be observed by a colleague. Both interns and administrators of participating colleges have expressed enthusiasm for the programs.

Fellowship and Institute Programs

Several foundations and agencies have allocated funds specifically for the preparation of college teachers and the improvement of college teaching. The Danforth Teacher Study Grant Program, which was established in 1927 to serve the needs of young men and women is confined

---

18 The institutions which have participated in such programs include: Amherst College, Brown University, Carleton College, Case Institute of Technology, University of Chicago, Colgate University, Columbia College, Dartmouth College, Goucher College, Hunter College, Knox College, University of Minnesota, Reed College, St. Joseph's College, seven colleges in southern California, Vassar College, Wesleyan University, and Williams College. (footnote 19, p. 33)

largely to higher education. From 1954 to 1958, a total of 169 teachers used the program for assistance in their studies for the Ph.D. degree. The Foundation also grants graduate fellowships to promising college graduates who intend to enter college teaching as a profession.\textsuperscript{20} Appointments are made annually to approximately one hundred men who are preparing for college teaching and who, at the time of application, have had no graduate study. Applications are accepted for any academic discipline common to the undergraduate college. Men in the natural and the social sciences are particularly encouraged to apply.

The Woodrow Wilson National Fellowship Foundation began at Princeton University in 1945 as an attempt to attract promising young scholars into college teaching.\textsuperscript{21} In 1952 the program became national under the sponsorship of the Association of Graduate Schools, and in 1956 a total of 162 fellowships was awarded. To further implement the Program, the Carnegie Corporation and the General Education Board pledged $100,000 each per year for five years, beginning in 1952 and terminating in 1958. In 1957 the Ford Foundation made a grant of $24,500,000 for five years, beginning in 1958. This grant provides for 1000 fellowships a year. One feature of the Program provides that, along with each Fellow, will go $2,000 to the graduate school he is attending. One-fourth of this sum may be used in any way the school sees fit, the remainder is to go into a fund to provide fellowship aid after the first year of graduate work.


to which the Program is limited. One of the essential parts of the Pro-
gram is the recruitment of Woodrow Wilson Fellows. Present plans provide
for one hundred faculty members on campuses in all parts of the country,
on a part-time, released-time basis, to devote their efforts to spread-
ing information about the Program to colleges in their area. In 1957-58
there were 253 Fellows enrolled in the Program. A recent announcement
by the Woodrow Wilson National Fellowship Foundation gave the names of
1200 students who had been awarded fellowships for the 1959-60 academic
year. The announcement further revealed that 38 percent of the winners
are planning to pursue graduate study in the humanities, 30 percent in
the social studies, and 26 percent in the natural sciences and mathe-
matics.

Beginning in December, 1958, the National Science Foundation has
awarded Science Faculty fellowships as a means of providing individuals
with an opportunity for improving their competence as college or univer-
sity teachers of science, mathematics or engineering. Awards are made
primarily on the basis of demonstrated teaching ability at the under-
graduate level. Applicants must submit an individualized plan of study
and/or research which is designed as a means of improving the individual's
competence as a teacher. Grants may not exceed $12,000 a year and must
be at least $2000 a year. Individual grants are adjusted to provide re-
muneration equal to that which the Science Faculty fellow received in his


23National Science Foundation, "Science Faculty Fellowships for
the Improvement of College Teaching," Announcement for 1958 (Washington:
The Foundation).
academic position. The tenure of a fellowship is normally an academic year of nine months or a calendar year of twelve months. Fellowships are awarded in mathematical, physical, medical, biological, engineering, and other scientific fields. The National Science Foundation also sponsors a Summer Institute Program which was begun in 1953, in recognition of the important role of high school and college teachers in developing our scientific manpower potential. One hundred and twenty-six grants were made in 1958 for the support of Summer Institutes for high school and college teachers.\textsuperscript{24} The number of grants for 1959 has been increased to 350. It is estimated that these institutes will benefit over 18,000 high school and college science teachers.

The establishment of various grants and fellowships as described above gives some indication of the emphasis which is being placed on improving the quality as well as the quantity of prospective college teachers. Some organizations such as the Danforth Foundation, give some preference to students in fields where the shortage of teachers is the greatest. This foundation also stipulates that the student must agree to enter the teaching profession. The Woodrow Wilson National Fellowship Foundation seeks to make awards to students who have shown an interest in teaching but it does not require that the recipient agree to enter the teaching field. While some studies have been made of the grants for the improvement of high school science instruction, insufficient infor-

\textsuperscript{24} National Science Foundation, \textit{Programs for Education in the Sciences} (Washington: The Foundation, March, 1959), p. 11.
Information is available on grants for prospective college teachers to adequately evaluate the results at the present time.  

General Features of Present Programs

With a few exceptions the graduate programs which are presently offered for the improvement of college teaching emphasize the humanities and the social studies. Syracuse University, Vanderbilt University, Michigan State University, and Oregon State College have programs for students in the sciences as well as in other fields. These programs show an encouraging trend but do not indicate any marked change in the philosophy of the graduate schools. There is reluctance on the part of some administrative officers in liberal arts colleges to employ an applicant who has obtained an interdepartmental or teaching degree. The programs now in existence do show some very commendable features which should be given serious consideration in planning a program for the preparation of college physics teachers. One study includes twelve commendable features which result from institutional programs. These features include provision for (1) recruitment and selection, (2) a well-balanced general education, (3) interdepartmental programs, (4) modification of the dissertation, (5) professional seminars and workshop courses, (6) supervised apprentice experience, and (7) a positive program for the preparation of college teachers. While very few, if any, of the programs provide all


26 Blegen and Cooper, The Preparation of College Teachers, pp. 165-68.
the benefits which have been summarized the conclusion must be drawn that a well planned program for the preparation of college teachers would, in addition to improving the quality of college teaching, engender many other benefits for higher education. When it is recalled that Gilman envisioned a program for preparing college teachers as a part of the newly founded Johns Hopkins University, it is somewhat puzzling that so little has been done from then until the present to give specific preparation for college teaching. Perhaps one of the most important factors in the lack of definite programs has been the great emphasis on the development of research. As has been previously shown this development in graduate education has overshadowed all others. Scientists and engineers have realized only in recent years that consideration must be given to science teaching in order to provide sufficient scientific manpower. It is fortunate that serious thought is now being given to this phase of scientific development.

A factor which has been influential in causing an interest in programs for college teacher preparation has been the development of general education and the need for qualified personnel to teach in these programs. The great increase in enrollments after World War II ended, when serious minded veterans returned to the college campuses, awakened the need for something to be done. It is to be hoped that with the impending increase in college enrollments during the next decade the programs now in existence will expand to include all disciplines and that all graduate departments will assume the responsibility of training prospective college teachers as an integral part of their functions.
Specific Evidence of the Problem as Applied to Physics 
and Steps Which Have Been Taken to Solve It

Thus far, consideration has been given to problems which pertain to the preparation of prospective college teachers in various disciplines. This procedure has been followed for two reasons. In the first place, many of the pedagogical problems in the graduate preparation of prospective physics teachers are similar and in some cases identical to problems which are to be found in other fields of study. In the second place, much more has been done in the humanities, for example, toward the improvement of the teaching performance of the beginning instructor than has been done in physics. By considering the programs which have been developed in other fields many helpful suggestions may be obtained which should prove valuable in planning a program for the preparation of college physics instructors. Furthermore, the prospective college teacher today must be prepared to teach in a general education program. Consequently, his graduate program of study should have some features in common with other disciplines.

Present Status of Undergraduate Physics Instruction

As it was indicated previously, research developments in physics in our universities have far exceeded any other developments. Prior to 1950 practically all subsidization for physics students and physics departments was for the furtherance of research. It is true that many of those helped by grants or fellowships entered the teaching profession. However, the primary purpose of the grant or fellowship was generally to

\[27\text{Supra, pp. 18-19.}\]
assist the student in research and to encourage the production of future scientists and engineers in order to alleviate the manpower shortage in these areas. This problem is still very acute and probably will continue to be one of the nation's number one problems for a number of years. During the past decade, however, a number of organizations and foundations have directed their attention toward efforts which are designed to increase the number of physics instructors and to improve the quality of general physics instruction both in college and in high school courses. As evidence of the gravity of the situation a leading physics journal recently published the following statement:

There are indications that the physics teaching situation in the United States is especially acute at the present time and that it will be even more so in the years to come unless physicists act promptly to expand and intensify their programs relating to physics education.28

In light of this situation a conference was sponsored by the National Research Council and the American Institute of Physics at White Sulphur Springs, West Virginia, in March, 1955 to survey the situation and make recommendations for steps to be taken. This conference was devoted largely to physics at the secondary level in an effort to increase interest in physics prior to college entrance. In commenting on the teaching objectives of college physics courses one speaker made some very pertinent observations. To quote:

In my judgment the average elementary college physics course falls far short of even modest intellectual standards and fails utterly to satisfy present day requirements in physics education. This situation is deplorable, to say the least. I am amazed, not so much that high school physics

leaves so much to be desired, but that it is as good as it is, when one considers the low quality of beginning college physics courses.

One can get very sad or angry at the teaching methods employed: The laws of physics are presented to the student by the teacher or the textbook, or both, as dogmatic truths. The student is to take them on faith and then proceeds to enter a period of learning how to apply these principles to applications of one sort or another to as quantitative a degree as his background and training will allow. This may be a fine way to teach theology, but it is a pretty sorry way of teaching science.  

The above are very strong statements, especially when it is considered that they were made by the chairman of the physics department in one of our most widely recognized institutions. One of the recommendations made by the National Research Council and the American Institute of Physics Conference on the Production of Physicists was that the greatest possible effort should be devoted in improving the quality and effectiveness of introductory college physics courses as one of the most promising means of increasing the number of physics majors for careers both in teaching and in research.  

Considerable attention is being given to the improvement of high school physics instruction by grants from the National Science Foundation for summer study institutes and fellowships for secondary school science teachers. A number of industries, as for example the General Electric Company, sponsor summer institute programs. It is only within the past few years, however, that efforts have been made by some insti-


tutions and by the National Science Foundation toward improving the quality of college physics instruction. In spite of the fact that many changes have occurred in the objectives of college physics during and since World War II very little change, if any, has occurred in undergraduate physics instruction. Perhaps no area of instruction is better adapted to a moderate utilization of audio-visual aids than beginning courses in college physics. The content and method of instruction of beginning and intermediate physics courses in college today are generally much the same as they were twenty-five or even fifty years ago with modern developments in physics added to the compartmentalized sections of mechanics, optics, heat, and other classical topics. In a number of cases very little effort is made to lead the student to do inductive or reflective thinking. As one physicist stated:

As now set up, the best that one can get, apart from mere accumulation of factual information, is a degree of quantitative analytical discipline.31

If physics is to render the service it should to general as well as special education, efforts must be made to offer physics courses on the undergraduate level, and particularly courses for non-science majors, which will stimulate scientific thinking. No other discipline has a greater wealth of opportunities for doing this than physics. Scientific methods should be employed to determine the objectives or goals of physics teaching and the logical methods of attaining these goals.

The problem of the preparation of college physics instructors for small liberal arts colleges is a result of a number of recent develop-

31Frank, Physics Today, VIII (June, 1955), 20.
ments. The great demands by industry for trained scientists has far exceeded the supply of trained physicists. This has resulted in a shortage of physicists both for college and for high school instruction. A study which was made in 1957 by the American Institute of Physics included 490 of the 536 institutions of higher education in the United States that offer a major in physics. The study disclosed that 451 of the 490 responding institutions reported that their needs for physics teachers were not being met and that they had to resort to various substitutes to meet the emergency.\textsuperscript{32} Responding institutions employed the following percentages of substitutes:

\begin{itemize}
  \item Overloading departmental staff \hspace{1cm} 49
  \item Reduction of departmental staff research \hspace{1cm} 46
  \item Cancellation of classes \hspace{1cm} 21
  \item Undesirable increase in class size \hspace{1cm} 36
\end{itemize}

According to reports from physics departments there was a recognized total shortage of 434 physicists, or 16 percent of the total number of physics teachers reported by institutions. Half of this shortage was in departments having six or less members on the staff. In 1957 physics ranked fifth in the number of Ph.D.'s awarded, being exceeded only by education, chemistry, engineering, and biology.\textsuperscript{34}

The shortage of physics teachers for college instruction in 1957


\textsuperscript{33}\textit{Ibid.}, pp. 2-3.

may be accounted for largely by the fact that a major percentage of recipients of degrees enter research or industrial work. A questionnaire which was forwarded to all institutions which award graduate degrees in Ohio and the five adjoining states provided the information which has been summarized in Table 2.\(^35\) It will be noted from the table that approximately 14% percent of those persons receiving an advanced degree during the years 1955-58 were reported to have entered teaching. Information obtained from data tabulated by the United States Department of Health, Education, and Welfare indicates that there were a total of 3,749 graduate degrees awarded in physics during the years 1955-58. These same reports indicate that the states listed in Table 2 awarded 738 second and third level degrees during the same period or approximately 20 percent of the total number of higher degrees awarded.\(^36\) If the percentage of physicists earning a graduate degree during the past three years who entered or who had already been engaged in college teaching holds throughout the nation, there were approximately 524 college physics instructors or prospective instructors who earned graduate degrees during the period. No information is available on the number of new instructors included in this group. While these figures are only approximate, they do show that the number of physicists entering teaching is wholly inadequate. It is interesting to note that during the years 1955-58 the

\(^{35}\)Appendix, p. 257.

## Table 2

Graduate Degrees Awarded, 1955-58, by Institutions in Ohio and Adjoining States with Percentage of Recipients of Degrees Who Entered College Teaching

<table>
<thead>
<tr>
<th>State</th>
<th>Number of Schools&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Number of Replies</th>
<th>Degrees Awarded</th>
<th>College Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Masters</td>
<td>Ph.D.</td>
</tr>
<tr>
<td>Indiana</td>
<td>3</td>
<td>3</td>
<td>66</td>
<td>6</td>
</tr>
<tr>
<td>Kentucky</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Michigan</td>
<td>4</td>
<td>4</td>
<td>129</td>
<td>49</td>
</tr>
<tr>
<td>Ohio</td>
<td>8</td>
<td>6</td>
<td>88</td>
<td>40</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>8</td>
<td>5</td>
<td>115</td>
<td>77</td>
</tr>
<tr>
<td>West Virginia</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>18</td>
<td>381</td>
<td>231</td>
</tr>
</tbody>
</table>

<sup>a</sup>The above information does not include seven graduate schools which did not reply. Information for these institutions was obtained from: U.S. Department of Health, Education, and Welfare, Office of Education, Earned Degrees Conferred by Higher Education Institutions (Washington: U.S. Government Printing Office), 1955-56, Circular No. 199, Table 17, pp. 137-39; 1956-57, Circular No. 527, Table 19, pp. 151-53; 1957-58, Prepublication Report from Department. When data for these schools is added to the above totals the total number of degrees awarded is as follows: Ph.D. degrees - 214; Masters degrees - 489. If the percentage of those who entered college teaching, that is 14 percent, is applied to the 120 degree recipients thus obtained the approximate total number who entered college teaching during the period 1955-58 is 100 out of the 738 who obtained a second or third degree.
University of Michigan awarded thirty-five Ph.D. degrees in physics. Eighteen of this number were reported to have entered college teaching. The University of Michigan has had a strong fellowship program for prospective college teachers since 1932, although no definite course work in the teaching of physics is offered. No information is available on the influence a well planned program for prospective college physics teachers would have in causing graduates to enter the teaching field. It is reasonable to believe, however, that a number of candidates would be led to enter teaching if they gained their first teaching experience under very favorable circumstances.

Another problem which must be considered in planning the preparation of prospective physics teachers is the nature of the educational objectives of the students the undergraduate physics instructor will teach. There is a growing need to present the fundamentals of a tremendously expanding field to an increasing number of students of different interests and at different levels. Scientists have developed a highly technical world which is handed over to non-scientists to run. This is not only an unfortunate situation but it is a dangerous one. When it is realized that most of our economic problems and many of our social problems are the result of scientific developments, it is clearly evident that scientists can no longer overlook their unique responsibility in general education. In an attempt to meet its responsibility in this area the physics department at Harvard College now offers four types of physics courses which are planned primarily to meet the needs and interests of 

37 Letter from chairman of the Physics Department, University of Michigan, October 10, 1958.
four general types of students.\textsuperscript{38} One course is aimed at science students who must acquire a certain competence in the subject; a second course is planned for future business men or executives who should have a course more of method and spirit than of details; a third course is for those who are interested in the historical and social aspects of scientific developments; and the fourth course is for liberal arts and other students who may be distrustful of science, if not actually inimical toward it. While it is not possible for the small liberal arts college to offer the variety of courses which are offered at Harvard College the smaller colleges do have a responsibility to provide courses in physics which are adapted to meet the needs of their physics and science majors as well as the needs of students who will become leaders in business and legislative matters, and often will occupy positions in which they must make major decisions pertaining to science and technology. This means that the prospective liberal arts physics teacher must be prepared to teach in a general education program as well as a program which is planned for physics majors.

Obviously, if the graduate student is to become a good undergraduate teacher, he must know more than physics subject matter. He will be faced with a number of pedagogical problems, some of which have been summarized by one physicist as follows:

1. The problem of understanding physics teaching in relation to general education and the general problem of teaching non-science majors
2. The problem of training future scientists and physicists

3. Problems involving the psychology of teaching and the learning process
4. Problems relating factual knowledge to creative endeavor
5. Problems in effective oral and written communication of ideas.
6. Problems in testing the attainment of various objectives
7. More specific problems in handling lecture demonstrations, laboratories, and quizzes or recitations

Currently more emphasis is given to the second item in the above list than any of the others in the preparation of college physics teachers. It seems a little strange that a university which does so much in physics for its physicists often does little or nothing in teaching methods for prospective college physics teachers. Little or no attention is given by many graduate physics departments to the items listed above other than giving the graduate student a laboratory section which he often teaches with very little if any supervision.

Perhaps this lack of attention to problems associated with college teaching has resulted, not from the feeling that at this level an adequate preparation in a subject matter field is all that one needs for satisfactory teaching, but rather from a conviction that the qualities of a good teacher are those with which an individual is endowed at birth or if he is not endowed with them they are qualities which the individual can develop without outside assistance. This of course is a debatable question. There are certain qualifications which, if the individual does not possess them, will preclude success in college teaching. However, if the individual possesses the qualifications which will enable him to become a successful college physics teacher, there is no reason

\[39\text{Ibid.}\]
to believe that he would not be a better beginning teacher if he had special training. The following statement substantiates this:

It seems fairly evident that, given individuals with an adequate mastery of a subject matter field and the appropriate basic personal characteristics, the conscious attention to the problems of college teaching cannot help but produce better college faculty members. 10

Attempts to Improve the Quality of Undergraduate Physics Instruction

The fact that a number of institutions or graduate departments are now offering graduate work which is directly associated with college teaching or the preparation for college teaching, indicates that many colleges agree that something should be done for improvement of the situation. 11 Recommendations made by the Committee of Fifteen, which investigated current practices in the preparation of college teachers, echo the same sentiment. According to the Committee the specific needs of future college teachers must be recognized by graduate schools. That this feeling was unanimous is quite evident from the expression:

All the members of our group felt that graduate schools pay too little attention to the fact that many of their students will become teachers and need help to become good ones. College teachers prepare the next crop of graduate students; and by neglecting their training the graduate schools are doing themselves a poor service.

It seemed equally clear to us that present practices are far from satisfactory, and that something much more fundamental than mere tinkering with the techniques of using teaching assistants is needed before the graduate schools can be said to be doing everything in their power to train good college teachers. 12

11 Supra, pp. 45-46.
The establishment of the National Science Foundation in 1950 is evidence that the Federal Government has recognized the importance of the preparation of science teachers. According to the Act, the Foundation is authorized and directed to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences.\(^3\)

In endeavoring to foster the development of research and education the Foundation has established research grants, the Fellowship Program, and a Program for Education in the Sciences, which includes the Summer Institutes Program, the Academic Year Institutes Program, and the Special Projects in Science Education Program. The research grants and the Fellowship Program provide training for persons preparing for careers in science. The Summer Institutes and Academic Year Institutes are designed for high school and college science teachers. The Special Projects in Science Education Program seeks and explores means of improving the quality and effectiveness of science education. Among its activities are studies and projects directed toward (1) curriculum improvement, (2) production of teaching aids in the sciences, (3) conferences on science teaching, and other projects which are designed to improve science teaching and to motivate qualified students to consider science or mathematics as a career.

One such project is the Physical Science Study Committee which was organized in 1956 under the sponsorship of the Massachusetts Institute of Technology with support from the National Science Foundation. The

specific aims of the Committee are

(1) to plan a course of study in which major developments in physics, up to the present time, are presented in a logical and integrated whole; (2) to present physics as an intellectual and cultural pursuit which is a part of a present-day human activity and achievement; and (3) to assist physics teachers, by means of various teaching aids, to carry out the proposed program. 

One hundred persons, including thirty secondary school teachers, forty physicists from colleges and industry, and thirty supporting staff members were organized in six writing groups and in groups to develop new experiments and equipment, teaching films, teaching aids, a guide for teachers, examination questions, and a reading reference. One of the primary goals of the Committee in writing another new text or syllabus has been to design a course which would arouse interest and lead students to relate scientific concepts to their own experiences. In keeping with this goal a completely new text has been written which stresses fundamental concepts of physics in the perspective of modern developments. Experiments are being designed as an integral part of the course and generally require apparatus that can be improvised by the student in the school shop. It is the hope of the Committee that when the project is completed the new text, the films, the lecture demonstration and laboratory instructions, the teachers' guide, and all other elements of the study will produce a well integrated program for the teaching of physics in our secondary schools.

While the organization of the Physical Sciences Study Committee was instigated for the improvement of physics instruction at the second-

ary level it does show what is being done in one phase of the training of future physicists. There are indications that a similar study could be made with profit in the beginning college physics courses. In fact, a study was made in 1954 at Northwestern University of college physics laboratory instruction with primary emphasis on the training of laboratory assistants. Over forty institutions, including Massachusetts Institute of Technology, Pennsylvania State University, Ohio State University, Princeton University, and Purdue University were represented at the conference. The results of this study indicate that policies and practices followed in various physics departments with respect to the use of graduate students as laboratory assistants vary from the well planned program that is in effect at Pennsylvania State University to laboratories which are conducted by graduate students with little or no supervision by regular staff members. As reported by one representative:

The supervision given to the laboratory instructors in most universities is not what it should be. Too often the supervisor, generally an older staff member, watches the lab instructor only once or twice, and talks with him only a few times more, and that is all the supervision for the entire year.45

The program which is followed at the Pennsylvania State University is quite a contrast to the above description. The essential features of the Pennsylvania State University Program are (1) a teaching apprenticeship, (2) a graduate seminar on science methodology, and (3) a seminar on college teaching. In the apprentice program graduate students report

for an orientation period one week prior to the beginning of classes in order to become familiar with the policies of the department. Conferences are held periodically on the objectives of physics teaching. A system of visitation of both laboratory sections and recitation sections taught by graduate students has been inaugurated followed by a conference with the senior staff member making the visit. The seminar on methodology in science is taught by a staff member of the Physics Department and stresses the philosophical aspects of physics. The third venture, a seminar on college teaching, is also taught by a member of the Department. This seminar endeavors, among other objectives, (1) to introduce the prospective physics teacher to important problems in higher education -- with special reference to the possible contributions the physicist may make to their solution, (2) to consider the various functions and obligations of a college teacher, (3) to study effective procedures and techniques for effectively teaching physics, and (4) to develop a professional attitude and consciousness on the part of the prospective physics teacher.\(^{46}\) The tendency of many college professors when confronted with an issue relating to college teaching is to decide the issue on the basis of opinion rather than making a systematic study of the literature and planning a scientific approach for solving the problem. The program at Pennsylvania State University endeavors to lead prospective physics teachers to approach educational problems in a scientific manner. One of the weaknesses in the program has been the need

---

for more extensive cooperation with other departments, particularly the departments of education and psychology. This situation has been generally true in many institutions. However, there are indications that significant changes are occurring in interdepartmental cooperation. As one writer has stated:

No longer is it felt that the members of the education departments should be the only ones responsible for and concerned with the training of teachers. It is encouraging to see the cooperation that is now taking place in the colleges and universities all over the country between academic departments and departments of education. And universities all over the country between academic departments and departments of education. instituted a Seminar on Educational Problems and Methods in 1949. Attendance is voluntary at the monthly meetings. The following topics have been included in discussions: The Educational Aims and Objectives of the Institute; How Can the Effectiveness of Teaching at the Institute Be Improved; What Steps Should Be Taken to Train Graduate Students for Teaching Positions. To encourage qualified persons to enter teaching the Massachusetts Institute of Technology offers its highest paying fellowships to teaching fellows. The Institute adheres to the policy that teaching comes first. If something needs repair for teaching, research must wait. All staff members teach elementary courses. Teaching assistants are paid 30 percent more than research assistants. All laboratory assistants meet together where they can discuss their problems. The laboratory assistants have produced a teaching manual which is very helpful for class recitations. Rather than have staff visitations in the laboratories an elaborate objective questionnaire is completed early in the session on each

[Note: The citation is not visible in the text provided.]
graduate instructor. A senior staff member discusses the results of the questionnaire with an individual instructor and points out measures which he should take to improve his laboratory instruction.

It was indicated earlier\textsuperscript{168} that several graduate schools or departments have definite programs for the preparation of college teachers. The chairman of the physics department in each institution, which had a program that was available to prospective physics teachers, was contacted with rather disappointing results. In schools such as Oregon State College, Michigan State University, and Syracuse University very few students had taken advantage of the opportunities which the programs offered. Some of the reasons which were suggested for this were (1) a lack of time to cover the field of physics and the courses relating to college teaching, (2) the fear that a degree obtained through the program would not have the prestige that the conventional Ph.D. degree in physics is accorded, and (3) the necessity for competence in three sciences as at Michigan State University. Altogether a total of nine students were reported to be pursuing a graduate program or had obtained a Ph.D. with emphasis on the teaching of college physics. With the emphasis which has recently been placed on the improvement of college physics instruction this lack of participation in the programs by prospective physics instructors is rather disturbing. It leaves one with the thought which

\textsuperscript{168}Supra, pp. 53-58.
was expressed by the American Institute of Physics Committee on Preparation of College Teachers when it observed:

In considering the preparation of students for the college teaching profession, the Committee is inclined to believe that the teaching outlet for graduate students is, at some place, given scant or disparaging attention. Nevertheless, it is everywhere recognized that without college teaching -- good college teaching -- we would fail to maintain or strengthen the source of our scientists.\(^{49}\)

Various steps have been taken to improve the preparation of prospective college teachers. In some institutions the measures which have been taken have been limited to the inclusion of seminars on the organization and purposes of higher education. In a few institutions an all-university program has been organized to provide for the preparation of college teachers. Generally, however, programs have been started on a departmental basis and in a few instances have spread to the rest of the university. Studies indicate that approximately 50 percent of the graduate institutions in this country have one or more courses which deal with the problems of higher education and college teaching but only a limited number of institutions have programs which are specifically planned to help the prospective teacher be more competent in the performance of his teaching duties.

Only a very few institutions have programs which include the preparation of physics instructors for undergraduate teaching as part of their program. Physicists have begun to recognize the need for such training and have developed programs in several schools. The program at the Pennsylvania State University is perhaps one of the best physics departmental programs for the preparation of prospective college physics instructors.

The programs which are now being followed in institutions have some very commendable features. Among other things they provide for (1) a definite program of recruitment and selection, (2) a broad general education, (3) interdepartmental programs, (4) a period of internship.
training, (5) supervised teaching under senior staff members, and (5) professional training, including seminars on problems in higher education, the psychology of learning, testing and measurement and other problems of a professional nature.
CHAPTER IV

METHOD OF SOLVING THE PROBLEM

General Plan for Securing Information

Some steps are being taken to prepare prospective physicists who indicate a primary interest in teaching, for academic careers at the undergraduate level. Generally, however, additional information is needed to permit one to draw definite conclusions upon which to make recommendations for a program that would be specifically planned to prepare prospective physics instructors for positions in liberal arts colleges. Not much conclusive information is available, for example, on such factors as the characteristics and training which administrators in liberal arts colleges desire in physics instructors whom they seek as members of their faculties. Since the physics instructor in the small college is concerned largely with teaching and associated problems and devotes very little, if any, of his time to research, the question has been raised as to whether or not he should pursue a graduate course that would lead to the acquisition of a teaching degree rather than the conventional Ph.D. degree which is obtained by the physicist who plans on following a career in which research is one of the primary duties.¹

Some studies have been made in which this question was considered and tentative recommendations were made but no definite conclusions have been reached.\(^2\)

Another factor about which there is considerable difference of opinion deals with the extent to which professional education should be included in the graduate program of the prospective college physics teacher. Despite the fact that a number of authorities, including some physicists, recognize that something should be done on the graduate level to train the prospective college teacher professionally for his chosen career, there are a number of leaders in academic circles who still hold to the belief that little can be done to help beginning instructors in their teaching performance. Their convictions are that one learns to teach by teaching. The benefits which should be derived from professional training would depend to a great extent upon the individual — his qualifications and his past experience. It seems reasonable, however, to assume that such training would be of value to all prospective college physics teachers in varying degrees and it is a factor which should be given consideration in graduate training programs. The possibility of larger classes and the need for utilizing new media of instruction, such as closed circuit television, in the near future, when the impending increase in college enrollments materialize, further accentuates the need for professional preparation.

The strong emphasis which is now being placed on general education

programs in the liberal arts colleges and the social implications of re-
cent scientific and technological developments present problems and im-
plications which must be considered in a graduate program for the prepa-
ration of prospective physics instructors for our liberal arts colleges. Scien-
tists, and particularly physical scientists, have been very intent on where 
they were going but have not been much concerned about keeping the layman 
informed on the progress they were making. With a few excep-
tions to the contrary, it is only within the past few years that physi-
cists have given any thought to the social effects of developments in 
physics. These are problems which must be considered in the liberal arts 
college. They present a challenge which must be met if the liberal arts 
college is to perform its function of providing a liberal education for 
our teachers of the future.

With a few exceptions, a survey of the literature yields little 
concrete information on these and other important problems which must be 
taken into consideration in planning an effective program for the prepa-
ration of physics instructors during the next few years. A study of 
college catalogues of a majority of the institutions does not yield much 
additional information which is pertinent to the problem. In fact little, if any, 
difference is to be found in graduate course offerings for pro-
spective research workers and prospective undergraduate instructors in 
practically all graduate physics departments. There is a need for addi-
tional information from the liberal arts colleges on the nature of the training 
they expect future members of their physics staffs to have and the type of courses they expect these instructors to teach. There is a 
need also for information from instructors in the institutions regarding
their duties and the specific preparation they need for teaching in a liberal arts college. While the graduate school should set the standard of training for college teachers it should adapt this training to meet the needs of the liberal arts college. For this reason the chief source of information upon which to base recommendations for a solution of the problem is to be found in the liberal arts college and not in the graduate physics departments. This is not to be interpreted to indicate that the graduate physics departments should lower scholastic standards, but that instead they should have as one of their goals the production of scholar-teachers.

Restrictions of the Study

In view of the above facts, it was decided that a good method of approach for obtaining information upon which to make recommendations for a solution to the problem was to solicit the aid of academic deans, chairmen of physics departments, and instructors in liberal arts colleges. In order to do this, it was decided that two methods should be employed. In the first place, questionnaires which would yield specific information on important phases of the graduate preparation of prospective college physics instructors, would be sent to deans, chairmen of physics departments, and beginning instructors in selected liberal arts colleges.3 Realizing that it is very difficult to obtain replies from

3 The term "instructor" is used in the sense of the duty performed and not as a reference to the academic rank. It will be used hereafter to refer to all ranks of college physics instructors. The term "beginning" instructor is restricted to an instructor who has taught three or less years in college since he obtained his highest degree.
more than 50 percent of the respondents to whom questionnaires are sent, it was decided to supplement this phase of the study by visits to selected institutions for an interview with the dean or the chairman of the physics department. It was later found that this procedure resulted in a much higher percentage of responses to questionnaires which were sent out than would have been anticipated otherwise.

In order to visit representative institutions in each of the states included in the study it was decided to limit the area in which institutions would be selected to Ohio and the adjoining states of Indiana, Kentucky, Michigan, Pennsylvania, and West Virginia. This selection would make it possible to visit the campuses of a representative number of liberal arts colleges in each of the six states. Also since approximately 20 percent of the graduate degrees which are annually granted in physics in the United States are awarded by graduate schools in these states any conclusions which could be drawn from a study of institutions located in this area should be characteristic of other areas in the nation. Furthermore, the selected area contains 25 percent of the institutions in the United States which grant an undergraduate degree in physics according to a 1957 report. Institutions to be included in the study were limited to liberal arts colleges which offer an undergraduate major in physics. This included some teachers colleges which offer a

---


5Ibid.

6Mary Irwin (ed.), American Universities and Colleges, Seventh
liberal arts program. Graduate institutions were not included in the study except to obtain information regarding recent physics graduates. On this basis eight-two institutions were selected for inclusion in the study.\(^7\)

**Questionnaires and Interviews**

Personal letters\(^8\) which explained the purpose of the study were included with questionnaires\(^9\) that were sent to deans and chairmen of the physics departments in the eighty-two colleges that were selected for the study.\(^10\) In most cases the academic dean of the institution was contacted. It was suggested that he work with his physics department in supplying the information desired. In some cases, where there were several members in the department, the chairman of the physics department was contacted. A total of eighty-two questionnaires were sent to deans and chairmen of departments during the first week of July, 1958. Replies were received from sixty-two institutions by the last week of August, 1958.\(^11\) A follow-up letter\(^12\) and card\(^13\) were sent to each of the institutions that had not responded by the first week in September. Nine additional responses were obtained as a result of this request, for a total of seventy-one replies or 87 percent of the eighty-two questionnaires that were mailed. No further effort was made to secure replies

---

\(^7\)Table 3, p. 92.

\(^8\)Appendix, pp. 258, 260. \(^9\)Appendix, p. 261.

\(^10\)Table 3, p. 92. \(^11\)Ibid.

\(^12\)Appendix, p. 271. \(^13\)Appendix, p. 272.
<table>
<thead>
<tr>
<th>State</th>
<th>Colleges Included</th>
<th>Number of Replies</th>
<th>Percent</th>
<th>Instructors Included</th>
<th>Number of Replies</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indiana</td>
<td>11</td>
<td>10</td>
<td>91</td>
<td>14</td>
<td>11</td>
<td>89</td>
</tr>
<tr>
<td>Kentucky</td>
<td>7</td>
<td>5</td>
<td>71</td>
<td>10</td>
<td>8</td>
<td>80</td>
</tr>
<tr>
<td>Michigan</td>
<td>10</td>
<td>9</td>
<td>90</td>
<td>19</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td>Ohio</td>
<td>22</td>
<td>21</td>
<td>95</td>
<td>40</td>
<td>18</td>
<td>45</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>24</td>
<td>18</td>
<td>75</td>
<td>37</td>
<td>19</td>
<td>51</td>
</tr>
<tr>
<td>West Virginia</td>
<td>8</td>
<td>8</td>
<td>100</td>
<td>8</td>
<td>5</td>
<td>63</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>82</strong></td>
<td><strong>71</strong></td>
<td><strong>87</strong></td>
<td><strong>128</strong></td>
<td><strong>77</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

*aThe number of replies from instructors who were teaching in colleges includes two instructors who were reported by graduate schools included in the study. These schools are included in Table 2 on page 72. Questionnaires were sent to 45 instructors whose names and addresses were furnished by graduate schools. Only 15 instructors returned the questionnaires, 13 of whom were teaching in universities. The total number of replies from instructors, including the 13 who were teaching in universities, is 90.*
from institutions that had not completed the questionnaire since each of these institutions had indicated either by letter or card that it did not wish to participate in the study.

It was initially planned to select beginning instructors, to whom questionnaires would be sent, from information which was furnished by the deans and the chairmen of physics departments. In many cases, however, respondents failed to supply the names of their physics staff. In the latter event the information was obtained from the college catalogue. Also, it was found that, from the instructor's standpoint, many institutions would be eliminated from the study if questionnaires were sent only to individuals who had recently obtained the Ph.D. degree. It was decided that experienced as well as beginning instructors, irrespective of the highest degree, should be included in order to obtain responses from instructors in all institutions and with various backgrounds of preparation and experience. An additional group of instructors was obtained by requesting the chairman of the physics department in each graduate institution in the area to supply the number of graduate degrees his department awarded during the years 1955-58, along with the names of those recipients who had entered college teaching.\textsuperscript{14} On the basis of these three sources of information the names of a total of one hundred and seventy-three instructors were obtained.\textsuperscript{15} Some of this number were teaching in universities, either in the area of the study or in other states. It was decided to include reports from the university instructors for purposes of comparison, especially since they were beginning

\textsuperscript{14}Appendix, p. 257. \textsuperscript{15}Table 3, p. 92.
instructors. Questionnaires
similar to those sent to college deans
and personal letters, which explained the purpose of the study were
sent to each of the instructors. A total of sixty-six replies were re-
ceived initially. A follow-up letter and card increased the number
of responses to ninety. No further attempt was made to secure replies
from instructors who failed to return the card requesting information as
to whether or not they wished to participate in the study. Six question-
naires were returned by postal authorities without a forwarding address.
A total of seventy-seven questionnaires were returned by instructors who
were teaching in liberal arts colleges in the area of the study, or 60
percent of the questionnaires that were sent to liberal arts college in-
structors. Only fifteen responses were obtained from the instructors
whose names were obtained from the chairmen of graduate physics depart-
ments, two of which were included in the seventy-seven instructors in
liberal arts colleges. This represented a response of 30 percent for
instructors in universities. A total of ninety, or 52 percent, of the
one hundred and seventy-three questionnaires were completed and returned.

As a supplement to the information which would be obtained from
the questionnaires, interviews were arranged with deans and chairmen of
physics departments. Thirty-eight campuses were visited and interviews
held with the dean or the chairman of the physics department in thirty
institutions. Some difficulty was encountered initially in arranging
for the interviews since the questionnaire, which included a request for

18 Appendix, p. 284. 19 Appendix, p. 272. 20 Table 3, p. 92.
a possible interview, were dispatched the first week in July when many faculty personnel were on vacation. In spite of this disadvantage many administrators very agreeably arranged for an interview. In fact, it was not found possible to visit all institutions at which it was indicated an interview could be arranged. In some instances, when institutions in a specific area were scheduled to be visited, other institutions in the locality were contacted by telephone and an appointment for an interview arranged. It is felt that the high percentage of responses to questionnaires which were sent out was due in no small measure to the personal contacts which were made during visits to campuses in the months of July and August. The reaction to this phase of the study was most gratifying and gave evidence of the interest which was taken by college administrators in efforts to improve the qualifications of prospective physics teachers for their institutions.
Questionnaires to Deans and Chairmen of Physics Departments

The questionnaire which was sent to the deans and the chairmen of physics departments in liberal arts colleges requested information on the preparation of prospective college physics instructors under five headings:

1. Qualifications, strengths and weaknesses of physics instructors
2. Academic preparation of college physics instructors
3. Professional preparation of college physics instructors
4. Research and the dissertation
5. Miscellaneous

No information was requested on recruitment and selection of graduate students as possible candidates for college teaching or on in-service training since it was realized that deans or chairmen of departments would not be in a position in many cases, to answer adequately questions pertaining to these factors. It is possible in only a few of the larger liberal arts colleges to provide supervised in-service training which is specifically applicable to physics. In the majority of the institutions that were contacted the physics department consisted of three or less instructors.

Qualifications, Strength and Weaknesses of Physics Instructors

It would be difficult to select a single list of characteristics or qualifications which could be used as a standard to determine whether or not an individual would be a good teacher. In fact very few, if any,

---

\[21\] Appendix, p. 269.
college instructors would excel in all characteristics or qualifications which are considered desirable. There are certain qualifications, however, which are highly desirable for every college teacher. One writer has listed six qualities which it would seem not unreasonable to expect the prospective college teacher to possess to a substantial degree. They are —

1. emotional control and maturity.
2. a strong drive and persistence.
3. at least a "B" average in intellectual capacity.
4. a deep interest in students and other people.
5. a vital enthusiasm for the subjects taught.
6. imagination, inventiveness and curiosity.

Personality traits play an important part in the success one achieves in the classroom. While there is no substitute for an understanding of the subject to be taught this qualification will not of itself insure good teaching. A former dean at Dartmouth College made this statement in reference to the essential qualification of an effective teacher:

Concerning effective teaching it should first be noted that what a teacher is, as a human being, is as important as what he knows or can learn. He must be a person of character and integrity beyond question. On a campus one often hears a student say, "From what I know of Professor X, I'd like to take a course with him. What is he teaching?" To these students, and they are frequently among the best, the important thing is not the subject, but the teacher. In this, judgment is the beginning of wisdom.

In the same article the author proceeds to enumerate a number of characteristics which he considers essential for effective teaching. Fifty per

---


cent of the characteristics listed pertain to individual personality traits rather than to a high degree of scholarship. A study which was made of the traits and characteristics most often desired by students in college instructors included fifty-two traits, ten of which dealt with scholarship. Of these only one, an unusually high academic record in a special field, rated as high as 50 percent on a rating of the most desired characteristics. Sixteen other characteristics rated as high or higher than a high academic record. The results of the study indicate that the ten characteristics which are most highly desired in the order of preference are that a college instructor—

1. inspires students to think for themselves and to express their own ideas sincerely.
2. is emotionally stable and mature.
3. is friendly, democratic, tolerant, and helpful in his relations to students.
4. understands the problems which are met by students.
5. organizes his materials and prepares carefully for each meeting with a class.
6. exhibits a behavior which reflects high ideals.
7. takes a broad rather than a departmental view.
8. has an infectious enthusiasm which leads students to want to teach.
9. leads students to become self-reliant and to assume responsibilities.
10. takes an interest in the personal problems of students.

Other authorities, such as the President's Commission on Higher Education, Ordway Tead, Earl J. McGrath, and the deans of engi-


27 Blegen and Cooper (eds.), The Preparation of College Teachers, p. 35.
neering schools\(\textsuperscript{28}\) have indicated qualifications which they consider desirable for an effective college teacher. In many cases their selections are very similar to those indicated in the above study. These studies, however, are concerned with the general qualifications of a college teacher and do not give the specific qualifications which are to be desired in a physics instructor.

In order to ascertain those qualifications which administrators or chairmen of physics departments desire in physics instructors whom they may employ, selected qualifications from the above references were incorporated with specific qualifications of physics teachers.\(\textsuperscript{29}\) Respondents were requested to check those qualifications which they would particularly desire in physics instructors whom they would employ. Sufficient space was provided for any additional qualifications that respondents might wish to add. It was intended that only those qualifications which were particularly desired for physics instructors, in addition to the general qualifications all teachers would be expected to possess, would be checked. While many administrators interpreted the instructions in this way, some checked practically all items. It was found, however, when the results were tabulated in the order of desirability that some qualifications were definitely strong and that others were definitely not considered essential.

As a further check on the qualifications of beginning instructors the dean or the chairman of the physics department was requested to complete a rating sheet on each instructor in his department who had taught

\(\textsuperscript{28}\)Ibid., p. 26.  \(\textsuperscript{29}\)Appendix, p. 261.
three or less years in college since obtaining his highest degree.\textsuperscript{30} The rater was requested to indicate qualifications in which the instructor had exhibited marked strengths as well as those in which he had shown that he was very weak or deficient. The highest degree and rank of the instructor were also requested for comparison purposes. The purpose of this portion of the study was to determine if there were any specific weaknesses or strengths in present programs for the preparation of college physics instructors.

\textbf{Academic Preparation of Physics Instructors}

The second section of the questionnaire to deans and physics department chairmen requested information on the academic preparation of prospective physics instructors.\textsuperscript{31} The President's Commission on Higher Education suggested that studies should be included in the graduate program for the Ph.D. degree to broaden the training of the candidate. One of the major objectives of graduate study is to develop broad scholarship and special competence in a chosen field. To quote the Commission:

\begin{quote}
It is in the preparation of college teachers that the graduate school program is seriously inadequate. Its single-minded emphasis on the research tradition and its purpose of forcing all its students into the mold of a narrow specialization do not produce college teachers of the kind we urgently need.
\end{quote}

\begin{quote}
Without such teachers general education and liberal education of broadened scope are impossible. Without such teachers we shall not achieve the objectives and the programs recommended in this report. The graduate schools must provide the sort of educational experience that will produce such teachers.
\end{quote}

\textsuperscript{30}\textit{Tbid.}, p. 262.  \textsuperscript{31}\textit{Tbid.}, p. 261.
A special effort should be made, therefore, to add to graduate teaching staffs men of broad knowledge, men of imagination and understanding, and wisdom. They can then educate others, who will educate others and others, on through the whole educational system. 32

One of the strong features of the liberal arts college is that, at least through the sophomore year, the student is given a broad general education. The President's Commission has made a strong plea for continuance of a broad or liberal education during later undergraduate and graduate years. 33 There is an increased demand for specialists with a general education background. As stated by a committee of the American Association for the Advancement of Science:

Too frequently advanced degrees are granted in a narrow field of research, thus producing technicians in a very special field of science rather than scientists. 34

This specialization had its influence on the liberal arts college during the last quarter of the nineteenth and the first quarter of the twentieth century. It was during this period that the elective system, with concentration in a major field, developed. The elective system was introduced into higher education during the latter part of the eighteenth century in a reaction against the rigidly prescribed curriculum. It resulted from several factors, the major ones of which were the great increase in the number of college students during this period, the development of science and technology, the emphasis on specialization and vocational training, and the non-homogeneity of college students. By the beginning of the twentieth century it was found that the purely elective

32 President's Commission on Higher Education, I, 89.
33 Ibid., pp. 47-65, 71-75. 34 Ibid., p. 88.
system permitted a student to complete college by taking only elementary courses. The system of electives with concentration in a major and a minor was adopted by colleges to insure a greater degree of concentration in a chosen field. With this modification of the elective system the pendulum of college curriculums swung toward overspecialization. During the early part of the twentieth century efforts were being made to counteract this specialization but it was not until the second quarter of the century that the movement gained momentum.\(^{35}\)

The present movement for broader offerings in liberal arts colleges demands teachers who have had training with a broad scholastic background. Some graduate departments such as Syracuse University,\(^{36}\) Vanderbilt University,\(^{37}\) and Michigan State University\(^{38}\) offer programs that are interdepartmental and which endeavor to give the graduate student preparation that will fit him for teaching in an institution where broad scholarship is stressed. The charges, however, which are most often made against the graduate school programs are "over-specialization" and "narrowness." The Committee of Fifteen found that

the training of college teachers is oriented so overwhelmingly toward research in some special field that all too few are competent to teach general courses.\(^{39}\)

This is not to be interpreted to indicate there should be no specialization. The very nature of our educational philosophy and the or-

---


\(^{36}\)Supra, p. 53.  \(^{37}\)Supra, p. 56.  \(^{38}\)Supra, p. 55.

\(^{39}\)Strothmann, *The Graduate School Today and Tomorrow*, p. 23.
ganization of society make it essential that opportunities be afforded for reasonable specialization at the undergraduate level and marked specialization at the graduate level. At the same time there should be an inclusion of the broader concepts of science, its development in the past, its effects upon social, religious, and economic developments, and its developments in the future. The essential difference in special education and general education is that the former instructs in what things can be done and how to do them; the latter, in what needs to be done and its goals. There should be a blending of efforts to achieve the goals of both special and general education. Society cannot progress without scientific and technological developments. On the other hand there is a great need for persons with a fundamental knowledge of science, who can visualize where our scientific and technological developments will lead us. A thorough study of history could not be made without the inclusion of the scientific and technological developments which preceded or accompanied historical developments. The President's Commission on Higher Education in considering undergraduate education has stated:

The aim should be to integrate liberal and vocational education, letting them proceed simultaneously though in varying proportions throughout the student's college life, each enriching and giving meaning to the other.\(^4\)

During the period when the elective system predominated the undergraduate college curriculum and specialization was at its peak the young Ph.D. who had just completed the graduate work of a highly specialized nature could easily find a location where he could teach in his own very

\(^4\) President's Commission on Higher Education, I, 74.
highly specialized field. Although many colleges still hold to the specialization which was imposed upon them at the turn of the century the situation is rapidly changing. The young Ph.D. in physics who now enters college teaching may be faced with the problem of participating in courses which are planned for the entire student body as well as for physics majors. He is faced with the problem of justifying the legitimacy of physics as a part of the liberal education program. He must be able to present physics in a fashion that will enable the future lawyer, businessman, doctor, preacher, housewife and many others who may be in his classes to relate it to their total college program and derive beneficial results from the course.

A study of general education science programs which are being followed by a number of institutions throughout the nation discloses the following major objectives:

1. An understanding of the nature of one's self, physically and mentally, as a basis for developing a desirable maturity and a preparation for effective living
2. The development of clear thinking, scientific attitudes, spirit of inquiry, and experience in the use and application of scientific methods to the problems of modern life
3. A conception of the implications of scientific developments to the individual and society and an understanding of natural principles which underlie many of our social, economic, and international problems
4. An appreciation of the place of scientific knowledge in our modern culture

While a young physicist who has pursued a highly specialized course in a restricted phase of physics in his graduate program may do an excellent job in accomplishing the above objectives the average young physicist

---

should be able to realize these objectives much more readily if, in ad-
dition to his special competence, he has had training which is planned
to enable him to achieve them.

Some graduate schools have adopted graduate programs which permit
the graduate student to pursue an interdepartmental program. The doc-
toral program in science at Syracuse University\(^1\)\(^2\) perhaps does more to
prepare the prospective physics teacher for teaching in a general educa-
tion program than any other curriculum which is now in operation. How-
ever, only three graduate physics students have participated in the pro-
gram to date although it has been in operation for several years.\(^1\)\(^3\)

Much more needs to be done in this area of training of the prospective
physics teacher than has been done. The problem should increase in sig-
nificance within the next few years when college enrollments are much
greater than they are now. The problem can hardly be solved merely by
the addition of courses at the graduate level to broaden the graduate
student's educational background. This would merely be a continuance of
the present policy of general education in the undergraduate college.
It will necessitate a change in graduate philosophy. Some possible
means by which the graduate student may acquire a broader viewpoint and
a sympathetic understanding of other disciplines are through interde-
partmental programs and the establishment of graduate courses which
emphasize the social and philosophical implications of developments in

\(^1\)\(^2\)Supra, p. 53.

\(^1\)\(^3\)Letter from chairman of the physics department, Syracuse Uni-
versity, April 8, 1959.
physics. Programs similar to those supported by the Fund for the Ad-
ance of Education appear to be advances in the right direction and
should be given consideration for expansion.\textsuperscript{14}

In order to determine the desires and needs of liberal arts col-
eges in their endeavors to provide for the objectives of a general edu-
cation program in science, deans and chairmen of physics departments
were asked to indicate the desirability of several types of academic pro-
grams, some of which are now in operation, for the preparation of pro-
spective physics teachers whom they may employ.\textsuperscript{45} The suggested programs
which were presented for consideration were based on existing programs\textsuperscript{46}
which are now in operation some of which are supported by the Fund for
the Advancement of Education.\textsuperscript{47} The suggested programs included (1) a
thorough preparation in physics and mathematics with specialization in a
particular field of physics, (2) a thorough preparation in physics and
mathematics with inclusion of courses in allied areas, (3) an interde-
partmental program with inclusion of a major in physics and minors mathe-
matics, chemistry and other sciences, and (4) an interdepartmental pro-
gram with inclusion of a major in physics, and minor areas in mathematics,
another science and a course in the implications of science, philosophy,
the humanities, or social studies.\textsuperscript{48} Respondents were asked to rate

\textsuperscript{14}Strothmann, The Graduate School Today and Tomorrow, pp. 33-37.
\textsuperscript{45}Supra, p. 53.
\textsuperscript{46}Blegen and Cooper (eds.), The Preparation of College Teachers,
pp. 145-68.
\textsuperscript{47}Strothmann, The Graduate School Today and Tomorrow, pp. 33-37.
\textsuperscript{48}Appendix, p. 265.
each of these programs, independently of the others, on the basis of five degrees of desirability. The primary objective in including the four programs was to determine the extent of desirability of a program which would broaden the preparation of the prospective physics instructor. Several choices of programs were provided for the sake of thoroughly covering the areas of a broad field of study, although it was recognized that some of these areas were only remotely related to physics.

**Professional Preparation of Physics Instructors**

The third section of the questionnaire, which is devoted to the professional preparation of college physics instructors, was for convenience further subdivided into a section concerned primarily with courses of a professional nature and a section devoted to teaching and internship training. While not much has been done professionally for the preparation of prospective physics teachers, more has been done informally in the latter of the above areas of preparation than in the former. In fact, for many graduate physics departments the term "Internship" in its truest sense is a misnomer. The practice of using graduate students as teaching assistants in recitation and laboratory physics sections is rather widespread in graduate physics departments. In many cases the assistant has little or no serious supervision by a senior staff member.\(^{49}\)

The benefits to be derived from professional courses for the prospective teacher at any level are generally very strongly questioned in

\(^{49}\)Supra, p. 79.
any consideration which may be given them by academic scholars. This is particularly true in the case of faculty members and administrators in some of the more conservative liberal arts colleges. One should expect to encounter a very strong reaction to professional education courses by college physics instructors who are definitely research-minded. This is an area, however, which should be investigated from the standpoint of the physicist and the administrator in the liberal arts college. As the President's Commission has indicated the absence of programs for developing teaching ability is one of the major defects in our system of higher education, particularly in the graduate schools which train prospective college teachers.  

Some physicists have indicated that there is a recognized need of professional training for prospective physics teachers. One contributor to the American Journal of Physics, who has had considerable experience in planning the preparation of prospective college physics teachers, strongly advocates the inclusion of professional courses on a voluntary basis and feels that departments of education and psychology should have a part in such a program. Another writer has advocated the organization of a program for training college physics teachers which would include

1. close supervision of laboratory instruction by a senior staff member.
2. supervision of recitation periods and classroom instruction by a senior staff member, followed by a frank critique.

50 President's Commission on Higher Education, IV, 16.

3. regularly scheduled conferences between graduate assistants and senior staff members.
4. a teaching seminar for discussion of teaching methods and related topics, specifically applicable to physics.
5. a formal course on teaching methods with provisions for presentation before a group of fellow students and selected staff members for criticism.\textsuperscript{52}

Such a program, to be effective, should be supervised very closely by a senior member of the physics staff who should be relieved of routine duties to enable him to devote a reasonable amount of time to the supervision. Several additional staff members should be assigned to help him, some of whom should come from such other departments as education or psychology.\textsuperscript{53} A seminar of this nature was initiated by chemists at Oregon State College in 1951 and has since been extended to include students from various departments with the enthusiastic approval of all who have participated in the program.\textsuperscript{54}

A study was recently made to ascertain, if possible, (1) what qualifications or preparation make a young college teacher succeed, (2) what are the reasons for unsatisfactory teaching performances by young college teachers, and (3) what preparation the college teacher needs.\textsuperscript{55} The study involved 276 institutions, 117 of which were liberal arts colleges. On the basis of responses by college administrators to an inventory which sought to determine what preparatory elements should be given the most emphasis for persons contemplating college teaching, it was

\textsuperscript{52}Charles Süsskind, "On Teaching College Science Teachers to Teach," \textit{American Journal of Physics}, XXV (March, 1957), 201.
\textsuperscript{53}\textit{Ibid.}, p. 201. \textsuperscript{54}\textit{Ibid.}, p. 201.
found that (1) thorough scholarship in one's field, (2) thorough knowledge of one's subject, (3) intensive training in one's field, and (4) familiarization with the nature of college age students ranked at the top in that order. A knowledge of instructional procedures, and testing and measurements ranked sixth and seventh. Productive scholarship ranked thirteenth. At the bottom of the list of twenty-four items was the study of foreign language. Another portion of the study, which requested administrators to indicate those factors which most often contributed to unsatisfactory teaching performance indicated five major causes in the order of their frequency:

1. Lacked an infectious enthusiasm for teaching that inspired students to want to learn
2. Had weak skills in methods of instruction appropriate to his field
3. Did not organize material and prepare carefully for regular class meetings
4. Was unable to inspire students to think for themselves and to express their own ideas sincerely
5. Competent scholar but was unable to present his knowledge effectively

The second, third, and fifth items above are factors which should be improved with an adequate program in instructional procedures and teaching techniques. It is interesting to note that none of the twenty-one factors included in the report indicated a lack of scholastic preparation.

In general the prospective physicist has been given very little professional preparation for a career in a liberal arts college other than a thorough knowledge of his subject field, competence in research, and in some instances experience as a teaching assistant with very little supervision. It is very seldom that he has received instruction in other

56Ibid., p. 51.
important phases of college teaching such as counseling, testing and measurement, providing for the needs of individual students, use of audio-visual aids, and communication techniques. In a few instances graduate courses or seminars on higher education and other professional courses have been available for prospective college teachers; some institutions have gone so far as to include internship. Very few physics students have participated in these programs, however, for various reasons.

Different programs have been followed in the few graduate schools that have offered professional programs for prospective college instructors. In some instances the program is in charge of the department concerned; in some, the courses are taught by faculty members from several departments or by dual professors; and in some, the courses are in charge of the education department. In an attempt to evaluate the desirability of various professional programs for prospective college teachers respondents were asked to rate each of four professional programs independently of the others and to indicate any combination of the programs they felt would be desirable. Respondents were further asked to indicate the desirability of teaching assistantships with various degrees of supervision and under staff members from different departments. Work in an industrial or research plant was included as one phase of the practical experience of the prospective physics instructor because it was felt that such experience should add prestige to the training and give the beginning teacher more confidence.

57 Supra, pp. 53-59. 58 Supra, p. 82. 59 Appendix, p. 266.
Research and the Dissertation

When the graduate schools were first started in this country one of the strong features of the programs they followed was the requirement of original research for the Ph.D. degree, a policy which was copied from the German university. This feature of the graduate program laid special emphasis on creative research and enabled American universities to raise their scholastic standing to where they were on a par with European institutions. The rapid expansion of science and technology during two world wars created a great need for trained research workers and further emphasized the research phase of the Ph.D. degree. Thus the doctor of philosophy degree has developed primarily into a research degree in which the dissertation has become the test of the student's ability to make a scholarly addition to the current store of knowledge. With the establishment of regional accrediting associations for colleges and secondary schools, the Ph.D. degree became one of the essential requirements for entry into college teaching in many colleges, particularly those that were trying to meet accreditization requirements. The result was that a degree which attained its greatest prestige as a mark of the scholar and the researcher became the requirement of adequate preparation for college teaching. This is not to be interpreted to mean that scholarly research is not one of the primary functions of the graduate school. In fact, the work of the university research scientist has been and will continue to be of paramount importance. A former United States Commissioner of Education has stated:

The work of these research scholars has given our institutions of higher education an enviable reputation among the
learned men of the world. It has also been of immeasurable value generally in the development of American culture. It has raised our standard of living and increased the material comforts of life and the well-being of our people.\(^60\)

Research work must be continued and even expanded if universities are to make their maximum contribution to society. Research and creativity have played and should continue to play a vital role in the preparation of the prospective college physics teacher. Unless he has had some experience with research he does not enjoy the prestige he should to do an effective job of teaching. When a teacher ceases to use creativity in some form he becomes static and loses his effectiveness. This creativity may be in the improvement of his teaching methods or it may be in experimental research but it should be present.

Graduate schools have other functions besides fostering the development of research and increasing the store of knowledge. They must train research workers and they must train college teachers to pass the "torch of knowledge" on to others. One of the chief criticisms that have been leveled at the graduate school is not that too much research was being carried on but that research was being stressed out of proportion to such essential functions as the preparation of college teachers. Because the liberal arts college teacher seldom has an opportunity to do research in his teaching duties some authorities have even advocated that a new degree be established.\(^61\) It was argued that other professions such as law, medicine, and pharmacy have professional degrees and that

\[^{60}\text{Blegen and Cooper (eds.), The Preparation of College Teachers, p. 31.}\]

\[^{61}\text{Tbid., pp. 30-31.}\]
it is just as logical for the college teacher to have a degree which would indicate his profession. This would leave the Ph.D. as the degree of the research scholar. Other authorities have argued against the establishment of a new degree on the grounds that it would not have the prestige which the conventional Ph.D. degree enjoys.\textsuperscript{62}

The dissertation which is the essential part of the Ph.D. degree in physics is generally rather highly specialized. Because of this some graduate departments permit modifications in the dissertation so that it may include work in several sciences or it may be of an interpretative nature.\textsuperscript{63} Some authorities have expressed the belief that the chief value of the dissertation is the contribution it makes to the knowledge of its author and that a dissertation of an interpretative nature could be of great value.\textsuperscript{64} A work group of the Chicago Conference on the Preparation of College Teachers in 1949 has recommended that the topic of the dissertation be selected from a broad area, and that the nature of the topic be such that it will lend itself to interpretation and critical evaluation.\textsuperscript{65}

The advantages which are to be derived from research and the dissertation in the training of prospective college physics instructors are not to be denied. Without research, physics would cease to progress. It is true that some of our great physicists have advanced fundamental


\textsuperscript{63}Supra, p. 53.

\textsuperscript{64}Strothmann,\textit{ The Graduate School Today and Tomorrow}, pp. 26-28.

\textsuperscript{65}Elsagren and Cooper (eds.),\textit{ The Preparation of College Teachers}, p. 93.
theories without first establishing them in the laboratory. Eventually research and observations either will establish a theory or prove its incorrectness. Some physicists are more gifted in research ability than others and if they lack an aptitude for teaching they should be encouraged to enter research work. Others, who have a greater aptitude and interest for college teaching should be encouraged to prepare for such a career. At the same time they should be expected to become competent in research, although not to the high degree of specialization in this phase of preparation that is expected of the future researcher. Among other advantages, training in research develops an inquisitive and critical mind which is very necessary for effectively teaching college physics. It gives the prospective teacher experience in the exacting demands of research in physics and it gives him a familiarization with modern methods of research, which he will need to guide students who are very critically minded. In the final analysis it gives him personal experience in the search for truth and in the collection and interpretation of facts. Such an experience provides for a future source of interest in continued research. The concentration required of a dissertation gives the physics instructor a sense of accomplishment or mastery in a chosen segment of physics.

In view of the limited use the physics teacher makes of research in a liberal arts college there is some controversy as to whether it would not be wiser to utilize part of the time which is spent on the dissertation in other phases of preparation which have a more direct bearing on teaching problems. Some institutions such as Michigan State Uni-
versity,\textsuperscript{66} Oregon State College,\textsuperscript{67} and Syracuse University\textsuperscript{68} have introduced programs for the preparation of college teachers, which permit a dissertation of an interpretative or interdepartmental nature. Sections four and five of the questionnaire were included in the study to ascertain, if possible, the nature of the dissertation administrators in liberal arts colleges would prefer for prospective college physics teachers, whom they may employ, to perform.\textsuperscript{69} Inquiry was also made regarding the desirability of the acquisition of the Ph.D. for teaching in a liberal arts college or the acceptability of a rigorous Master of Science degree in view of the impending shortage of physicists with the Ph.D. degree who will be available for teaching in liberal arts colleges. While it is realized that the area of concentration the graduate student may choose will be determined largely by the facilities and the graduate professors where he does his graduate work, graduate physics departments should give consideration to the needs of liberal arts colleges when they plan programs for graduate research.

\begin{itemize}
\item \textsuperscript{66}\textit{Supra}, p. 55.
\item \textsuperscript{67}\textit{Supra}, p. 58.
\item \textsuperscript{68}\textit{Supra}, p. 53.
\item \textsuperscript{69}\textit{Appendix}, pp. 268-69, 281-82.
\end{itemize}
The questionnaire that was sent to physics instructors was very similar in most respects to the one which was submitted to the deans and the departmental chairmen. The purpose of this questionnaire was to obtain the viewpoint of the physics professor in the liberal arts college on the practices or proposed practices which were described in the previous section. Experienced as well as beginning instructors both with and without the Ph.D. degree were requested to participate in the study in an endeavor to get a broad viewpoint. Generally experienced instructors were more responsive than beginning instructors and tended to be more philosophical in their replies.

Respondents were asked to supply information in five general areas:

1. Problems or difficulties encountered by beginning physics instructors
2. Academic preparation and subjects taught
3. Professional preparation
4. Research and the dissertation
5. Miscellaneous

The information requested in the first section regarding difficulties which instructors encountered when they began teaching included essentially the same items that were included on the rating sheet administrators were requested to complete, except for such items as enthusiasm and personality traits. The section on academic preparation included additional items as the major and minor areas of study, subjects taught, and the desirability of courses on the history and implications of science.

---

70 Appendix, p. 275. 71 Appendix, p. 262.
Instructors were asked to indicate the courses and the experience they had in their professional preparation for teaching and to evaluate these on the basis of their experience. In addition to evaluation of various types of research they were requested to indicate the aspects of their graduate training which had contributed the least and those which had contributed the most in preparing them for teaching in a liberal arts college. In order to follow up a recommendation of the Chicago Conference on the Preparation of College Teachers, instructors were requested to indicate the extent to which they had utilized the dissertation for continued research.72 One of the primary purposes of this questionnaire was to locate those areas of graduate preparation physics instructors felt should be strengthened and those which could be de-emphasized in a graduate program for the preparation of prospective physics instructors for liberal arts colleges.

In an effort to determine the extent to which graduate programs, which are specifically planned to emphasize the preparation of college teachers, are being utilized by graduate physics students, the chairman of the physics department of selected institutions was requested to give an appraisal of the program at his institution and the names of any physics students who had participated in the program.73 These persons were contacted to ascertain the effectiveness of the programs which are now in operation. The results of this part of the study, as will be shown

72 Blegen and Cooper (eds.), The Preparation of College Teachers, p. 100.

73 Supra, p. 82.
later, 7\textsuperscript{th} were insufficient to draw any conclusions, but they did point out problems which must be considered in a program for the preparation of prospective college physics instructors.
Summary

To summarize, the following steps were taken in an effort to obtain information as a basis upon which to make recommendations for modifying or adapting present graduate programs for the acquisition of the Ph.D. degree in physics, to meet the needs of prospective physics instructors in liberal arts colleges:

1. A survey was made of the literature to ascertain what measures are being taken to prepare physicists for teaching in liberal arts colleges.
2. A questionnaire which incorporated current practices and recommendations for programs which lead to the acquisition of the Ph.D. degree for prospective physics instructors in liberal arts colleges was submitted to deans and chairmen of physics departments in selected liberal arts colleges for completion.
3. A similar questionnaire was submitted to instructors in selected liberal arts colleges.
4. Information was solicited from the chairman of the physics department in selected schools which have specific programs for the preparation of college teachers. On the basis of the information provided, physics instructors who have participated in the programs were contacted to ascertain the extent to which the programs had been successful.
5. Interviews were held with selected deans, physics department chairmen, and physics instructors in liberal arts colleges to obtain information which would supplement that which was obtained from responses to questionnaires.

No effort was made to obtain information from the colleges or instructors included in the study on the recruitment and selection of prospective physics instructors or the provision for an in-service program for the improvement of physics instruction.

---

75 Appendix, p. 261. 76 Appendix, p. 275.
CHAPTER V

RESULTS OF THE STUDY

Consolidation of Replies from Questionnaires

As it was indicated in the previous chapter,\(^1\) eighty-two questionnaires were sent to academic deans and chairmen of physics departments.\(^2\) Also, one hundred and seventy-three similar questionnaires were sent to physics instructors, most of whom were teaching in liberal arts colleges.\(^3\) Totals of seventy-one and ninety replies, respectively, were received from the above persons. In order to facilitate a comparison of the responses which were obtained and to gain a broader interpretation of the results, it was decided to divide the respondents who completed questionnaires into the following groups:

1. Deans and chairmen of physics departments
2. Beginning instructors\(^4\) with the Ph.D. degree who were teaching in liberal arts colleges\(^5\)
3. Experienced instructors with the Ph.D. degree who were teaching in liberal arts colleges
4. Beginning instructors with the Ph.D. degree who were teaching in universities
5. Beginning instructors with the Master's degree who were teaching in liberal arts colleges
6. Experienced instructors with the Master's degree who were teaching in liberal arts colleges

\(^1\)Supra, pp. 90-91, and Table 3, p. 92. \(^2\)Appendix, p. 261.
\(^3\)Appendix, p. 275. \(^4\)Footnote, p. 89.
\(^5\)Supra, p. 90. \(^6\)Supra, p. 93. \(^7\)Supra, p. 93.
Since each of the questionnaires was divided into five major sections, the results of the replies were consolidated in the following areas:

1. Qualifications, strengths, and weaknesses of physics teachers
2. Academic preparation of college physics teachers
3. Professional preparation of college physics teachers
4. Research and the dissertation
5. Miscellaneous

Five ratings were used in evaluating replies from respondents:

(1) very desirable, (2) desirable, (3) neutral, (4) undesirable, and (5) very undesirable. Whenever possible, replies from all groups were tabulated together for comparison and consolidation. Percentages were taken to the nearest whole number. Consequently, a total of the individual percentages will not necessarily have the same numerical value as the percentage which would be obtained if the computation were made on the basis of the total values. In order to determine the average of the ratings given an item, it was necessary to convert subjective ratings to numerical quantities and then reconvert the average numerical quantity to a subjective value. The conversion factors given in Table 4 were utilized for this purpose. The percentage of the respondents who gave a particular rating to an item was multiplied by the average numerical value of the rating. The total of the numerical quantities thus obtained for all ratings of an item was divided by the percentage of the respondents who replied to the item. The average subjective rating, which was equivalent to this last factor, was obtained by reference to the numerical range column in Table 4.

---

8Table 4, p. 123, Table 9, p. 140.
One rather important source of information was the interviews with representative deans and chairmen of physics departments, but no effort was made to tabulate the results thus obtained as was done with the questionnaires. Wherever possible the comments which were obtained during interviews were correlated with replies to the questionnaires. The responses to questionnaires will be given on the following pages.

### TABLE 4

**RATING CONVERSION SCALE**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Average Numerical Value</th>
<th>Numerical Range From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very desirable</td>
<td>2.00</td>
<td>1.50</td>
<td>2.49</td>
</tr>
<tr>
<td>Desirable</td>
<td>1.00</td>
<td>0.50</td>
<td>1.49</td>
</tr>
<tr>
<td>Neutral</td>
<td>0.00</td>
<td>-0.49</td>
<td>0.49</td>
</tr>
<tr>
<td>Undesirable</td>
<td>-1.00</td>
<td>-1.49</td>
<td>-0.50</td>
</tr>
<tr>
<td>Very undesirable</td>
<td>-2.00</td>
<td>-2.49</td>
<td>-1.50</td>
</tr>
</tbody>
</table>
Qualifications, Strengths and Weaknesses of Physics Teachers

Desired Qualifications of Physics Instructors

Deans and chairmen of physics departments were provided with a list of characteristics which several authorities have indicated are very desirable for college teachers. The following instructions were given with the list:

Below are listed some of the qualifications which are desired by many college administrators in teachers they employ. Please check those qualifications which you would particularly like to find in physics teachers whom you employ. 9

The intent of this request was for respondents to indicate those characteristics which would be desired for physics instructors in addition to those which are desired for all college teachers, irrespective of the subject they teach. Many respondents interpreted the instructions in this way and indicated only those additional qualifications which a physics instructor should have. Eighteen respondents checked all items. In view of this misinterpretation, the replies which indicated that a discrimination had been made were tabulated separately.

A study of Table 5 reveals that the qualifications desired by the highest percentage of administrators are an excellent preparation in physics, mathematics and other sciences; and in addition, a good liberal or broad education. 10 Such qualifications as enthusiasm, the ability to develop reflective thinking by students, dedication to teaching, sympathetic understanding of college youth, and a high degree of scholarship were desired by over one-third of the respondents who made a distinction

---

9Appendix, p. 261. 10Table 5, p. 125.
TABLE 5
QUALIFICATIONS OF UNDERGRADUATE PHYSICS INSTRUCTORS WHICH ARE PARTICULARLY DESIRED BY DEANS AND CHAIRMEN OF PHYSICS DEPARTMENTS IN SEVENTY-ONE COLLEGES

(Each entry indicates the percentage of the corresponding group who desire the qualification.)

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Groupa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Excellent preparation in physics</td>
<td>47</td>
</tr>
<tr>
<td>2. Good background in mathematics</td>
<td>43</td>
</tr>
<tr>
<td>3. Good liberal or general education</td>
<td>40</td>
</tr>
<tr>
<td>4. Good background in other physical sciences</td>
<td>39</td>
</tr>
<tr>
<td>5. Deep and sustained enthusiasm for physics</td>
<td>39</td>
</tr>
<tr>
<td>6. Dedication to teaching and leading others in scientific thought</td>
<td>36</td>
</tr>
<tr>
<td>7. High degree of scholarship</td>
<td>35</td>
</tr>
<tr>
<td>8. Ability to develop reflective thinking on the part of students</td>
<td>34</td>
</tr>
<tr>
<td>9. Sympathetic understanding of college age students</td>
<td>34</td>
</tr>
<tr>
<td>10. Ability to raise the level of accomplishment of students</td>
<td>31</td>
</tr>
</tbody>
</table>

aRespondents
I - 53 respondents who indicated desired qualifications
II - 71 or all respondents including 18 who checked all qualifications
### TABLE 5 (contd.)

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Appreciation for and understanding of the place of physics in higher education</td>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>12. Interest in maintaining and improvising equipment</td>
<td>30</td>
<td>48</td>
</tr>
<tr>
<td>13. General understanding of practical and industrial applications of physics</td>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>14. Ability to adapt instruction to the needs and interests of students</td>
<td>29</td>
<td>47</td>
</tr>
<tr>
<td>15. Constructive or affirmative philosophy of life (not sarcastic)</td>
<td>27</td>
<td>45</td>
</tr>
<tr>
<td>16. Respect for efforts to advance the frontiers of knowledge and ability to infect students with the delight of exploring the boundaries of knowledge</td>
<td>27</td>
<td>45</td>
</tr>
<tr>
<td>17. Appreciation for the obligation of science and the scientist to society</td>
<td>25</td>
<td>43</td>
</tr>
<tr>
<td>18. Ability to integrate into college and community life</td>
<td>24</td>
<td>42</td>
</tr>
<tr>
<td>19. Adeptness in counseling and advising students</td>
<td>22</td>
<td>40</td>
</tr>
<tr>
<td>20. Ability to adapt graduate training to undergraduate teaching</td>
<td>18</td>
<td>36</td>
</tr>
<tr>
<td>21. Competence in research</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>22. Active interest in religion (added by respondents)</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>
in the characteristics. It is interesting to note that 30 percent of the administrators expressed a desire for physics instructors to have an appreciation for and an understanding of the place of physics in higher education. This is an area which should be developed in courses that deal with the implications of scientific developments. Another very striking observation to be made is that only 4 percent of the group of fifty-three respondents desired that physics instructors be competent in research. This is rather significant with the stress that is placed on research. A total of 22 percent of all respondents indicated they feel that competence in research is an important qualification. Even so, competence in research is next to the bottom of a list of twenty-two qualifications. This should not be interpreted to mean that the prospective college physics teacher should not do research, but rather that there is not a great need for competence in research in the liberal arts college, as indicated by the responses from the administrators. In summary it would seem that administrators in liberal arts colleges particularly desire the following qualifications in their physics teachers:

1. A thorough preparation in physics
2. An excellent preparation in mathematics and other sciences
3. A good liberal education
4. Excellent scholarship
5. Enthusiasm for and dedication to teaching
6. A sympathetic understanding of college age youth
7. The ability to develop reflective thinking on the part of students
Strengths and Weaknesses of Beginning Physics Instructors

Administrators were asked to indicate those qualifications which their beginning physics instructors had exhibited to a marked degree. Also they were asked to indicate those qualifications in which they had observed their beginning physics instructors to be weak or deficient. They were advised to consider a beginning instructor one with three or less years of college teaching experience. Reports were received on fifty instructors, only fifteen of whom had obtained the Ph.D. degree. The strengths and the weaknesses were consolidated separately by degree. A study of Table 6 reveals that generally, the group of fifteen instructors excelled the other thirty-five by about 20 percent in all but six of the twenty-four characteristics, which is an indication of the better qualification of the physicists with the Ph.D. degree. At least 67 percent of the smaller group of instructors had shown exceptional qualifications in the following characteristics:

1. An excellent preparation in physics
2. An enthusiasm for teaching physics
3. A good background in mathematics
4. The ability to organize course material effectively
5. A high degree of scholarship
6. A good liberal education
7. Competence in research

At least 63 percent of the thirty-five instructors had exhibited exceptional qualifications in the following characteristics:

1. A good background in mathematics
2. An excellent preparation in physics
3. The ability to speak and enunciate properly
4. The ability to organize course material effectively

11 Appendix, p. 262. 12 Table 6, p. 129. 13 Table 7, p. 132.
TABLE 6

STRENGTHS OF BEGINNING PHYSICS INSTRUCTORS AS REPORTED
BY DEANS AND CHAIRMEN OF PHYSICS DEPARTMENTS
IN SEVENTY-ONE COLLEGES

(Each entry indicates the percentage of instructors with the specified
degree who exhibited a marked strength in the characteristic.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Master's 35 Instrs</th>
<th>Ph.D. 15 Instrs</th>
<th>Total 50 Instrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. High degree of scholarship</td>
<td>49</td>
<td>67</td>
<td>54</td>
</tr>
<tr>
<td>2. Excellent preparation in physics</td>
<td>71</td>
<td>93</td>
<td>78</td>
</tr>
<tr>
<td>3. Good background in other physical sciences</td>
<td>37</td>
<td>60</td>
<td>44</td>
</tr>
<tr>
<td>4. Good background in mathematics</td>
<td>74</td>
<td>87</td>
<td>78</td>
</tr>
<tr>
<td>5. Good liberal or general education</td>
<td>34</td>
<td>67</td>
<td>44</td>
</tr>
<tr>
<td>6. Competence in research</td>
<td>31</td>
<td>67</td>
<td>42</td>
</tr>
<tr>
<td>7. Interest in equipment</td>
<td>57</td>
<td>47</td>
<td>54</td>
</tr>
<tr>
<td>8. Ability to adapt instruction to the needs of students</td>
<td>40</td>
<td>60</td>
<td>46</td>
</tr>
<tr>
<td>9. Ability to raise the level of accomplishment of students</td>
<td>34</td>
<td>60</td>
<td>42</td>
</tr>
<tr>
<td>10. Ability to lead students to do reflective thinking</td>
<td>26</td>
<td>47</td>
<td>32</td>
</tr>
<tr>
<td>11. Ability to adapt graduate training to undergraduate teaching</td>
<td>37</td>
<td>47</td>
<td>40</td>
</tr>
<tr>
<td>12. Deep and sustained enthusiasm for teaching physics</td>
<td>49</td>
<td>87</td>
<td>60</td>
</tr>
<tr>
<td>13. Constructive and affirmative philosophy of life</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Characteristic</td>
<td>Master's</td>
<td>Ph.D.</td>
<td>Total</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
<td>----------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>14. Respect for efforts to advance the frontiers of knowledge and ability to infect students with the delight of exploring the boundaries of knowledge</td>
<td>49</td>
<td>60</td>
<td>52</td>
</tr>
<tr>
<td>15. Adeptness in counseling and advising students</td>
<td>29</td>
<td>40</td>
<td>32</td>
</tr>
<tr>
<td>Qualifications or proficiencies which apply specifically to instruction and show that the instructor—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Organizes the course well</td>
<td>66</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>17. Maintains the interest and attention of all students</td>
<td>49</td>
<td>60</td>
<td>52</td>
</tr>
<tr>
<td>18. Speaks and enunciates well and with the proper modulation</td>
<td>71</td>
<td>53</td>
<td>66</td>
</tr>
<tr>
<td>19. Is fair in assignments, tests and grades and shows no favoritism</td>
<td>63</td>
<td>60</td>
<td>62</td>
</tr>
<tr>
<td>20. Correlates real problems with theory</td>
<td>40</td>
<td>33</td>
<td>38</td>
</tr>
<tr>
<td>21. Affords students adequate opportunity for participation in discussions</td>
<td>40</td>
<td>53</td>
<td>44</td>
</tr>
<tr>
<td>22. Employs different methods of teaching</td>
<td>23</td>
<td>40</td>
<td>28</td>
</tr>
<tr>
<td>23. Spends a significant amount of time in the study of new developments</td>
<td>46</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>24. Encourages independent thinking rather than memorization</td>
<td>66</td>
<td>60</td>
<td>64</td>
</tr>
</tbody>
</table>
5. The ability to encourage independent thinking rather than memorization by students
6. A policy of fairness to students
7. An interest in maintaining equipment

It is not to be inferred that the first group of instructors did not exhibit qualifications which are listed for the second group, but that these are the qualifications in which each group showed the greatest degree of excellence. The first group equalled or excelled the second group in all of the qualifications listed except the ability to speak and enunciate properly and an interest in equipment. A comparison of these lists with that of the qualifications desired by administrators in physics instructors they employ shows that generally physics teachers have the qualifications that administrators desire except in such areas as teaching students to do reflective thinking and in adjusting their teaching to meet the various needs of students.

A study of Table 7 is more revealing than Table 6, since it discloses the weaknesses of physics instructors as reported by college deans and chairmen of physics departments. It will be observed that at least 40 percent of the group of instructors with the higher degree were reported to have exhibited weaknesses to a marked extent in the following areas:

1. An interest in equipment
2. The ability to adapt instruction to the needs of students
3. The ability to adapt graduate training to undergraduate teaching
4. An adeptness in counseling and advising students

The group of instructors who had attained only the Master's degree was reported to have contained a higher percentage of persons who had exhibited weaknesses in certain areas, ranging up to 63 percent for competence
TABLE 7

WEAKNESSES OF BEGINNING PHYSICS INSTRUCTORS AS REPORTED
BY DEANS AND CHAIRMEN OF PHYSICS DEPARTMENTS
IN SEVENTY-ONE COLLEGES

(Each entry indicates the percentage of instructors with the specified
degree who exhibited a marked weakness in the characteristic.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Master's</th>
<th>Ph.D.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Instrs</td>
<td>Instrs</td>
<td>Instrs</td>
</tr>
<tr>
<td>1. High degree of scholarship</td>
<td>34</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>2. Excellent preparation in physics</td>
<td>20</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>3. Good background in other physical sciences</td>
<td>43</td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td>4. Good background in mathematics</td>
<td>9</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>5. Good liberal or general education</td>
<td>49</td>
<td>27</td>
<td>42</td>
</tr>
<tr>
<td>6. Competence in research</td>
<td>63</td>
<td>13</td>
<td>48</td>
</tr>
<tr>
<td>7. Interest in equipment</td>
<td>29</td>
<td>40</td>
<td>32</td>
</tr>
<tr>
<td>8. Ability to adapt instruction to the needs of students</td>
<td>34</td>
<td>40</td>
<td>36</td>
</tr>
<tr>
<td>9. Ability to raise the level of accomplishment of students</td>
<td>34</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>10. Ability to lead students to do reflective thinking</td>
<td>37</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>11. Ability to adapt graduate training to undergraduate teaching</td>
<td>31</td>
<td>40</td>
<td>34</td>
</tr>
<tr>
<td>12. Deep and sustained enthusiasm for teaching physics</td>
<td>17</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>13. Constructive and affirmative philosophy of life</td>
<td>17</td>
<td>13</td>
<td>16</td>
</tr>
</tbody>
</table>
TABLE 7 (contd)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Master's</th>
<th>Ph.D.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Respect for efforts to advance the frontiers of knowledge and ability to</td>
<td>20</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>infect students with the delight of exploring the boundaries of knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Adeptness in counseling and advising students</td>
<td>49</td>
<td>40</td>
<td>46</td>
</tr>
<tr>
<td>Qualifications or proficiencies which apply specifically to instruction and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>which show that the instructor—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Organizes the course well</td>
<td>23</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>17. Maintains the interest and attention of all students</td>
<td>26</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>18. Speaks and enunciates well and with the proper modulation</td>
<td>11</td>
<td>27</td>
<td>16</td>
</tr>
<tr>
<td>19. Is fair in assignments, tests and grades and shows no favoritism</td>
<td>11</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>20. Correlates real problems with theory</td>
<td>26</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>21. Affords students adequate opportunity for participation in discussions</td>
<td>29</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>22. Employs different methods of teaching</td>
<td>43</td>
<td>20</td>
<td>36</td>
</tr>
<tr>
<td>23. Spends a significant amount of time in the study of new developments</td>
<td>34</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>24. Encourages independent thinking rather than memorization</td>
<td>17</td>
<td>13</td>
<td>16</td>
</tr>
</tbody>
</table>
in research. At least 43 percent of the instructors in the group were reported to have exhibited weaknesses in the following areas:

1. Competence in research
2. A good liberal education
3. A good background in other sciences
4. An adeptness in counseling and advising students
5. The employment of various methods of teaching

It will be noted that the weaknesses listed in the first group are in the general areas of problems dealing with students, instructional problems, and the care and use of equipment. The occurrence of these weaknesses in beginning physics instructors should be greatly reduced by the inclusion of courses in instructional methods and internship training, specific courses in education and psychology, and a course on the maintenance and use of equipment in the graduate program of the physics student who anticipates entering college teaching. While this study is restricted to those graduate programs which lead to the acquisition of the Ph.D. degree, it should be pointed out that the weaknesses which were reported to have been exhibited by the instructors who had attained only the Master's degree, should be greatly reduced by the acquisition of the Ph.D. degree; especially, if this program includes courses in other sciences, other disciplines, and professional courses.

**Difficulties Encountered by Beginning Physics Instructors**

Physics instructors, irrespective of the highest degree they had attained or the number of years they had taught, were asked to indicate the areas in which they had encountered their greatest difficulties in teaching undergraduate physics after they had obtained their highest de-
gree. A study of Table 8 reveals that the development of reflective thinking was the difficulty which was encountered by the highest percentage of instructors. Other difficulties which were encountered included the following in the order of their occurrence:

1. The development of student interest and enthusiasm for physics
2. The adaptation of instruction to raise the level of accomplishment of students
3. The adaptation of graduate training to undergraduate teaching
4. The adaptation of instruction to the needs of students
5. The proper utilization of methods of testing and grading students

The above list is based on the difficulties encountered by all instructors. On a group basis it is interesting to note that the group of recent Ph.D. graduates, who were teaching in college, had 36 percent of its number who reported that they had difficulties with the use of films and other teaching aids in their beginning teaching. In fact, as many of the instructors in this group encountered difficulties in this area as they did in the area of the development of reflective thinking by students.

In summary, a study of the qualifications desired by the deans and chairmen of physics departments in colleges included in the study, and the strengths and weaknesses observed in beginning physics teachers by these administrators reveals that present programs for the acquisition of the Ph.D. degree give prospective college physics teachers very excellent preparation in subject matter areas and research. There are certain areas, however, in which there are weaknesses or deficiencies in the preparation of physicists for teaching in a liberal arts college.

11Appendix, p. 275. 15Table 8, p. 136.
TABLE 8

AREAS IN WHICH UNDERGRADUATE PHYSICS INSTRUCTORS ENCOUNTERED PROBLEMS OR DIFFICULTIES AFTER THEY HAD ATTAINED THEIR HIGHEST DEGREE

(Each entry is a percent of the corresponding group.)

<table>
<thead>
<tr>
<th>Area of Difficulty</th>
<th>Ph.D.</th>
<th>Master's</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>1. Development of reflective thinking by students</td>
<td>36</td>
<td>38</td>
<td>62</td>
</tr>
<tr>
<td>2. Development of student interest and enthusiasm for physics</td>
<td>9</td>
<td>19</td>
<td>54</td>
</tr>
<tr>
<td>3. Adaptation of instruction to raise the level of accomplishment of students</td>
<td>18</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>4. Adaptation of graduate preparation to undergraduate teaching</td>
<td>9</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>5. Adaptation of instruction to the needs of students</td>
<td>18</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>6. Methods of testing and grading students</td>
<td>18</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>7. Preparation in allied sciences</td>
<td>9</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>8. Utilization of films, demonstration equipment and other teaching aids</td>
<td>36</td>
<td>19</td>
<td>0</td>
</tr>
</tbody>
</table>

^aRespondents

I - 11 beginning college instructors with the Ph.D. degree
II - 31 experienced college instructors with the Ph.D. degree
III - 13 beginning university instructors with the Ph.D. degree
IV - 12 beginning college instructors with the Master's degree
V - 23 experienced college instructors with the Master's degree and others
<table>
<thead>
<tr>
<th>Area of Difficulty</th>
<th>Highest Degree</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ph.D.</td>
<td>Master's</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>V</td>
</tr>
<tr>
<td>9. Competence in research ................................</td>
<td>0</td>
<td>13</td>
<td>8</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>10. Counseling and advising students</td>
<td>9</td>
<td>13</td>
<td>38</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>11. Extracurricular duties</td>
<td>9</td>
<td>16</td>
<td>8</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>12. Skill in improvising equipment</td>
<td>0</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>13. Employment of various methods of teaching</td>
<td>9</td>
<td>6</td>
<td>8</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>14. Laboratory instruction</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>25</td>
<td>13</td>
</tr>
<tr>
<td>15. Preparation in physics</td>
<td>9</td>
<td>3</td>
<td>8</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>16. Preparation in mathematics</td>
<td>9</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>17. Organization and presentation of subject material</td>
<td>0</td>
<td>13</td>
<td>0</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>18. Instruction in the use of special laboratory equipment</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>19. Application of principles of physics to scientific developments</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20. Student-teacher relationships</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
These pertain largely to problems of instruction and include such factors as, teaching for reflective thinking, adaptation of instruction to the needs of students, the use of audio visual aids, and others. The results of the responses to the request for information on the qualifications of prospective college physics teachers reveal that while present programs for the preparation of prospective college physics teachers are very effective there is a need for the inclusion of certain courses which are planned primarily to help the beginning physics teachers in the liberal arts college do a more effective job of teaching.
Academic Preparation of College Physics Teachers

Thorough Preparation in Physics and Mathematics

The President's Commission on Higher Education suggested that courses should be included in the graduate program to broaden the preparation of college teachers. In view of this suggestion and other indications of such a need, college deans, chairmen of physics departments, and physics instructors were asked to indicate the desirability of several programs for the preparation of college physics instructors. Each program was to be rated on the basis of its own merits and independently of the others. The first of these programs included a thorough preparation in all fundamental fields of physics and general mathematics with specialization in a particular field of physics. All groups of respondents except the first, which was composed largely of college deans, and the last, which was composed of experienced instructors with the Master's degree, indicated that this program was very desirable for the preparation of college physics teachers. The most frequent rating given the program by all groups of respondents was very desirable. All recent Ph.D. graduates who were teaching in colleges gave the program a very desirable rating, but it is quite probable that some of these would find with experience that this program as it is now administered, has some weaknesses in the preparation of college physics teachers.

\[\text{Supra, p. 100.}\]  
\[\text{Appendix, pp. 264, 276.}\]  
\[\text{Table 9, p. 140.}\]
TABLE 9

DESRIRABILITY OF A THOROUGH PREPARATION IN FUNDAMENTAL FIELDS
OF PHYSICS AND MATHEMATICS WITH SPECIALIZATION IN A
PARTICULAR FIELD OF PHYSICS

(Each entry in columns three through eight is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>Desirability Ratings</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>VD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>I</td>
<td>71</td>
<td>59</td>
<td>31</td>
<td>7</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>71</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>77</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>82</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>56</td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>67</td>
<td>23</td>
<td>5</td>
</tr>
</tbody>
</table>

Respondents

I - Deans and chairmen of physics departments
II - Beginning instructors, Ph.D., college
III - Experienced instructors, Ph.D., college
IV - Beginning instructors, Ph.D., universities
V - Beginning instructors, Master's, college
VI - Experienced instructors, Master's and others, college

Rating

VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable

Explanation of "Ave." column using Group VI as an illustration:

56% gave VD rating: \( (56)(2) = 112 \)  The numerical value of the desirability ratings is converted to letter values as follows:
26% gave D rating: \( (26)(1) = 26 \)
9% gave N rating: \( (9)(0) = 0 \)
5% gave U rating: \( (5)(-1) = -5 \)
0% gave VU rating: \( (0)(-2) = 0 \)
Total = 133 Rating From To

Since 4% of the respondents did not reply to the question the average is computed on the basis of 96%.

133 \( \div 96 = 1.39 \) or D
Interdepartmental Programs and Allied Courses

The second type of program which respondents were asked to evaluate was one which overlapped several sciences. Programs of this type are in operation in schools such as Michigan State University and Syracuse University. Specifically an evaluation was requested on an interdepartmental program with a major area in physics and minor areas in mathematics, chemistry and/or other sciences. Each of the groups of respondents indicated that such a program would be desirable. Thirty-eight percent of all respondents felt that the program would be very desirable. The beginning college instructors, both with the Master's degree and the Ph.D. degree, were more favorable toward such a program than other instructors. One reason which may be given for this is that the tendency would be for beginning instructors to be assigned interdepartmental teaching duties or classes in programs for general education; and as a result, they would be much more aware of a need for such a program. At least 75 percent of the beginning instructors with the Master's degree felt that it was a very desirable program. The general rating for the program was desirable. Comments which were included on questionnaires and which were made during interviews indicated that a number of respondents felt that this program would be very desirable for the preparation of college physics teachers, but they felt that there would not be time to include other sciences in the graduate program without sacrificing courses in physics. They recognized the fact that physics instructors should have a good foundation in other sciences but they ex-

\[\text{Supra, p. 53.} \quad \text{Appendix, p. 264.} \quad \text{Table 10, p. 142.}\]
TABLE 10

DESIRABILITY OF AN INTERDEPARTMENTAL PROGRAM WITH MAJOR AREA IN PHYSICS AND MINOR AREAS IN MATHEMATICS, CHEMISTRY AND/OR OTHER SCIENCES

(Each entry in column three through eight is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>VD</th>
<th>D</th>
<th>N</th>
<th>U</th>
<th>VU</th>
<th>No Reply</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>30</td>
<td>46</td>
<td>13</td>
<td>4</td>
<td>0</td>
<td>7</td>
<td>D</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>45</td>
<td>45</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>D</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>39</td>
<td>35</td>
<td>10</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>D</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>D</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>75</td>
<td>0</td>
<td>17</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>D</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>57</td>
<td>26</td>
<td>9</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>D</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>38</td>
<td>38</td>
<td>12</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>D</td>
</tr>
</tbody>
</table>

a Respondents

I - Deans and chairmen of physics departments in small colleges
II - Beginning instructors with Ph.D. degree in small colleges
III - Experienced instructors with the Ph.D. degree in small colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in small colleges
VI - Experienced instructors with the Master's and other degrees in small colleges

b Rating

VD - Very desirable
D  - Desirable
N  - Neutral
U  - Undesirable
VU - Very undesirable
pressed the opinion that these courses should be taken at the undergraduate level. The general answer to the request for an indication of the desirability of an interdepartmental program was desirable, but if the program had been one in which the courses in other sciences would be taken at the undergraduate level the general rating would quite probably have been very desirable.

The prospective physics instructor in the liberal arts college should consider taking allied science courses in his preparation for teaching in a liberal arts college for two reasons at least. In the first place, the physics professor in the small college is quite frequently asked to teach other science courses than physics. In the second place, such courses are excellent for background information and help to give one a good liberal education in the sciences. This training is excellent for teaching in a general education program. In order to ascertain to what extent allied courses should be considered a part of the preparation of the prospective physics instructor for the liberal arts college, respondents were asked to check those courses which they felt should be included as a part of the program that is described:

Thorough preparation in all fields of physics and general mathematics with inclusion of courses in allied areas such as--

- Astronomy  yes  no  
- Biology  yes  no  
- Chemistry  yes  no  
- Geology  yes  no  
- History of science  yes  no  
- Meteorology  yes  no  
- Photography  yes  no  
- Other  

It will be noted from Table 11 that in some cases a large percentage of respondents did not reply to this part of the questionnaire. It will

\(^{22}\)Appendix, p. 264. \(^{23}\)Table 11, p. 144.
## TABLE II
PREFERENCE OF A THOROUGH PREPARATION IN FUNDAMENTAL FIELDS OF PHYSICS AND MATHEMATICS WITH INCLUSION OF COURSES IN THE ALLIED AREAS LISTED

(Each entry is a percentage of the corresponding group.)

<table>
<thead>
<tr>
<th>Allied Area</th>
<th>Preference</th>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Astronomy</td>
<td>Yes</td>
<td></td>
<td>78</td>
<td>61</td>
<td>61</td>
<td>61</td>
<td>58</td>
<td>96</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>8</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>No reply</td>
<td></td>
<td>14</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Biology</td>
<td>Yes</td>
<td></td>
<td>32</td>
<td>18</td>
<td>32</td>
<td>32</td>
<td>17</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>14</td>
<td>45</td>
<td>23</td>
<td>31</td>
<td>42</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>No reply</td>
<td></td>
<td>54</td>
<td>36</td>
<td>45</td>
<td>46</td>
<td>42</td>
<td>38</td>
<td>48</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Yes</td>
<td></td>
<td>72</td>
<td>54</td>
<td>61</td>
<td>67</td>
<td>96</td>
<td>76</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No reply</td>
<td></td>
<td>28</td>
<td>27</td>
<td>16</td>
<td>23</td>
<td>33</td>
<td>4</td>
<td>23</td>
</tr>
<tr>
<td>Geology</td>
<td>Yes</td>
<td></td>
<td>36</td>
<td>36</td>
<td>45</td>
<td>31</td>
<td>42</td>
<td>52</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>11</td>
<td>36</td>
<td>6</td>
<td>23</td>
<td>25</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>No reply</td>
<td></td>
<td>51</td>
<td>27</td>
<td>48</td>
<td>46</td>
<td>33</td>
<td>39</td>
<td>45</td>
</tr>
<tr>
<td>History of science</td>
<td>Yes</td>
<td></td>
<td>56</td>
<td>61</td>
<td>58</td>
<td>61</td>
<td>50</td>
<td>74</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>11</td>
<td>18</td>
<td>6</td>
<td>15</td>
<td>17</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>No reply</td>
<td></td>
<td>32</td>
<td>18</td>
<td>35</td>
<td>23</td>
<td>33</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>Meteorology</td>
<td>Yes</td>
<td></td>
<td>37</td>
<td>18</td>
<td>42</td>
<td>0</td>
<td>17</td>
<td>61</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>18</td>
<td>45</td>
<td>6</td>
<td>38</td>
<td>33</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>No reply</td>
<td></td>
<td>45</td>
<td>36</td>
<td>52</td>
<td>61</td>
<td>50</td>
<td>35</td>
<td>46</td>
</tr>
<tr>
<td>Photography</td>
<td>Yes</td>
<td></td>
<td>18</td>
<td>9</td>
<td>12</td>
<td>8</td>
<td>17</td>
<td>30</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>18</td>
<td>61</td>
<td>13</td>
<td>38</td>
<td>50</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>No reply</td>
<td></td>
<td>62</td>
<td>27</td>
<td>45</td>
<td>54</td>
<td>33</td>
<td>48</td>
<td>52</td>
</tr>
</tbody>
</table>

*a Respondents

I - 71 college deans and chairmen of physics departments
II - 11 beginning college instructors with the Ph.D. degree
III - 31 experienced college instructors with the Ph.D. degree
IV - 13 beginning university instructors with the Ph.D. degree
V - 12 beginning college instructors with the Master's degree
VI - 23 experienced college instructors with the Master's degree and others
be noted that a marked desire was expressed for only three courses. Better than 60 percent of the respondents indicated a preference for the inclusion of astronomy, chemistry and the history of science in the program. It will be noted also that the percentage of experienced instructors who held this opinion was somewhat higher than that of the inexperienced instructors. Comments in regard to this program indicated that it was the feeling of many respondents that these courses should not be taken at the graduate level since there would be insufficient time in the graduate program. Some typical comments are cited:

"Graduate credit should not be given unless one has an undergraduate major in this field. These other courses are undesirable if one takes an appropriate liberal arts program." 24

"Some of the above are fine ideas, however, a person only has so much time he can devote to graduate study and if the above would stretch out his program then I believe they are all undesirable." 25

It would seem that the majority of the physics professors and the deans in the liberal arts colleges included in the study favor the inclusion of allied sciences and other broadening courses for prospective physics instructors, but they feel that this work should be taken in a liberal arts program at the undergraduate level.

24 Comment on a questionnaire from a physics professor, October 6, 1958.

Programs which Include Humanities, Social Studies or Philosophy

In program four, respondents were asked to evaluate each of four included courses, each independently of the others in the following:

An interdepartmental program with a major area in physics, a minor area in mathematics, a minor area in chemistry and/or other sciences, and a minor area in one of the following--
1. Economic, historical, and social implications of developments in science
2. Philosophy with particular emphasis on its relation to physics
3. Humanities
4. Social studies

 Replies showed that deans and experienced college instructors considered an interdepartmental program, which included courses on the economic, historical, and social implications of developments in science desirable. The group of beginning college instructors with the Ph.D. degree felt that such a program would be undesirable. Other instructors were neutral. A total of 49 percent of all respondents indicated that a program which included a study of the implications of scientific developments would be desirable. Replies regarding the inclusion of philosophy and the humanities in an interdepartmental program were very similar. Recent Ph.D. graduates, as a group, were neutral to these programs. The groups of experienced instructors indicated that such courses would be desirable. The average rating for each of these programs was desirable. The average rating for the social studies was neutral. General comments by respondents were to the effect that courses of this nature should be included in the undergraduate program. At the present time, however, very few liberal arts colleges have faculty members who are

26Appendix, p. 265. 27Table 12, p. 117. 28Table 13, p. 148.
29Table 14, p. 149. 30Table 15, p. 150.
TABLE 12

DESCRIPTIBILITY OF AN INTERDEPARTMENTAL PROGRAM WITH A MAJOR AREA IN PHYSICS, A MINOR AREA IN MATHEMATICS, A MINOR AREA IN CHEMISTRY AND/OR OTHER SCIENCE AND A MINOR AREA IN THE ECONOMIC, HISTORICAL AND SOCIAL IMPLICATIONS OF DEVELOPMENTS IN SCIENCE

(Each entry in columns three through eight is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>VD</th>
<th>D</th>
<th>N</th>
<th>U</th>
<th>VU</th>
<th>No Reply</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>10</td>
<td>38</td>
<td>31</td>
<td>9</td>
<td>1</td>
<td>11</td>
<td>D</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>0</td>
<td>37</td>
<td>9</td>
<td>27</td>
<td>9</td>
<td>18</td>
<td>U</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>16</td>
<td>45</td>
<td>32</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>D</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>8</td>
<td>31</td>
<td>38</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>N</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>0</td>
<td>8</td>
<td>59</td>
<td>8</td>
<td>0</td>
<td>25</td>
<td>N</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>13</td>
<td>48</td>
<td>35</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>D</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>10</td>
<td>39</td>
<td>32</td>
<td>9</td>
<td>1</td>
<td>9</td>
<td>D</td>
</tr>
</tbody>
</table>

*a Respondents
I - Deans and chairmen of physics departments in small colleges
II - Beginning instructors with the Ph.D. degree in small colleges
III - Experienced instructors with the Ph.D. degree in small colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in small colleges
VI - Experienced instructors with the Master's and other degrees in small colleges

*b Rating
VD - Very desirable
D  - Desirable
N  - Neutral
U  - Undesirable
VU - Very undesirable
**TABLE 13**

**DESIRABILITY OF AN INTERDEPARTMENTAL PROGRAM WITH A MAJOR AREA IN PHYSICS, A MINOR AREA IN MATHEMATICS, A MINOR AREA IN CHEMISTRY AND/OR OTHER SCIENCE AND A MINOR AREA IN PHILOSOPHY WITH PARTICULAR EMPHASIS ON ITS RELATION TO PHYSICS**

(Each entry in columns three through eight is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>VD</th>
<th>D</th>
<th>N</th>
<th>U</th>
<th>VU</th>
<th>No Reply</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>17</td>
<td>40</td>
<td>25</td>
<td>7</td>
<td>0</td>
<td>11</td>
<td>D</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>18</td>
<td>27</td>
<td>37</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>N</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>16</td>
<td>48</td>
<td>26</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>D</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>8</td>
<td>46</td>
<td>8</td>
<td>38</td>
<td>0</td>
<td>0</td>
<td>N</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>25</td>
<td>25</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>D</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>9</td>
<td>48</td>
<td>39</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>D</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>15</td>
<td>41</td>
<td>27</td>
<td>8</td>
<td>0</td>
<td>9</td>
<td>D</td>
</tr>
</tbody>
</table>

*a* Respondents

I - Deans and chairman of physics departments in small colleges
II - Beginning instructors with the Ph.D. degree in small colleges
III - Experienced instructors with the Ph.D. degree in small colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in small colleges
VI - Experienced instructors with the Master's and other degrees in small colleges

*b* Rating

VD - Very desirable
D  - Desirable
N  - Neutral
U  - Undesirable
VU - Very undesirable
### TABLE 14

DESIRABILITY OF AN INTERDEPARTMENTAL PROGRAM WITH A MAJOR AREA IN PHYSICS, A MINOR AREA IN MATHEMATICS, A MINOR AREA IN CHEMISTRY AND/OR OTHER SCIENCES AND A MINOR AREA IN THE HUMANITIES

(Each entry in columns three through eight is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Total Number</th>
<th>VD</th>
<th>D</th>
<th>N</th>
<th>U</th>
<th>VU</th>
<th>No Reply</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>15</td>
<td>35</td>
<td>32</td>
<td>9</td>
<td>0</td>
<td>9</td>
<td>D</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>9</td>
<td>18</td>
<td>27</td>
<td>37</td>
<td>9</td>
<td>0</td>
<td>N</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>16</td>
<td>45</td>
<td>23</td>
<td>6</td>
<td>0</td>
<td>10</td>
<td>D</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>8</td>
<td>8</td>
<td>46</td>
<td>38</td>
<td>0</td>
<td>0</td>
<td>N</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>8</td>
<td>25</td>
<td>42</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>D</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>13</td>
<td>57</td>
<td>26</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>D</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>14</td>
<td>36</td>
<td>31</td>
<td>10</td>
<td>1</td>
<td>8</td>
<td>D</td>
</tr>
</tbody>
</table>

<sup>a</sup>Respondents

I - Deans and chairmen of physics departments in small colleges
II - Beginning instructors with the Ph.D. degree in small colleges
III - Experienced instructors with the Ph.D. degree in small colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in small colleges
VI - Experienced instructors with the Master's and other degrees in small colleges

<sup>b</sup>Rating

VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
TABLE 15

DESIRABILITY OF AN INTERDEPARTMENTAL PROGRAM WITH A MAJOR AREA IN PHYSICS, A MINOR AREA IN MATHEMATICS, A MINOR AREA IN CHEMISTRY AND/OR OTHER SCIENCES AND A MINOR AREA IN THE SOCIAL STUDIES

(Each entry in columns three through eight is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>VD</th>
<th>D</th>
<th>N</th>
<th>U</th>
<th>VU</th>
<th>No Reply</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>11</td>
<td>31</td>
<td>38</td>
<td>7</td>
<td>2</td>
<td>11</td>
<td>N</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>45</td>
<td>45</td>
<td>9</td>
<td>0</td>
<td>U</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>10</td>
<td>38</td>
<td>29</td>
<td>13</td>
<td>0</td>
<td>10</td>
<td>D</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>8</td>
<td>8</td>
<td>31</td>
<td>45</td>
<td>8</td>
<td>0</td>
<td>N</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>0</td>
<td>17</td>
<td>42</td>
<td>8</td>
<td>8</td>
<td>25</td>
<td>N</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>4</td>
<td>4</td>
<td>52</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>N</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>8</td>
<td>24</td>
<td>38</td>
<td>19</td>
<td>2</td>
<td>9</td>
<td>N</td>
</tr>
</tbody>
</table>

aRespondents
I - Deans and chairmen of physics departments in small colleges
II - Beginning instructors with the Ph.D. degree in small colleges
III - Experienced instructors with the Ph.D. degree in small colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in small colleges
VI - Experienced instructors with the Master's and other degrees in small colleges

bRating
VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
prepared to offer courses which stress the history and social implications of science. The National Science Foundation sponsored one Summer Institute which included courses on the History and Philosophy of Science and Mathematics during 1959.\textsuperscript{31} Much of this training will need to originate at the graduate school, initially.

**Nature of Graduate Programs of Physics Instructors**

Physics instructors were asked to supply the following information on the nature of their graduate programs and the courses they studied:

1. The major and the minor areas of study for the highest degree
2. A list of courses which were not studied but which would have helped to prepare the respondent to teach undergraduate physics
3. A list of graduate courses which were studied by the respondent but which had been of little value in preparing him to teach undergraduate physics\textsuperscript{32}
4. The value of graduate courses dealing with the historical and social implications of science, if these courses had been studied\textsuperscript{33}

A consolidation of the replies reveals that 63 percent of the instructors who obtained the Ph.D. degree had physics and mathematics as their major and minor areas of study, and that 12 percent did not have a minor area. Considering all instructors, 78 percent had a major area in physics and a minor area in mathematics, chemistry, philosophy, engineering, or education. The predominant areas of study were physics, mathematics, and chemistry.\textsuperscript{34} No respondent reported a minor in college teaching. One instructor who had obtained the Master's degree, reported that he was


\textsuperscript{32}Appendix, p. 277. \textsuperscript{33}Ibid., p. 278. \textsuperscript{34}Table 16, p. 152.
### TABLE 16

**MAJOR AND MINOR AREAS OF STUDY PURSUED BY EIGHTY-EIGHT PHYSICS INSTRUCTORS FOR THEIR HIGHEST DEGREE**

(Each entry is a percentage of the corresponding group.)

<table>
<thead>
<tr>
<th>Major Area</th>
<th>Minor Area(s)</th>
<th>Master's Degree</th>
<th>Ph.D. Degree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physics</td>
<td>Mathematics</td>
<td>47</td>
<td>63</td>
<td>57</td>
</tr>
<tr>
<td>2. Physics</td>
<td>None</td>
<td>6</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>3. Physics</td>
<td>Chemistry</td>
<td>12</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>4. Physics</td>
<td>Chemistry, mathematics</td>
<td>3</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>5. Physics</td>
<td>Mathematics, philosophy</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>6. Physics</td>
<td>Engineering</td>
<td>6</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>7. Physics</td>
<td>Science education</td>
<td>6</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>8. Physics</td>
<td>Chemistry, education</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>9. Physics</td>
<td>Biology, education</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>10. Physics</td>
<td>Mathematics, education</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>11. Physics</td>
<td>Electronics</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>12. Physics</td>
<td>Biology</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>13. Physics</td>
<td>Mathematics, engineering</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>14. Chemistry</td>
<td>Education</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>15. Chemistry</td>
<td>Metallurgy</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>16. Engineering</td>
<td>Mathematics</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>17. Science education</td>
<td>Physical education</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
pursuing a course of graduate study for the doctorate in the teaching of science.

A study of Table 17 reveals that with the exception of chemistry and the history and philosophy of science, fewer than 10 percent of all the instructors had found a need for any of the courses which were reported.\(^{35}\) A greater percentage of the group of instructors who had earned the Ph.D. degree than any other group, or 38 percent, recognized a need for courses in the history and philosophy of science. Instructors who had obtained only the Master's degree found a greater need for courses in mathematics, electronics, and modern physics than they did for other courses. The fact that approximately two out of every five instructors with the Ph.D. degree had not studied courses in the history and philosophy of science, but had found a need for it in their teaching is rather significant. It will be shown later that approximately 12 percent of this group had courses which dealt with the history and philosophy of science. All of these felt that this had been a very valuable part of their graduate study.\(^{36}\) While these results give no indication of the amount of course work which should be offered in this area, they do indicate, very definitely, that some courses at the graduate level should be offered for prospective physics teachers in the general area of the history and philosophy of science, and its implications. Approximately 73 percent of all physics instructors who had courses of this nature felt that these studies had been very valuable to them in their teaching.

\(^{35}\)Table 17, p. 154. \(^{36}\)Table 18, p. 155.
### TABLE 17

COURSES IN PHYSICS AND ALLIED SCIENCES WHICH COLLEGE PHYSICS INSTRUCTORS DID NOT HAVE BUT WHICH, IN THEIR JUDGMENT, WOULD HAVE HELPED THEM IN THEIR PREPARATION FOR UNDERGRADUATE TEACHING

(Each entry is a percentage of the corresponding group.)

<table>
<thead>
<tr>
<th>Course</th>
<th>Groupa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>9</td>
</tr>
<tr>
<td>1. History and philosophy of science</td>
<td></td>
</tr>
<tr>
<td>2. Electronics</td>
<td>11</td>
</tr>
<tr>
<td>3. Mathematical physics</td>
<td>9</td>
</tr>
<tr>
<td>4. Modern and nuclear physics</td>
<td>14</td>
</tr>
<tr>
<td>5. Advanced laboratory and lecture demonstrations</td>
<td>6</td>
</tr>
<tr>
<td>6. Solid state physics</td>
<td>0</td>
</tr>
<tr>
<td>7. Thorough basic undergraduate course in physics</td>
<td>6</td>
</tr>
<tr>
<td>Other sciences and mathematics</td>
<td></td>
</tr>
<tr>
<td>8. Advanced chemistry</td>
<td>6</td>
</tr>
<tr>
<td>9. Advanced mathematics</td>
<td>20</td>
</tr>
<tr>
<td>10. Astronomy</td>
<td>3</td>
</tr>
<tr>
<td>11. Geology</td>
<td>3</td>
</tr>
<tr>
<td>12. General chemistry</td>
<td>3</td>
</tr>
</tbody>
</table>

*Respondents

I - 35 college instructors with the Master's degree
II - 42 college instructors with the Ph.D. degree
III - 13 university instructors with the Ph.D. degree
TABLE 18
JUDGMENT OF RESPONDENTS REGARDING THE VALUE OF GRADUATE COURSES WHICH DEAL WITH THE HISTORICAL AND SOCIAL IMPLICATIONS OF SCIENCE FOR PROSPECTIVE UNDERGRADUATE INSTRUCTORS
(Entries are in percentage.)*

<table>
<thead>
<tr>
<th>Response</th>
<th>Groupa</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Had course</td>
<td>I</td>
<td>18</td>
<td>10</td>
<td>0</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>Very valuable</td>
<td>IV</td>
<td>11</td>
<td>11</td>
<td>15</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Little or no value</td>
<td>V</td>
<td>89</td>
<td>89</td>
<td>85</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>2. Did not have course</td>
<td>Total</td>
<td>82</td>
<td>87</td>
<td>100</td>
<td>92</td>
<td>48</td>
</tr>
<tr>
<td>Consider such a course would be valuable</td>
<td>I</td>
<td>11</td>
<td>11</td>
<td>15</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>No comment</td>
<td>II</td>
<td>89</td>
<td>89</td>
<td>85</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>3. No reply</td>
<td>III</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>35</td>
</tr>
</tbody>
</table>

*Respondents
I - 11 beginning college instructors with the Ph.D. degree
II - 31 experienced college instructors with the Ph.D. degree
III - 13 beginning university instructors with the Ph.D. degree
IV - 12 beginning college instructors with the Master's degree
V - 23 experienced college instructors with the Master's degree and others

*Entries in lines (1), (2) and (3) are percentages of the corresponding groups. Each entry in lines labeled "very valuable," "little or no value," etc., is a percentage of the respondents in a corresponding group who either had or did not have the course.
There were eighteen comments on this item, only two of which indicated that the courses had been of little value. Some of the typical comments are listed:

"Very little."37

"It helps in effective teaching."38

"I like to include historical notes whenever possible, and regret that there is not time to bring in more."39

"I took some work at the Princeton Seminary and at the University of Basel, Switzerland. This was extremely valuable but not a part of my doctoral work."40

"This is certainly one of my weaknesses."41

"I feel that they would be of great value."42

"I would rather pick it up on my own."43

"I would have liked one, no more, because you can certainly do this on your own."44

On the basis of the above observations it is quite evident that physics instructors in institutions included in the study have found a need for courses dealing with the historical, philosophical, and social aspects of physics.

In response to the request for information on courses which had been of little value to them, 35 percent of the instructors indicated

37Comment from an instructor who had the course, October 6, 1958.
40Ibid., October 3, 1958.
41Comment from an instructor who did not have the course, September 13, 1958.
44Ibid., October 3, 1958.
that highly technical courses, such as Laplace transforms, constituted the major area of their graduate study which had been of little value in preparing them to teach undergraduate physics. It should be noted that Table 19 shows none of the instructors in Groups I or III felt that highly technical courses had been of little value to them in their teaching.\textsuperscript{145} The general conclusion to be drawn is that most of the graduate courses taken by prospective college physics teachers prove to be of value to them at some time in their work. The courses which have been of the least value are the highly technical treatments of physical and mathematical principles.

Courses Which Physics Instructors Should Be Prepared to Teach

In order to determine what courses physics instructors had taught, or would be expected to teach in a liberal arts college in the area of the study, two procedures were followed. Information was requested on the courses which had been taught on the undergraduate level in physics and other subjects; and as a supplement to this, a survey was made of seventy-one college catalogues from institutions in the study to determine what courses were most frequently offered.\textsuperscript{146} Table 21 shows that all major courses in undergraduate physics had been taught by 38 percent of the college instructors.\textsuperscript{147} Algebra was taught by 43 percent of the instructors who had obtained the Ph.D. degree and calculus by 38 percent of this same group. Almost 25 percent had taught astronomy and 21 percent chemistry. A comparison of these figures with the course listings

\textsuperscript{145}Table 19, p. 158. \textsuperscript{146}Table 20, p. 159. \textsuperscript{147}Table 21, p. 160.
TABLE 19

JUDGMENT OF RESPONDENTS REGARDING GRADUATE COURSES THEY HAD WHICH WERE OF LITTLE VALUE IN PREPARING THEM TO TEACH UNDERGRADUATE PHYSICS

(Each entry is a percentage of the corresponding number of replies.)

<table>
<thead>
<tr>
<th>Group(^a)</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Replies</td>
<td>10</td>
<td>24</td>
<td>10</td>
<td>11</td>
<td>18</td>
<td>73</td>
</tr>
</tbody>
</table>

1. Respondents who felt that all courses had been of value . . . 90 53 90 45 50 60

2. Courses judged of little value by respondents

| Highly technical courses in physics and mathematics such as nuclear magnetic resonance, wave mechanics, Laplace transforms, spherical harmonics, matrices, etc. | 0 21 0 36 39 35 |
| Courses in education including administration and teaching methods | 0 17 0 0 17 10 |
| History of science | 0 0 0 0 11 3 |
| Biology, chemistry and sociology, one each | 0 13 0 0 0 4 |

\(^a\) Respondents

I - 11 beginning college instructors with the Ph.D. degree
II - 31 experienced college instructors with the Ph.D. degree
III - 13 beginning university instructors with the Ph.D. degree
IV - 12 beginning college instructors with the Master's degree
V - 23 experienced college instructors with the Master's degree and others
<table>
<thead>
<tr>
<th>Physics Course</th>
<th>Colleges Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General physics for liberal arts students</td>
<td>71</td>
<td>100</td>
</tr>
<tr>
<td>2. Electricity and magnetism</td>
<td>64</td>
<td>90</td>
</tr>
<tr>
<td>3. Mechanics</td>
<td>64</td>
<td>90</td>
</tr>
<tr>
<td>4. Optics</td>
<td>62</td>
<td>87</td>
</tr>
<tr>
<td>5. Heat and thermodynamics</td>
<td>60</td>
<td>84</td>
</tr>
<tr>
<td>6. Electronics</td>
<td>53</td>
<td>75</td>
</tr>
<tr>
<td>7. Modern physics</td>
<td>45</td>
<td>63</td>
</tr>
<tr>
<td>8. Advanced or senior laboratory</td>
<td>40</td>
<td>56</td>
</tr>
<tr>
<td>9. Survey of physics for non-science majors</td>
<td>37</td>
<td>52</td>
</tr>
<tr>
<td>10. Honors and seminar courses</td>
<td>32</td>
<td>45</td>
</tr>
<tr>
<td>11. Atomic physics</td>
<td>31</td>
<td>44</td>
</tr>
<tr>
<td>12. Sound, ultrasonics, and acoustics</td>
<td>29</td>
<td>41</td>
</tr>
<tr>
<td>13. Theoretical physics</td>
<td>27</td>
<td>38</td>
</tr>
<tr>
<td>14. Nuclear physics</td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>15. General physics for physics majors</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td>16. Descriptive astronomy</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>17. Teaching of high school physics</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>18. Electrical measurements</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>19. Advanced general physics with calculus</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>20. Machine shop</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>21. Other offerings</td>
<td>16</td>
<td>22</td>
</tr>
</tbody>
</table>
TABLE 21

COURSES IN PHYSICS, MATHEMATICS AND ALLIED SCIENCES WHICH NINETY PHYSICS INSTRUCTORS REPORTED THEY HAD TAUGHT ON THE UNDERGRADUATE LEVEL

(Each entry is a percentage of the corresponding group.)

<table>
<thead>
<tr>
<th>Course</th>
<th>Groupa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Physics</td>
<td></td>
</tr>
<tr>
<td>1. General physics for liberal arts students</td>
<td>100</td>
</tr>
<tr>
<td>2. Electricity and magnetism</td>
<td>57</td>
</tr>
<tr>
<td>3. Mechanics</td>
<td>43</td>
</tr>
<tr>
<td>4. Heat and thermodynamics</td>
<td>34</td>
</tr>
<tr>
<td>5. Atomic and nuclear physics</td>
<td>23</td>
</tr>
<tr>
<td>6. Optics</td>
<td>31</td>
</tr>
<tr>
<td>7. Modern physics</td>
<td>29</td>
</tr>
<tr>
<td>8. Electronics</td>
<td>40</td>
</tr>
<tr>
<td>9. General physics for engineers</td>
<td>37</td>
</tr>
<tr>
<td>10. Physical science</td>
<td>11</td>
</tr>
<tr>
<td>11. Sound and acoustics</td>
<td>9</td>
</tr>
<tr>
<td>12. Advanced laboratory</td>
<td>11</td>
</tr>
<tr>
<td>13. Other courses in physics including quantum mechanics,</td>
<td></td>
</tr>
<tr>
<td>history of physics, senior seminars, or spectroscopy</td>
<td>14</td>
</tr>
</tbody>
</table>

aRespondents

I - 35 college instructors with the Master's degree and others
II - 42 college instructors with the Ph.D. degree
III - 13 university instructors with the Ph.D. degree
<table>
<thead>
<tr>
<th>Course</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Mathematics and allied sciences</td>
<td></td>
</tr>
<tr>
<td>14. Algebra and trigonometry ...........................................</td>
<td>29</td>
</tr>
<tr>
<td>15. Calculus ......................................................................</td>
<td>11</td>
</tr>
<tr>
<td>16. Differential equations, theory of equations and vector analysis</td>
<td>6</td>
</tr>
<tr>
<td>17. Astronomy .....................................................................</td>
<td>6</td>
</tr>
<tr>
<td>18. Chemistry ....................................................................</td>
<td>0</td>
</tr>
<tr>
<td>19. Biology .......................................................................</td>
<td>0</td>
</tr>
<tr>
<td>20. Courses in education and the teaching of physics ..................</td>
<td>3</td>
</tr>
</tbody>
</table>
in college catalogues shows very close correlation, except in a few cases where courses are offered on alternate years, or when there is a demand for them. In summary, prospective physics instructors for liberal arts colleges should, in general, be prepared to teach courses in mathematics, astronomy, and quite frequently, chemistry in addition to all major courses in undergraduate physics.

---

48 Table 20, p. 159.
Professional Preparation of College Physics Teachers

The training of physics teachers has two facets: they must be trained as physicists; and they must be given professional preparation as teachers. The previous section was devoted to the academic preparation of prospective physics instructors, exclusive of research preparation. The present section is devoted to the graduate professional preparation of the physics teacher. For convenience in obtaining information this section was divided into professional courses, and teaching and internship training. Not many graduate departments make provision for professional courses in the preparation of college teachers. More has been done in the social studies and the humanities than has been done in the sciences. Generally as pointed out by Rusk, an experienced physics professor, physicists have been notoriously backward with reference to a more definite training of the physicist in the larger implications of their subject, both for their own sakes, and to aid them in more effective teaching.\(^9\)

Seminars and Methods Courses

In an attempt to determine the desirability of certain practices which are being followed in some graduate schools to improve the preparation of college teachers, deans, chairmen of physics departments, and physics instructors were asked to indicate the desirability of certain courses which are specifically planned for this purpose. Specifically, deans and chairmen of physics departments were asked to indicate the de-

sirability of each of the following courses, or seminars for inclusion in a graduate program for the preparation of physics teachers whom they might employ, each course to be considered on its merits and independently of the others:

1. Seminars or methods courses which are taught by well qualified physics professors, and are devoted to the improvement of class and laboratory instruction

2. Seminars or methods courses which are taught by well qualified professors in science education as well as physics professors

3. Methods courses or seminars which are devoted to general methods of teaching at the college level in other sciences as well as in physics

4. Courses or seminars in which a study is made of the administration, organization, and purposes of higher education

Physics instructors were presented with essentially the same request, but in addition, they were asked to indicate whether or not they had such a course, and the value it had been to them if they had it.

The most frequent response from deans and chairmen of physics departments indicated that they felt seminars or methods courses which were taught by well qualified physics professors were desirable in the graduate programs for the preparation of physics instructors whom they might employ. They had the same opinion in regard to courses which were taught by science education professors, but were neutral to the inclusion of courses which would be devoted to methods of teaching other sciences as well as physics, or courses which would include a study of education. Comments from this group indicated they felt that not more

50 Appendix, p. 266.  51 Table 22, p. 165.

52 Table 23, p. 168, Table 24, p. 169, and Table 25, p. 170.
TABLE 22

DESIRABILITY OF SEMINARS OR METHODS COURSES TAUGHT BY WELL QUALIFIED PHYSICS PROFESSORS AND DEVOTED TO THE IMPROVEMENT OF CLASS AND LABORATORY INSTRUCTION

(Each entry in columns four through nine is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>Had Course</th>
<th>Desirability Ratings</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>VD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>I</td>
<td>71</td>
<td>----</td>
<td>45</td>
<td>39</td>
<td>11</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>yes/no</td>
<td>18/27</td>
<td>0/27</td>
<td>0/18</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>yes/no</td>
<td>10/19</td>
<td>0/39</td>
<td>0/16</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>yes/no</td>
<td>0/8</td>
<td>0/53</td>
<td>0/23</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>yes/no</td>
<td>0/34</td>
<td>0/50</td>
<td>0/8</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>yes/no</td>
<td>22/22</td>
<td>1/34</td>
<td>0/9</td>
</tr>
<tr>
<td>Total Instrs.</td>
<td>90</td>
<td>yes/no</td>
<td>9/20</td>
<td>1/14</td>
<td>0/14</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>----</td>
<td>37</td>
<td>41</td>
<td>13</td>
</tr>
</tbody>
</table>

*a Respondents

I - Deans and chairmen of physics departments in small colleges
II - Beginning instructors with the Ph.D. degree in small colleges
III - Experienced instructors with the Ph.D. degree in small colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in small colleges
VI - Experienced instructors with the Master's and other degrees in small colleges

bRating

VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
than one or two courses of this nature should be included in the graduate program of the prospective college teacher. Some typical comments are given:

"These should be 'meaty' courses, not the usual 'claptrap' for secondary school methods."53

"An ideal professor for a methods course would be a dual professor, holding rank in both science education and the physics department."54

"All the above are desirable, however, a few methods courses are quite sufficient. Major time should be devoted to subject matter."55

"Have the candidate actually conduct classes under the direction of a senior staff member. In other words have a course of Student Teaching for the graduate student which would give him actual classroom experience."56

"The best training in methods comes through supervision in actual class work."57

"Anyone who does the necessary preparation for high competence in his chosen field, will not have time to waste on such courses! There are no such teachers!"58 [well qualified professors in science education]

In tabulating the responses of instructors regarding professional courses, replies from those who had the course were recorded separately. Percentages, based on the total number, were then calculated for those who had the course, and those who did not have it. In order to determine what percentage of a group had the course it is merely necessary to

53Comment on a questionnaire from a college dean, July 18, 1958.
56Comment on a questionnaire from an instructor, October 6, 1958.
57Comment on a questionnaire from a professor of physics, November 5, 1958.
58Ibid., dean, August 6, 1958.
add the percentages for the separate ratings. For example, in Table 23, the line for total instructors gives percentages of six, four, and three for instructors who had the course.\textsuperscript{59} Adding these, one obtains a percentage of approximately thirteen for instructors who had the course, or twelve out of the total of ninety instructors.

In response to the request for the desirability of a seminar or methods course which was taught by a well qualified physics professor, 10 percent or nine of the ninety instructors indicated that they had such a course.\textsuperscript{60} All of these instructors gave the course a rating of very desirable except one person who gave it a rating of desirable. The average of the ratings by instructors who did not have the course was desirable. The overall rating given this course by deans and instructors was desirable. Instructors who had seminars which were taught by science education professors gave these courses a desirable rating, but the average rating given these courses by all instructors and college deans was neutral.\textsuperscript{61}

All instructors who had seminars or methods courses which were devoted to general methods of teaching other sciences, as well as physics, rated these courses as very desirable.\textsuperscript{62} Other instructors, who had not had the course, rated a course of this type neutral or undesirable. The average rating given a methods course which includes other sciences was neutral. The same general rating was given seminars which are devoted to a study of higher education.\textsuperscript{63}

\textsuperscript{59}Table 23, p. 168. \textsuperscript{60}Table 22, p. 165. \textsuperscript{61}Table 23, p. 168. \\
\textsuperscript{62}Table 24, p. 169. \textsuperscript{63}Table 25, p. 170.
## TABLE 23

DESIRABILITY OF SEMINARS OR METHODS COURSES TAUGHT BY WELL QUALIFIED PROFESSORS OF SCIENCE EDUCATION AS WELL AS PHYSICS PROFESSORS

(Each entry in columns four through nine is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>Had Course</th>
<th>Desirability Ratings</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>VD D N U VU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>71</td>
<td>----</td>
<td>28 32 16 10 8 6</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>yes/no</td>
<td>0/9 0/9 0/9 0/36 0/18 0/18</td>
<td>-/U</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>yes/no</td>
<td>3/6 3/23 6/26 0/19 0/0 0/13</td>
<td>D/N</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>yes/no</td>
<td>0/0 0/8 0/46 0/38 0/0 0/8</td>
<td>-/U</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>yes/no</td>
<td>0/8 0/33 0/17 0/33 0/8 0/0</td>
<td>-/N</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>yes/no</td>
<td>17/4 13/9 4/30 0/9 0/4 0/9</td>
<td>D/N</td>
<td></td>
</tr>
<tr>
<td>Total Instrs.</td>
<td>90</td>
<td>yes/no</td>
<td>6/5 4/17 3/27 0/24 0/4 0/10</td>
<td>D/N</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>----</td>
<td>19 26 24 17 6 8</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Respondents

I - Deans and chairmen of physics departments in small colleges
II - Beginning instructors with the Ph.D. degree in small colleges
III - Experienced instructors with the Ph.D. degree in colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in colleges
VI - Experienced instructors with the Master's and other degrees in colleges

\(^b\)Rating

VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
TABLE 24

DESIRABILITY OF METHODS COURSES OR SEMINARS WHICH ARE DEVOTED TO GENERAL METHODS OF TEACHING OTHER SCIENCES AS WELL AS PHYSICS AT THE COLLEGE LEVEL

(Each entry in columns four through nine is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>Had Course</th>
<th>Desirability Ratings</th>
<th>No Reply Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>----</td>
<td>16 28 41 7 4 4</td>
<td>N</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>yes/no</td>
<td>0/9 0/9 0/18 0/27 0/18 0/18</td>
<td>-/-N</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>yes/no</td>
<td>6/3 3/13 0/16 0/13 0/3 0/13</td>
<td>VD/N</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>yes/no</td>
<td>0/0 0/7 0/39 0/31 0/15 0/8</td>
<td>-/-U</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>yes/no</td>
<td>0/17 0/25 0/25 0/25 0/8 0/0</td>
<td>-/-N</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>yes/no</td>
<td>18/0 8/18 0/30 0/4 0/4 0/18</td>
<td>VD/N</td>
</tr>
<tr>
<td>Total Instrs.</td>
<td>90</td>
<td>yes/no</td>
<td>7/4 3/14 0/34 0/17 0/8 0/12</td>
<td>VD/N</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>----</td>
<td>13 22 38 12 6 9</td>
<td>N</td>
</tr>
</tbody>
</table>

*a Respondents

I - Deans and chairmen of physics departments in small colleges
II - Beginning instructors with the Ph.D. degree in small colleges
III - Experienced instructors with the Ph.D. degree in small colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in small colleges
VI - Experienced instructors with the Master's and other degrees in small colleges

*b Rating

VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
TABLE 25

DESIRABILITY OF COURSES OR SEMINARS IN WHICH A STUDY IS MADE OF THE ADMINISTRATION, ORGANIZATION AND PURPOSES OF HIGHER EDUCATION

(Each entry in columns four through nine is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>Had Course</th>
<th>Desirability Ratings</th>
<th>No Reply Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>VD</td>
<td>D</td>
</tr>
<tr>
<td>I</td>
<td>71</td>
<td>----</td>
<td>11</td>
<td>31</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>yes/no</td>
<td>0/0</td>
<td>0/9</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>yes/no</td>
<td>0/0</td>
<td>3/16</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>yes/no</td>
<td>0/8</td>
<td>0/8</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>yes/no</td>
<td>0/0</td>
<td>0/17</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>yes/no</td>
<td>0/0</td>
<td>9/22</td>
</tr>
<tr>
<td>Total Instrs.</td>
<td>90</td>
<td>yes/no</td>
<td>0/1</td>
<td>3/16</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>----</td>
<td>6</td>
<td>24</td>
</tr>
</tbody>
</table>

\[a\] Respondents

I - Deans and chairmen of physics departments in small colleges
II - Beginning instructors with the Ph.D. degree in small colleges
III - Experienced instructors with the Ph.D. degree in small colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in small colleges
VI - Experienced instructors with the Master's degree and others in small colleges

\[b\] Rating

VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
The most significant fact to be observed about the responses of instructors regarding the methods courses or seminars is that those instructors who had such courses consistently rated them as more desirable in the preparation of prospective college teachers than did those instructors who did not have the courses. In fact, they rated the three methods courses as very desirable. Although an average of only 10 percent of all instructors who returned questionnaires had professional courses on the graduate level, the fact that all but an insignificant number indicated they were very valuable is an indication that serious consideration should be given to including courses of this nature in the graduate program for the preparation of college physics teachers. Comments made during interviews left the impression that many liberal arts college personnel are not fully aware of the nature of courses or seminars which are devoted to a study of higher education; nor do they appreciate the advantage it is to an institution for some members of the faculty to have had courses in this area on the graduate level.

Some typical comments by instructors on methods courses and seminars are given below:

"So much depends on the course and on the instructor. As a graduate student I got much help from a professor who gave the lectures in general physics and who held a weekly period to discuss such things as definitions of terms."  

"Started a methods course which was a waste of time. Would have liked a course in laboratory techniques."

"Graduate assistantships under good supervision are probably the best training."

64 Comment on a questionnaire from an instructor, September 30, 1958.

65 Ibid., September 26, 1958.  

66 Ibid., September 13, 1958.
A course in demonstration methods or laboratory techniques was mentioned more often than any other course as one which should be included in the preparation for college teaching. In a previous response instructors indicated that the utilization of films, demonstration equipment, and other teaching aids ranked eighth in a list of twenty areas in which they had encountered problems. These results indicate that there is an apparent need for a course which is devoted to a study of the use of audio-visual aids, the improvisation of equipment, and special laboratory techniques and procedures.

Teaching and Internship Training of College Physics Teachers

One of the most fruitful steps which may be taken toward improvement of the effectiveness of beginning physics instructors is to make provision for some form of class or laboratory teaching under the supervision of an experienced staff member. This type of training is being offered to some degree in practically all graduate physics departments. In some instances it is highly organized and very closely supervised. In others, it amounts to nothing more than the award of a teaching fellowship, or assistantship to a graduate student who does his teaching with little or no supervision. In an effort to determine the desirability of practices which are now being followed in providing for internship or teaching experience, deans and chairmen of physics departments were asked to indicate the desirability for physics teachers, whom

67 Table 8, p. 136. 68 Supra, pp. 79-81.
they might employ, to have training during their graduate program in
which the graduate student --

1. teaches class and laboratory sections with little or no supervision.
2. teaches class and laboratory sections under the supervision of well qualified physics professors.
3. teaches class and laboratory sections under the supervision of well qualified professors of science education as well as physics professors.
4. observes well qualified physics professors teach class and laboratory sections.
5. attends seminars devoted to the discussion of techniques and special methods which are applicable to a class the graduate student teaches.
6. works in an industrial or research plant.

Instructors were presented with the same request; but in addition, they were asked to indicate whether or not they had the training and the value this training was to them. In consolidating the responses to the above requests, the procedure described for the consolidation of results for seminars and methods courses was followed. The percentage of instructors who had a specified experience may be determined in the same manner as outlined there. All respondents were asked to include other methods of training they wished to suggest. They were also asked to indicate any combinations of the above programs which they felt would be desirable.

Replies from deans and chairmen of physics departments indicate that they consider the practice of having graduate students teach class and laboratory sections with little or no supervision is undesirable. Table 26 shows that 44 percent of these respondents rated the practice

69Appendix, p. 267. 70Appendix, p. 280.
71Supra, pp. 166-67.
TABLE 26

DESIRABILITY OF EXPERIENCE IN WHICH THE PROSPECTIVE COLLEGE PHYSICS INSTRUCTOR TEACHES CLASS AND LABORATORY SECTIONS WITH LITTLE OR NO SUPERVISION

(Each entry in columns four through nine is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>Had Course</th>
<th>Desirability Ratings</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>VD  D  N  U  VU  D/N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>71</td>
<td>----</td>
<td>3  15  17  44  21  0</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>yes/no</td>
<td>27/0 27/9 9/18 0/9 0/0 0/0</td>
<td>D/N</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>yes/no</td>
<td>11/11 0/7 7/11 35/14 0/4 0/10</td>
<td>N/N</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>yes/no</td>
<td>31/0 38/0 8/0 15/0 0/8 0/0</td>
<td>D/VU</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>yes/no</td>
<td>17/0 8/0 17/0 8/33 0/8 0/8</td>
<td>D/U</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>yes/no</td>
<td>4/0 18/4 4/18 13/18 0/13 0/8</td>
<td>N/U</td>
<td></td>
</tr>
<tr>
<td>Total Instr.</td>
<td>90</td>
<td>yes/no</td>
<td>14/3 14/4 8/10 18/14 0/7 0/7</td>
<td>N/N</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>----</td>
<td>11   17   17   38   13   4</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

\*Respondents

I - Deans and chairmen of physics departments in small colleges
II - Beginning instructors with the Ph.D. degree in small colleges
III - Experienced instructors with the Ph.D. degree in small colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in small colleges
VI - Experienced instructors with the Master's and other degrees in small colleges

\*Rating

VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
Instructors who had taught under these conditions rated the experience desirable or neutral. Generally, beginning instructors who had the experience rated it desirable. Instructors who had not had such training rated it neutral or undesirable. The general rating of all respondents for this training was neutral. A further study of Table 26 reveals that 54 percent of all instructors taught class and laboratory with little or no supervision. Yet the general rating of this practice as indicated above was neutral. The benefits to be derived from such a program would depend upon the individual. Those instructors who had the experience and felt that it was desirable quite probably would require a minimum of supervision to become effective teachers. On the other hand, an instructor who would profit from close supervision would probably get little benefit from such an experience; and in fact, he could easily develop habits which would be detrimental to effective teaching.

Deans and chairmen of physics departments indicated they felt that an experience in which prospective physics instructors taught class and laboratory sections under the supervision of well qualified physics professors would be desirable. Forty-nine percent of this group rated such an experience as very desirable and 44 percent rated it desirable. All groups of instructors that had this training rated it a very desirable experience; those groups that had not, rated it as desirable. A total of 52 percent of all instructors had this training, 82 percent of whom rated the experience as very desirable and 13 percent as desirable.

72Table 26, p. 174. 73Table 27, p. 176.
TABLE 27

DESIRABILITY OF EXPERIENCE IN WHICH THE PROSPECTIVE PHYSICS INSTRUCTOR TEACHES CLASS AND LABORATORY SECTIONS UNDER THE SUPERVISION OF WELL QUALIFIED PHYSICS PROFESSORS

(Each entry in columns four through nine is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>Had Course</th>
<th>Desirability Ratings</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>71</td>
<td>---</td>
<td>49</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>yes/no</td>
<td>64/18</td>
<td>9/9</td>
<td>0/0</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>yes/no</td>
<td>45/16</td>
<td>13/13</td>
<td>0/3</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>yes/no</td>
<td>38/15</td>
<td>15/15</td>
<td>8/8</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>yes/no</td>
<td>33/33</td>
<td>0/17</td>
<td>0/8</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>yes/no</td>
<td>35/26</td>
<td>4/4</td>
<td>0/13</td>
</tr>
<tr>
<td>Total Instrs.</td>
<td>90</td>
<td>yes/no</td>
<td>43/22</td>
<td>7/11</td>
<td>1/7</td>
</tr>
<tr>
<td>Total 161</td>
<td>----</td>
<td>57</td>
<td>30</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

aRespondents
I - Deans and chairmen of physics departments in colleges
II - Beginning instructors with the Ph.D. degree in colleges
III - Experienced instructors with the Ph.D. degree in colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in colleges
VI - Experienced instructors with the Master's and other degrees in colleges

bRating
VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
The average rating of this training by all respondents was very desirable. It is to be noted that generally those respondents who had the training gave it a higher rating than respondents who did not have it.

Approximately 96 percent of the deans and departmental chairmen who participated in the study replied to the request for information regarding the desirability of an experience in which the prospective physics instructor would observe the teaching of well qualified physics professors. Thirty-one percent of the administrators thought it would be a very desirable experience and 25 percent thought it would be at least desirable. The most frequent response of the group was desirable. All groups of instructors who had this experience, except Group VI, indicated that it was very desirable. The average rating of all respondents, including those who did not have the training, was desirable. However, the rating of very desirable, which was the average of all responses given by the instructors who had the experience, represented 66 percent of the instructors. Their judgment should be given more consideration than that of instructors who did not have the training. It should be pointed out that only one instructor of the sixty who indicated that they had this training, felt that it was undesirable.

Only three instructors indicated that they had taught class or laboratory sections under the supervision of well-qualified science education professors. One of these, who had the Ph.D. degree, gave the experience a very desirable rating; the others, who had the Master's degree, gave the experience a very undesirable rating. The most frequent

74Table 28, p. 178. 75Table 29, p. 179.
TABLE 28
DESIRABILITY OF EXPERIENCE IN WHICH THE PROSPECTIVE PHYSICS
INSTRUCTOR OBSERVES THE TEACHING OF WELL QUALIFIED
PHYSICS PROFESSORS WITH THE PRIMARY MOTIVE
OF LEARNING METHODS OF INSTRUCTION

(Each entry in columns four through nine is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>Had Course</th>
<th>Desirability Ratings</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>----</td>
<td>31 25 25 10 4 4</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>yes/no</td>
<td>73/0 9/9 0/0 0/0 0/0 0/9</td>
<td>VD/D</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>yes/no</td>
<td>38/10 13/13 3/13 0/0 0/0 0/10</td>
<td>VD/D</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>yes/no</td>
<td>54/0 31/7 0/0 0/7 0/0 0/0 0/0</td>
<td>VD/N</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>yes/no</td>
<td>30/17 8/13 3/13 0/0 0/0 0/0 8/0</td>
<td>VD/VD</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>yes/no</td>
<td>35/9 17/13 9/0 4/0 0/0 0/13</td>
<td>D/D</td>
<td></td>
</tr>
<tr>
<td>Total Instrs.</td>
<td>90</td>
<td>yes/no</td>
<td>45/8 16/12 3/4 1/1 0/0</td>
<td>1/8</td>
<td>VD/D</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>----</td>
<td>43 27 15 6 2 7</td>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>

*a Respondents

I - Deans and chairmen of physics departments in colleges
II - Beginning instructors with the Ph.D. degree in colleges
III - Experienced instructors with the Ph.D. degree in colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in colleges
VI - Experienced instructors with the Master's degree and others in colleges

*b Rating

VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
**TABLE 29**

**DESIRABILITY OF EXPERIENCE IN WHICH THE PROSPECTIVE PHYSICS INSTRUCTOR TEACHES CLASS AND LABORATORY SECTIONS UNDER THE SUPERVISION OF WELL QUALIFIED PROFESSORS OF SCIENCE EDUCATION AS WELL AS PHYSICS PROFESSORS**

(Each entry in columns four through nine is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>Had Course</th>
<th>Desirability Ratings</th>
<th>No Reply Ave.</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>---</td>
<td>38 42 11 6 0 3</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>yes/no</td>
<td>0/9 0/9 0/36 0/36 0/9 0/9 0/0</td>
<td>N/N</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>yes/no</td>
<td>3/3 0/26 0/45 0/10 0/3 0/10</td>
<td>UD/N</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>yes/no</td>
<td>0/0 0/0 0/69 0/31 0/0 0/0</td>
<td>N/N</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>yes/no</td>
<td>0/8 0/17 0/33 17/0 17/0 0/8</td>
<td>WU/N</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>yes/no</td>
<td>4/0 0/13 9/52 4/0 0/0 17/0</td>
<td>N/N</td>
<td></td>
</tr>
<tr>
<td>Total Instrs.</td>
<td>90</td>
<td>yes/no</td>
<td>2/3 0/16 2/48 3/12 2/2 5/5</td>
<td>N/N</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>----</td>
<td>19 27 33 11 3 6</td>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>

*a* Respondents

I - Deans and chairmen of physics departments in colleges

II - Beginning instructors with the Ph.D. degree in colleges

III - Experienced instructors with the Ph.D. degree in colleges

IV - Beginning instructors with the Ph.D. degree in universities

V - Beginning instructors with the Master's degree in colleges

VI - Experienced instructors with the Master's and other degrees in colleges

*b* Rating

VD - Very desirable

D - Desirable

N - Neutral

U - Undesirable

WU - Very undesirable
response from all other groups except the deans, was neutral. The average of the rating of all respondents for this type of training was desirable. The fact that the average of all ratings by the instructors was neutral is indicative of a lack of knowledge of this type of supervision. Approximately 50 percent of the instructors gave a rating of neutral rather than indicating a preference for the training. The following comment bears this out:

On questions involving science education teachers, I will remain neutral until I am convinced they have something unique to offer.76

The above comment is quite a contrast to one made by the chairman of a physics department in a liberal arts college when he stated:

Items 3, 4, and 5 would represent a real contribution to one of the most glaring needs of many graduate programs. Perhaps the worst feature of the present situation is not the lack of such experience but the fact that often the young Ph.D. in physics, for example, feels more sense of 'virtue' in this lack of [E]ducation. [italics in original]77

Only 32 percent of the instructors had attended a seminar which was devoted to a discussion of techniques and special methods applicable to a class they were teaching.78 The average rating these instructors gave this training was very desirable. All other respondents felt that such training would be desirable, or they gave it a neutral rating, which would indicate that they lacked sufficient information to express an opinion. The average rating for this type of training by all respondents was desirable.

76Comment on a questionnaire from a physics professor, October 16, 1958.
77Ibid., physics department chairman, September 30, 1958.
78Table 30, p. 181.
TABLE 30

DESIRABILITY OF EXPERIENCE IN WHICH THE PROSPECTIVE PHYSICS INSTRUCTOR ATTENDS SEMINARS DEVOTED TO DISCUSSIONS OF TECHNIQUES AND SPECIAL METHODS APPLICABLE TO A CLASS THE PROSPECTIVE INSTRUCTOR IS TEACHING

(Each entry in columns four through nine is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>Had Course</th>
<th>Desirability Ratings</th>
<th>No Reply Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>VD  D  N  U  VU</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>71</td>
<td>---</td>
<td>42  37  16  1  0  4</td>
<td>D</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>yes/no</td>
<td>0/27 9/18 0/27 0/9 0/9 0/0</td>
<td>-/D</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>yes/no</td>
<td>13/19 3/45 0/13 0/3 0/0 0/3</td>
<td>VD/D</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>yes/no</td>
<td>38/0 31/0 15/15 0/0 0/0 0/0</td>
<td>D/N</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>yes/no</td>
<td>0/33 0/17 8/17 0/17 0/0 0/8</td>
<td>N/D</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>yes/no</td>
<td>13/4 26/35 4/13 0/4 0/0 0/0</td>
<td>D/D</td>
</tr>
</tbody>
</table>

Total Instrs. 90  yes/no  11/15 11/29 4/15 0/6 0/1 0/2  D/D

Total 161  ----  35  40  17  4  1  3  D

aRespondents
I - Deans and chairman of physics departments in colleges
II - Beginning instructors with the Ph.D. degree in colleges
III - Experienced instructors with the Ph.D. degree in colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in colleges
VI - Experienced instructors with the Master's degree and others in colleges

bRating
VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
A total of 61 percent of all instructors had experience working in an industrial or research plant. None of those who had the experience felt that it was undesirable for a part of their training for college teaching; in fact, all but four of the fifty-five instructors who had this experience felt that it was desirable or very desirable. The average of the rating given by all respondents of the value of industrial or research experience as a part of the training of the prospective physics teacher was desirable.

Respondents offered practically no suggestions on other means of providing internship training. A total of thirty-one respondents did indicate some combinations of programs they would like. The chief combination which was suggested included class and laboratory sections under the supervision of physics professors and science education professors, along with seminars dealing with problems which the graduate student currently met in a class he was teaching.

Instructors were asked to indicate the number of years of experience they had before they obtained their highest degree, and in addition, to comment on the value of this experience. Table 33 shows that 66 percent of the instructors had an average of five years experience teaching in a senior college. Only 21 percent indicated that they had experience as a laboratory assistant. The second highest percentage of experience was in secondary school teaching where 30 percent of the instructors had averaged nine years. It was indicated by 53 percent of the instructors that this experience was very valuable in their prepara-

79 Table 31, p. 183. 80 Table 32, p. 184. 81 Table 33, p. 185.
TABLE 31

DESIRABILITY OF EXPERIENCE IN WHICH THE PROSPECTIVE PHYSICS INSTRUCTOR WORKS IN AN INDUSTRIAL OR RESEARCH PLANT

(Each entry in columns four through nine is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Instrs.</th>
<th>Course</th>
<th>Had Course</th>
<th>VD</th>
<th>D</th>
<th>N</th>
<th>U</th>
<th>VU</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>---</td>
<td>17</td>
<td>52</td>
<td>18</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>D</td>
</tr>
<tr>
<td>II</td>
<td>11 yes/no</td>
<td>45/0</td>
<td>27/9</td>
<td>0/18</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
<td>VD/N</td>
</tr>
<tr>
<td>III</td>
<td>31 yes/no</td>
<td>45/13</td>
<td>16/10</td>
<td>3/6</td>
<td>0/3</td>
<td>0/0</td>
<td>0/0</td>
<td>0/3</td>
<td>0/3</td>
<td>VD/D</td>
</tr>
<tr>
<td>IV</td>
<td>13 yes/no</td>
<td>38/0</td>
<td>31/0</td>
<td>15/15</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
<td>D/N</td>
</tr>
<tr>
<td>V</td>
<td>12 yes/no</td>
<td>25/18</td>
<td>25/17</td>
<td>8/8</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
<td>0/8</td>
<td>D/D</td>
</tr>
<tr>
<td>VI</td>
<td>23 yes/no</td>
<td>17/17</td>
<td>22/22</td>
<td>0/13</td>
<td>0/0</td>
<td>0/0</td>
<td>0/4</td>
<td>0/4</td>
<td>0/4</td>
<td>D/D</td>
</tr>
<tr>
<td>Total</td>
<td>90 yes/no</td>
<td>35/10</td>
<td>22/12</td>
<td>4/11</td>
<td>0/1</td>
<td>0/1</td>
<td>0/1</td>
<td>0/3</td>
<td>0/3</td>
<td>D/D</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>---</td>
<td>32</td>
<td>42</td>
<td>17</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>D</td>
</tr>
</tbody>
</table>

*a Respondents
I - Deans and chairmen of physics departments in colleges
II - Beginning instructors with the Ph.D. degree in colleges
III - Experienced instructors with the Ph.D. degree in colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in colleges
VI - Experienced instructors with the Master's degree and others in colleges

*b Rating
VD - Very desirable
D  - Desirable
N  - Neutral
U  - Undesirable
VU - Very undesirable
TABLE 32

COMBINATIONS OF TEACHING AND INTERNSHIP TRAINING METHODS FOR PROSPECTIVE COLLEGE PHYSICS INSTRUCTORS, DESIRED BY SOME DEANS, CHAIRMEN OF PHYSICS DEPARTMENTS AND INSTRUCTORS IN COLLEGES

(Each entry is a percentage of the corresponding number of replies.)

<table>
<thead>
<tr>
<th>Combination</th>
<th>Group and Number of Replies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>1. Class and laboratory sections taught under the supervision of science education as well as physics professors</td>
<td>50</td>
</tr>
<tr>
<td>2. Seminars devoted to problems applicable to a class the prospective instructor is teaching combined with (1)</td>
<td>0</td>
</tr>
<tr>
<td>3. Industrial or research work combined with (1)</td>
<td>0</td>
</tr>
<tr>
<td>4. Class and laboratory sections taught under the supervision of physics professors combined with (3)</td>
<td>25</td>
</tr>
<tr>
<td>5. Class and laboratory sections taught under the supervision of physics professors combined with seminars described in (2)</td>
<td>25</td>
</tr>
</tbody>
</table>

Respondents

I - 71 college deans and chairmen of physics departments
II - 11 beginning college instructors with the Ph.D. degree
III - 31 experienced college instructors with the Ph.D. degree
IV - 13 beginning university instructors with the Ph.D. degree
V - 12 beginning college instructors with the Master's degree
VI - 23 experienced college instructors with the Master's degree and others
TABLE 33

TEACHING EXPERIENCE OF RESPONDENTS PRIOR TO OBTAINING THEIR
HIGHEST DEGREE AND THE VALUE OF THIS EXPERIENCE IN
PREPARATION FOR COLLEGE PHYSICS TEACHING

(Percentages are based on the total in a corresponding group.)

<table>
<thead>
<tr>
<th>Experience</th>
<th>Groupa</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>1. None</td>
<td>9%</td>
<td>6%</td>
</tr>
<tr>
<td>2. Laboratory assistant</td>
<td>9%</td>
<td>13%</td>
</tr>
<tr>
<td>Average number of years</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. High school</td>
<td>9%</td>
<td>29%</td>
</tr>
<tr>
<td>Average number of years</td>
<td>2</td>
<td>6.5</td>
</tr>
<tr>
<td>4. Military school</td>
<td>9%</td>
<td>3%</td>
</tr>
<tr>
<td>Average number of years</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5. Junior college</td>
<td>9%</td>
<td>16%</td>
</tr>
<tr>
<td>Average number of years</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>6. Senior college</td>
<td>73%</td>
<td>68%</td>
</tr>
<tr>
<td>Average number of years</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>7. Work in an industrial plant</td>
<td>28%</td>
<td>10%</td>
</tr>
<tr>
<td>Average number of years</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>8. Very valuable experience</td>
<td>81%</td>
<td>58%</td>
</tr>
<tr>
<td>(no comment by others)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Average years of experience</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

aRespondents

I - 11 beginning college instructors with the Ph.D. degree
II - 31 experienced college instructors with the Ph.D. degree
III - 13 beginning university instructors with the Ph.D. degree
IV - 12 beginning college instructors with the Master's degree
V - 23 experienced college instructors with the Master's degree
and others
tion for college teaching. Only 10 percent of the total number of instructors had no teaching experience before they obtained their highest degree. Some typical comments by instructors follow:

"The half-time assistant job in graduate school probably accomplished more than anything else as far as teaching goes. The senior college work in a small college was ok but the teaching load was so great one was often just meeting deadlines."\(^{82}\)

"This two years [senior college] was extremely valuable in determining the fact that I wanted to be a college professor."\(^{83}\)

"Invaluable. You must have teaching experience to know whether or not you will like it. In almost every case I have observed, the first effort at teaching is almost always very sad, but the instructor improved rapidly with experience."\(^{84}\)

These comments emphasize several factors. In the first place, the physics professor in the liberal arts college is often overloaded to the extent that he has no opportunity to reflect on his teaching methods. These can be learned much more effectively in the graduate school where supervision by experienced staff members may be provided. In the second place, teaching experience prior to the acquisition of the degree may be a determining factor in influencing the graduate student to enter college teaching as a career. Most beginning teachers improve with experience. This improvement should be much more rapid under the sympathetic supervision of an experienced physics professor than it would be when the beginning instructor is on his own in a small college where he has no colleagues in his field with whom to discuss his problems.

---

\(^{82}\)Comment on a questionnaire from a physics professor, October 21, 1958.

\(^{83}\)Ibid., November 4, 1958. \(^{84}\)Ibid., October 3, 1958.
TABLE 34

TOTAL YEARS OF TEACHING EXPERIENCE AND YEARS TAUGHT AT THE PRESENT LOCATION AS REPORTED BY NINETY INSTRUCTORS

(The first entry in each column is the percentage of a corresponding group who have taught the number of years indicated. The second entry is the percentage of a corresponding group who have taught the number of years indicated at their present location.)

<table>
<thead>
<tr>
<th>Years</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>27</td>
<td>0</td>
<td>7</td>
<td>8</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>18</td>
<td>0</td>
<td>7</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>4-6</td>
<td>27</td>
<td>9</td>
<td>7</td>
<td>16</td>
<td>31</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>9</td>
<td>13</td>
<td>16</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>7-10</td>
<td>27</td>
<td>9</td>
<td>13</td>
<td>16</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>11-15</td>
<td>9</td>
<td>0</td>
<td>10</td>
<td>29</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>16-25</td>
<td>0</td>
<td>0</td>
<td>19</td>
<td>10</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Over 25</td>
<td>0</td>
<td>0</td>
<td>52</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

aRespondents

I - 11 beginning college instructors with the Ph.D. degree
II - 31 experienced college instructors with the Ph.D. degree
III - 13 beginning university instructors with the Ph.D. degree
IV - 12 beginning college instructors with the Master's degree
V - 23 experienced college instructors with the Master's degree and others
Research and the Dissertation

The Committee of Fifteen, which was sponsored by the Fund for the Advancement of Education, suggested that the dissertation should be primarily a contribution to the knowledge of its author. The objective of the dissertation at the time of the establishment of the first graduate schools was to make a specific contribution to knowledge. Such a dissertation stresses research and is extremely valuable to the prospective research physicist. The prospective college physics teacher should also have research experience; but in view of the above suggestion, it may be questioned whether the prospective teacher should have the same research experience as the prospective researcher. In view of this, respondents were asked to indicate the desirability for the preparation of physics teachers of the following dissertations:

1. Emphasizes original research in a restricted phase of pure or applied physics
2. Overlaps other sciences and broaden the student's knowledge of experimental procedures in other sciences as well as physics
3. Emphasizes original research but would be planned to meet the specific needs of a person preparing for college teaching rather than for research and/or graduate teaching
4. Emphasizes a study of the problems which deal with the social effects of scientific developments, the teaching of college physics, or other problems of an interpretive nature

The average of the ratings of all groups of respondents, except the beginning college instructors who had recently obtained the Ph.D. degree, was desirable for a dissertation which emphasizes original research.

---


86 Appendix, p. 268.
search in a restricted phase of pure or applied physics. The most frequent response from instructors who had recently obtained the Ph.D. degree was that a dissertation which emphasizes original research in a restricted phase of pure or applied physics would be very desirable. A total of 34 percent of the respondents indicated that this dissertation would be very desirable. Only 7 percent indicated any degree of undesirability. The average of all the ratings given this type of dissertation was desirable.

The replies of respondents regarding a dissertation which would overlap other sciences indicated that the majority felt it would be desirable. Only 8 percent, largely beginning instructors, felt that it would in any way be undesirable. Approximately 75 percent of the deans and experienced instructors gave a dissertation of this type a desirable or a very desirable rating. It would appear that personnel with experience in a liberal arts college had a better perspective of the need for a broader research background than the beginning instructors. The average of all the ratings of respondents was desirable.

A dissertation which emphasizes original research but is planned to meet the specific needs of a person who is preparing for college teaching was given essentially the same rating, namely desirable, as the previous two types of dissertations. Beginning instructors were generally neutral in their opinions, but approximately 65 percent of the other respondents felt that research with this emphasis would be at

87 Table 35, p. 190. 88 Table 36, p. 191. 89 Table 37, p. 192.
TABLE 35

DESIRABILITY OF A DISSERTATION WHICH EMPHASIZES ORIGINAL
RESEARCH IN A RESTRICTED PHASE OF PURE OR APPLIED
PHYSICS AS INDICATED BY RESPONDENTS

(Each entry in columns three through eight is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group a</th>
<th>Total Number</th>
<th>VD</th>
<th>D</th>
<th>N</th>
<th>U</th>
<th>VU</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>27</td>
<td>35</td>
<td>25</td>
<td>8</td>
<td>0</td>
<td>4</td>
<td>D</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>72</td>
<td>19</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>VD</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>39</td>
<td>32</td>
<td>16</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td>D</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>54</td>
<td>38</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>D</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>33</td>
<td>42</td>
<td>17</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>D</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>22</td>
<td>30</td>
<td>35</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>D</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>34</td>
<td>33</td>
<td>22</td>
<td>6</td>
<td>1</td>
<td>4</td>
<td>D</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>aRespondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>I — Deans and chairmen of physics departments in colleges</td>
</tr>
<tr>
<td>II — Beginning instructors with the Ph.D. degree in colleges</td>
</tr>
<tr>
<td>III — Experienced instructors with the Ph.D. degree in colleges</td>
</tr>
<tr>
<td>IV — Beginning instructors with the Ph.D. degree in universities</td>
</tr>
<tr>
<td>V — Beginning instructors with the Master's degree in colleges</td>
</tr>
<tr>
<td>VI — Experienced instructors with the Master's degree and others in colleges</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>bRating</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD — Very desirable</td>
</tr>
<tr>
<td>D — Desirable</td>
</tr>
<tr>
<td>N — Neutral</td>
</tr>
<tr>
<td>U — Undesirable</td>
</tr>
<tr>
<td>VU — Very undesirable</td>
</tr>
</tbody>
</table>
TABLE 36

DESIRABILITY OF A DISSERTATION WHICH OVERLAPS OTHER SCIENCES AND BROADENS THE STUDENT'S KNOWLEDGE OF EXPERIMENTAL PROCEDURES IN RELATED SCIENCES AS WELL AS IN PHYSICS

(Each entry in columns three through eight is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Total Number</th>
<th>VD</th>
<th>Desirability Ratings&lt;sup&gt;b&lt;/sup&gt;</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td>N</td>
<td>U</td>
</tr>
<tr>
<td>I</td>
<td>71</td>
<td>31</td>
<td>44</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>9</td>
<td>55</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>16</td>
<td>45</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>15</td>
<td>54</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>17</td>
<td>25</td>
<td>41</td>
<td>17</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>23</td>
<td>41</td>
<td>32</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>23</td>
<td>44</td>
<td>23</td>
<td>7</td>
</tr>
</tbody>
</table>

<sup>a</sup>Respondents
I - Deans and chairmen of physics departments in colleges
II - Beginning instructors with the Ph.D. degree in colleges
III - Experienced instructors with the Ph.D. degree in colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in colleges
VI - Experienced instructors with the Master's degree and others in colleges

<sup>b</sup>Rating
VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
TABLE 37

DESIRABILITY OF A DISSERTATION WHICH IS DEVOTED TO ORIGINAL RESEARCH BUT IS PLANNED TO MEET THE SPECIFIC NEEDS OF A PERSON WHO IS PREPARING FOR COLLEGE TEACHING RATHER THAN FOR RESEARCH AND/OR GRADUATE TEACHING

(Each entry in columns three through eight is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Total Number</th>
<th>VD</th>
<th>Desirability Ratings&lt;sup&gt;b&lt;/sup&gt;</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td>N</td>
<td>U</td>
</tr>
<tr>
<td>I</td>
<td>71</td>
<td>35</td>
<td>33</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>18</td>
<td>18</td>
<td>27</td>
<td>37</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>29</td>
<td>16</td>
<td>42</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>23</td>
<td>39</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>33</td>
<td>8</td>
<td>33</td>
<td>17</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>22</td>
<td>61</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>30</td>
<td>31</td>
<td>21</td>
<td>11</td>
</tr>
</tbody>
</table>

<sup>a</sup>Respondents

I - Deans and chairmen of physics departments in colleges  
II - Beginning instructors with the Ph.D. degree in colleges  
III - Experienced instructors with the Ph.D. degree in colleges  
IV - Beginning instructors with the Ph.D. degree in universities  
V - Beginning instructors with the Master's degree in colleges  
VI - Experienced instructors with the Master's degree and others in colleges

<sup>b</sup>Rating

VD - Very desirable  
D - Desirable  
N - Neutral  
U - Undesirable  
VU - Very undesirable
least desirable. Nearly half of the respondents who approved of this type of dissertation felt that it would be very desirable.

The average of all ratings given by beginning instructors was unsatisfactory for a dissertation of an interpretive nature as described above. Experienced instructors and deans were generally neutral in their replies. The average of the ratings from all respondents was neutral. Comments which were made during interviews indicated that some respondents did not fully understand the nature of the fourth type of dissertation. For example, a physics departmental chairman, who had indicated on the questionnaire that he felt a dissertation of an interpretive or pedagogical nature would be undesirable, expressed the need during a later interview at his institution for a Ph.D. candidate who would be interested in preparing a completely new series of laboratory experiments for their general physics laboratory as his dissertation. A number of persons who were interviewed indicated that they did not class this study as one of an interpretive nature, but rather as one which was suited to the needs of the individual. Several typical comments are cited:

"[It should be] original research aimed at improving the teaching of physics, rather than research in one limited area of pure or applied physics." [addition mine]

---

90 Table 38, p. 194.

91 Ohio Wesleyan University, July 15, 1958.

92 Comment on a questionnaire from an instructor with the M.A. degree, October 6, 1958.
TABLE 38

DESIRABILITY OF A DISSERTATION WHICH IS DEVOTED TO THE STUDY OF A PROBLEM CONCERNED WITH THE SOCIAL EFFECTS OF SCIENTIFIC DEVELOPMENTS, THE TEACHING OF COLLEGE PHYSICS OR A PROBLEM OF AN INTERPRETIVE NATURE

(Each entry in columns three through eight is a percentage of the group.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>VD</th>
<th>D</th>
<th>N</th>
<th>U</th>
<th>VU</th>
<th>No Reply</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>11</td>
<td>20</td>
<td>31</td>
<td>31</td>
<td>6</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>36</td>
<td>46</td>
<td>0</td>
<td>U</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>0</td>
<td>6</td>
<td>45</td>
<td>32</td>
<td>10</td>
<td>6</td>
<td>N</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>46</td>
<td>46</td>
<td>0</td>
<td>U</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>0</td>
<td>8</td>
<td>17</td>
<td>67</td>
<td>8</td>
<td>0</td>
<td>U</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>4</td>
<td>22</td>
<td>52</td>
<td>18</td>
<td>0</td>
<td>4</td>
<td>N</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>6</td>
<td>14</td>
<td>33</td>
<td>33</td>
<td>12</td>
<td>2</td>
<td>N</td>
</tr>
</tbody>
</table>

*Respondents

I - Deans and chairmen of physics departments in colleges
II - Beginning instructors with the Ph.D. degree in colleges
III - Experienced instructors with the Ph.D. degree in colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in colleges
VI - Experienced instructors with the Master's degree and others in colleges

*Rating

VD - Very desirable
D - Desirable
N - Neutral
U - Undesirable
VU - Very undesirable
"Is a dissertation necessary in the preparation for undergraduate teaching? I doubt it."93

"Any good work in any field is satisfactory. Seeing its value as related to the whole of science is the important thing."94

"It should demonstrate the author's ability to carry out original research and contribute to knowledge."95

"I believe the dissertation should be of concern to the individual and directly a problem-solving in his major field of interest."96

"The dissertation should involve real research; if properly handled, historical and biographical studies could be used."97

There was little difference in the rating given the first three types of dissertations. The average of all ratings for each was desirable. On the basis of these results, it would seem that any one of the three types of dissertations would be satisfactory. The selection of a dissertation should depend upon the needs and interests of the individual, and upon his aptitude for research work. In some instances an interpretive dissertation could be of more value to the individual and to physics in general than a dissertation in pure research. No suggestions were made, however, as to what are the needs and interests of the prospective college physics teacher; nor were any suggestions made as to the type of dissertation that would meet these needs.

93Ibid., Ph.D. degree, October 12, 1958.
94Comment on a questionnaire from an instructor with the M.S. degree, November 30, 1958.
95Ibid., an instructor with the Ph.D. degree, July 30, 1958.
96Ibid., an instructor with the Ed.D. degree, November 4, 1958.
97Ibid., an instructor with the Ph.D. degree, November 5, 1958.
General Topics of Research Study

The dissertation and Master's thesis topics, which were reported by eight-one instructors, were of three general classes: (1) theoretical, (2) experimental, and (3) teaching or demonstration. Only 10 percent of the instructors did research work of a theoretical nature. The greater percentage of this was reported by beginning university instructors with the Ph.D. degree. Very little use had been made of this work for further research. Seventy-five percent of the instructors did research of an experimental nature for the degree and 13 percent utilized this for further research or publication. A small percentage of the instructors had done research work of a teaching or demonstration nature. Generally, little research work was done as an outgrowth of the work for the dissertation. One respondent did report that he was awarded a $30,000 Office of Naval Research Grant for continuance of a study of physics laboratories for naval personnel which he had developed as part of his degree program.

Essentiality of the Ph.D. Degree for Undergraduate Teaching

Thirty-five percent of all respondents who replied to the question regarding the essentiality of the Ph.D. degree indicated they feel that it is an essential part of the preparation for college teaching. Some respondents included the comment that they feel it is very desirable although they do not feel that it is essential. It is quite significant

---

98 Table 39, p. 197. 99 Table 40, p. 198.
TABLE 39

NATURE OF THE DISSERTATION OR THE THESIS AND EXTENT TO WHICH IT HAS BEEN UTILIZED FOR FURTHER RESEARCH AND PUBLICATIONS

(Each entry is a percentage of the corresponding number of replies.)

<table>
<thead>
<tr>
<th>Dissertation or Thesis</th>
<th>Groupa and Number of Replies</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>1. Theoretical</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Utilized for research</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Utilized for publications</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. Experimental</td>
<td>100</td>
<td>83</td>
</tr>
<tr>
<td>Utilized for research</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td>Utilized for publications</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>3. Teaching or demonstration</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Utilized for research</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Utilized for publications</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Total number of publications per respondent (not percentage)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Books</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

aRespondents

I - 11 beginning college instructors with the Ph.D. degree
II - 31 experienced college instructors with the Ph.D. degree
III - 13 beginning university instructors with the Ph.D. degree
IV - 12 beginning college instructors with the Master's degree
V - 23 experienced college instructors with the Master's degree and others
TABLE 40
JUDGMENT OF RESPONDENTS REGARDING THE ESSENTIALITY OF THE PH.D. DEGREE IN THE PREPARATION FOR UNDERGRADUATE PHYSICS TEACHING

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Number</th>
<th>No Reply</th>
<th>Replies</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>71</td>
<td>7</td>
<td>64</td>
<td>30</td>
<td>34</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>0</td>
<td>11</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>III</td>
<td>31</td>
<td>0</td>
<td>31</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>IV</td>
<td>13</td>
<td>0</td>
<td>13</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>0</td>
<td>12</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>VI</td>
<td>23</td>
<td>1</td>
<td>22</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>161</td>
<td>153</td>
<td>53</td>
<td>100</td>
</tr>
</tbody>
</table>

*Respondents

I - Deans and chairmen of physics departments in colleges
II - Beginning instructors with the Ph.D. degree in colleges
III - Experienced instructors with the Ph.D. degree in colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in colleges
VI - Experienced instructors with the Master's degree and others in colleges
that twelve of the thirteen university instructors included in the study indicated they do not feel that the Ph.D. degree is essential for undergraduate physics teaching duties. On the other hand, five of the eleven recent Ph.D. graduates who were teaching in colleges indicated that they feel the degree is essential. Their responses were very similar to those of the deans, which would indicate that their replies were colored by the requirement of the Ph.D. degree for advancement in many liberal arts colleges. The respondents who indicated they do not feel that the Ph.D. degree is essential were asked to indicate whether or not a rigorous Master of Science degree with an experimental thesis would be sufficient for teaching undergraduate physics in a liberal arts college. Eighty-five percent of these respondents indicated that such a degree should be sufficient.\textsuperscript{100} A large percentage of these instructors were very probably already on tenure. Better than 80 percent of them had taught four or more years at their present location.\textsuperscript{101} They had sufficient experience to evaluate the need of the degree from an instructional standpoint; and in addition, their responses would not generally be colored by the personal need to obtain the Ph.D. degree. In this sense the opinion most frequently expressed by the experienced instructors was very probably a truer indication of the degree needs of prospective physics teachers in the liberal arts college than was the opinion expressed by other instructors.

Probably one of the main reasons for the requirement of the Ph.D. degree is to meet regional accrediting association requirements. It

\textsuperscript{100}Table 41, p. 200. \textsuperscript{101}Table 34, p. 187.
TABLE 4.1

JUDGMENT OF RESPONDENTS, WHO DO NOT FEEL THAT THE PH.D. DEGREE IS ESSENTIAL PREPARATION FOR UNDERGRADUATE TEACHING, REGARDING THE SUFFICIENCY OF A RIGOROUS MASTER OF SCIENCE DEGREE WITH AN EXPERIMENTAL THESIS

<table>
<thead>
<tr>
<th>Group</th>
<th>Total</th>
<th>No Reply</th>
<th>Replies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>I</td>
<td>31</td>
<td>0</td>
<td>31 91%</td>
</tr>
<tr>
<td>II</td>
<td>6</td>
<td>0</td>
<td>3 50%</td>
</tr>
<tr>
<td>III</td>
<td>19</td>
<td>0</td>
<td>14 74%</td>
</tr>
<tr>
<td>IV</td>
<td>12</td>
<td>1</td>
<td>9 82%</td>
</tr>
<tr>
<td>V</td>
<td>9</td>
<td>0</td>
<td>8 88%</td>
</tr>
<tr>
<td>VI</td>
<td>20</td>
<td>0</td>
<td>20 100%</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>1</td>
<td>85 85%</td>
</tr>
</tbody>
</table>

a Respondents

I - Deans and chairmen of physics departments in colleges
II - Beginning instructors with the Ph.D. degree in colleges
III - Experienced instructors with the Ph.D. degree in colleges
IV - Beginning instructors with the Ph.D. degree in universities
V - Beginning instructors with the Master's degree in colleges
VI - Experienced instructors with the Master's degree and others in colleges

b See column seven, Table 40, p. 198.
would be difficult for an institution to set up the requirement for the degree in some departments and not require it in others. Consequently, if the institution subscribes to this requirement it must do so in all departments where the Ph.D. degree is normally offered by graduate schools. Responses from deans and chairmen of physics departments indicate that approximately 90 percent of the institutions which participated in the study stress the Ph.D. degree. Not all institutions, however, hold to a fixed requirement. Neither is the requirement of the degree to meet accrediting standards the sole reason for stressing it. As stated by the dean of a liberal arts college which does not make it a fixed requirement in all cases:

We stress the Ph.D. degree as the best available criterion of adequate professional preparation, but not as an absolute sine qua non. 102

Or as stated by the chairman of the physics department in another institution:

When good physics teachers without Ph.D.'s are found they should be advanced in rank and salary. This quality is above a formal Ph.D. degree. 103

The extreme view which is held by some institutions was expressed by a departmental chairman when he stated:

The Ph.D. degree is essential to give a thorough knowledge of physics needed for college teaching. 104

It is quite probable that this feeling will moderate with the expected decrease in the number of available physics instructors who have the

102 Capital University, Columbus, Ohio, August, 1958.
103 Dickinson College, Carlisle, Pennsylvania, August 20, 1958.
104 Comment on a questionnaire, October 10, 1958.
Ph.D. degree. This opinion was expressed by one dean when he stated "We may be unable to continue to stress the Ph.D. degree for undergraduate teaching as the teacher shortage grows." As it now stands the Ph.D. degree is the general requirement in the preparation to teach in a liberal arts college. The majority of the institutions included in the study stress it as a requirement for permanent appointment and advancement. It is probably the best criterion available for determining the qualifications of the prospective physics instructor, but as it was pointed out in Chapter II it does not necessarily prepare one for teaching in a liberal arts college.

Contributions of Graduate Training toward Preparation for Teaching

Instructors were asked to indicate the aspects of their graduate training which had made the least contribution toward preparing them for effective teaching, and those which had made the greatest contribution. The results of this inquiry were so varied that it would be difficult to tabulate all responses. Consequently, only those aspects of training which were mentioned several times were summarized. Responses which were very closely related, such as those pertaining to different aspects of advanced graduate courses or highly technical courses, were tabulated under a single heading. A number of respondents merely indicated none or all. Some stated that it would be difficult to say which made the least or the greatest contribution. The results shown on Table 4.2, therefore, indicate the responses obtained from seventy-one instructors.

---

105 Denison University, Granville, Ohio, July 22, 1958.
106 Appendix, p. 283.
107 Table 4.2, p. 203.
<table>
<thead>
<tr>
<th>Aspect of Training</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Made greatest contribution</strong></td>
<td></td>
</tr>
<tr>
<td>1. Good intermediate and beginning graduate courses in physics</td>
<td>25</td>
</tr>
<tr>
<td>2. Experience as a laboratory or a teaching assistant</td>
<td>12</td>
</tr>
<tr>
<td>3. Research work</td>
<td>11</td>
</tr>
<tr>
<td>4. Observation of and instruction under good professors</td>
<td>10</td>
</tr>
<tr>
<td>5. Experience in demonstration and laboratory work</td>
<td>8</td>
</tr>
<tr>
<td>6. Close supervision by and informal conferences with senior staff members</td>
<td>8</td>
</tr>
<tr>
<td><strong>Made least contribution</strong></td>
<td></td>
</tr>
<tr>
<td>1. Highly specialized or technical courses in chemistry, mathematics and/or physics</td>
<td>8</td>
</tr>
<tr>
<td>2. Thesis writing and research work</td>
<td>8</td>
</tr>
<tr>
<td>3. Foreign language requirement per se</td>
<td>5</td>
</tr>
<tr>
<td>4. Instruction under poor teachers</td>
<td>3</td>
</tr>
<tr>
<td>5. Courses in educational administration</td>
<td>3</td>
</tr>
</tbody>
</table>

*a*Includes reports from seventy-one instructors.
It will be observed that course work which deals with fundamental principles of physics at the intermediate and beginning graduate level were mentioned more frequently than any aspects of graduate training which made the greatest contribution to effective teaching. Furthermore, the study of highly specialized or technical courses was mentioned more often than other factors which made the least contribution. While the number of responses in each case is insufficient to establish definite conclusions, the combination of the two indicates that one of the most important phases — if not the most important — of graduate preparation for undergraduate college teaching is a sound and thorough preparation in intermediate phases of fundamental principles of physics. While advanced graduate work may at times make a contribution toward effective teaching at the undergraduate level it is essential that intermediate courses, which make the greatest contribution, be thoroughly understood even though it may be necessary to omit some of the more theoretical or highly technical courses at the advanced graduate level. All items which were mentioned by instructors to have made a contribution toward their preparation for effective teaching, when considered collectively, form the basis for an effective program at the graduate level for prospective undergraduate physics instructors. These include (1) a strong foundation in the fundamental principles of physics, (2) experience in class and laboratory teaching, (3) research work, (4) excellent graduate instruction, (5) supervision by and informal conferences with senior staff members, and (6) experience with demonstration and laboratory equipment. Such a program, if carried out effectively, would include many other factors which have not been mentioned but which are essential
in the preparation of physicists for effective teaching; and with the cooperation of other departments, it should form the basis of a very functional program. The most significant observation to be made regarding the items which had contributed the least is that there were very few aspects of the graduate training of the reporting instructors which did not make some contribution to their preparation. In planning any program, consideration should be given first to those items which make the most contribution. If time permits during the graduate program other items may be included.

Suggestions for Improvement of Graduate Preparation for Teaching

Suggestions which were offered by physics instructors for improving the present programs now available for prospective college physics teachers covered a rather wide band in the educational spectrum, ranging from narrow views which expressed the opinion that nothing could be done to help the beginning physics teacher to broad views which expressed a need for better cooperation between departments of education and physics. A study of the suggestions revealed, however, that they could be classified into groups which were very similar in nature and were confined to a rather narrow range. Typical comments have been included where appropriate to emphasize a suggestion. Approximately 70 percent of all instructors who participated in the study made suggestions in regard to present programs; some made suggestions for modifications, some advocated no change, and some went so far as to advocate a different degree for prospective teachers.

One of the most frequently offered suggestions was that fundamen-
tal physics courses in the general areas the liberal arts college physics instructor teaches, but at a more advanced level, should be given more emphasis. Some suggestions went so far as to advocate the inclusion of a very thorough and rigorous general physics course which would be taught by an experienced teacher who was recognized for his pedagogical skill. Such a course would give prospective physics instructors an opportunity to observe the teaching of an intermediate course by an outstanding teacher. It could be expanded into a practical methods course in which the students did part of the teaching. Students should take the course with two objectives in mind: (1) to gain a thorough understanding of the fundamentals of physics and (2) to observe and participate in various teaching methods. The following comment emphasizes such a course:

I would like to suggest a course at the first year graduate level, using an engineering college physics text which is devoted to a thorough coverage of physics, including background material, with emphasis on a solid understanding of the fundamentals and the scope of physics. This would include requiring students to work problems of every type included in the text. Better students could be extended by delving into the development of a particular law and its extension beyond the scope of the text. 108

Other respondents expressed a desire for fewer highly specialized courses, a balanced emphasis on classical physics, and more opportunity for independent thought in the fundamental principles of physics.

A large percentage of the suggestions stressed greater emphasis on opportunities for graduate students to have experience in teaching class and laboratory sections under the supervision of good physics

108 S. C. Wheeler, Denison University, Granville, Ohio, August 11, 1958.
teachers who were interested in improving physics instruction, and who would be sympathetic with the graduate student in his first efforts at teaching. The greatest criticism in this area of the prospective physics teacher's graduate study was that there should be much closer critical supervision of the teaching performance of the graduate student. He should also be afforded the opportunity to observe and participate in various methods of teaching. The teaching assistant should be given responsibility for the course he teaches but under close supervision. Some provision should be made for acquainting the prospective teacher with demonstration equipment and other teaching aids. The following comment gives a good summary of the suggestions that were made:

I would suggest that the undergraduate courses in universities be given by the best teachers and that graduate students work closely with them to (1) make the undergraduate course as effective as possible, and (2) put conscious effort into the problems of teaching at the undergraduate level. When a number of students cooperate with a good teacher in the teaching of an undergraduate course they can learn much discussing their experiences in a small seminar. 109

Several respondents went so far as to urge that opportunities be made for the beginning teacher to have supervision by senior staff members during his first year of actual teaching in the small college as shown by the following suggestion:

Effective teaching can be aided after the Ph.D. is obtained if on the first job the instructor is given a chance to discuss his problems and get constructive criticism from an able teacher. 110


Some instructors expressed the feeling that graduate courses for prospective physics teachers should be taught, whenever possible, by members of the graduate faculty who are interested in teaching as well as doing research. The graduate physics departments should make a conscious effort to improve graduate teaching and to set examples of good teaching for the observation of graduate students. This can be accomplished to a marked degree, but the methods of graduate instruction differ considerably from those which are employed in undergraduate teaching. Observation of good teaching should be emphasized in the intermediate courses. Several suggestions, however, indicated the need for improvement of instruction in graduate physics departments. The following comments express this:

"The poorest teaching in the whole school system is found in the graduate school."\textsuperscript{111}

"My suggestion for the improvement of the Ph.D. degree program is better graduate school teachers."\textsuperscript{112}

The idea of a different type of degree or a degree with a different emphasis was suggested by some. One comment was to the effect that the degree for the prospective teacher should be made easier to obtain in the sense that it would not require four or five years and that a lengthy, highly specialized thesis should not be required. As stated by one instructor:

The best teachers I have studied under in high school, college, and graduate school are the ones who loved and enjoyed their work, not the ones who were the possessors of the most

\textsuperscript{111}Comment on a questionnaire from an instructor, August 25, 1958.

\textsuperscript{112}Ibid., a chairman of a physics department, July 27, 1958.
knowledge in their field. Let these do research and if they do not want to teach keep them out of the classroom.\textsuperscript{113}

One respondent went so far as to recommend a Ph.D. degree for physics teachers, one for experimental physicists, and one for high level theoretical physicists. The prospective teacher should concentrate on principles and let the research man master involved solutions to practical problems. In contrast to this, one instructor stated:

I don't feel that it should in any way differ or be weaker than the program followed by a Ph.D. candidate who intends to go into, say industrial research.\textsuperscript{114}

Most of the suggestions, however, were that the present Ph.D. program should be retained very much as it is, but that emphasis should be placed on preparation for teaching wherever it is possible to do so. Some who expressed this feeling did urge that the beginning graduate preparation be broadened to include other sciences, and some studies on the history and social implications of developments in physics. The Ph.D. degree for prospective teachers should also be less research centered. The inclusion of methods courses was suggested by a number of respondents. Generally, these should be in charge of physics staff members, but in some cases the respondent suggested the inclusion of science education professors. Such courses should cover teaching techniques, communication, and the use of various teaching aids.

Interviews with college deans, chairmen of physics departments, and physics instructors proved very satisfactory as a supplement to the comments and suggestions which were made on the questionnaires. One

\textsuperscript{113}Ibid., an instructor, September 26, 1958.

\textsuperscript{114}Ibid., an instructor, September 28, 1958.
feeling which was gained during the interviews was that many college ad-
ministrators think there should be mutual cooperation by various depart-
ments in efforts to improve instruction. Education departments can make
a contribution and should have a part in efforts to improve the effec-
tiveness of physics instruction, that is, in ways in which they may be
of help to physics staff members. Also the liberal arts college itself
must assume a part of the training of beginning teachers. One of the
greatest difficulties which deans reported was the inability of begin-
ning teachers to adjust graduate training to liberal arts college teach-
ing. As expressed by several administrators, the liberal arts college
teacher is more apt to appreciate the interests of the non-science major.
Consequently, he should have a broader preparation which would include
courses in other sciences.

Several deans expressed the desire for some preparation in social
studies with particular emphasis on the implications of science. This
was especially true in some areas of West Virginia where automation had
been strongly felt. As stated by one dean:

The inclusion of philosophy and the social implications of
science are very important in the preparation of physics
teachers. Such a course on the graduate level should come
after other courses have been completed so the student would
be able to relate the courses of physics to social develop-
ments. This is very important but it is not stressed as much
as it should be. It should not be left to chance on the part
of the graduate student. Definite courses should be planned. 115

The Assistant Dean at Berea College expressed much the same sentiment. 116

Many deans felt that the prospective teacher should have at least

115 Interview with Frederic W. Ness, August 26, 1958.
116 Interview, July 30, 1958.
one methods course. Some felt that these courses should be taught by physics professors or dual professors. As expressed by one dean it is unfair to the beginning teacher not to give him all the breaks possible to help him succeed. The chairman of a physics department in discussing the advantages of methods courses stated:

I think good methods courses would be very helpful. I doubt if physics professors would be qualified for this in very many cases. I think the preparation of teachers should also be an obligation of the employing college. We give some help, but it is not near as much as it should be.\textsuperscript{117}

One feeling that was encountered was that the beginning physics instructor is too highly specialized. This results in difficulties when the beginning teacher tries to adjust his teaching to general education courses at the undergraduate level. Many strong liberal arts colleges endeavor to educate the whole man. They stress a broad general education and seek faculty members with such training. At the same time they require a highly specialized Ph.D. degree in physics for members of the physics department. One dean, when asked what he felt was the greatest weakness in the preparation of college physics teachers for his institution stated in substance that the members of the physics staff were too highly specialized. They attempted to compete with the technical schools in their requirements for the general physics classes. Yet when this same dean was asked to indicate the type of graduate training he would recommend for prospective physics teachers whom he might employ, he stressed a rigorous Ph.D. degree with a highly specialized dissertation

\textsuperscript{117}Antioch College, July 12, 1958.
in a restricted field. He did favor internship training, but did not favor methods courses.

Some suggestions were made in regard to the nature of the dissertation. Several administrators very strongly favored a dissertation which would be suited to the needs of the individual but when asked to indicate the nature of such a degree very few had specific suggestions to make. Several felt that interpretive dissertations would be valuable for physics, but would not be very beneficial to the individual.

In summary, the interviews supplemented the answers obtained from questionnaires, but perhaps the greatest benefit derived from them was the feeling of rapport which was developed for the study. This was reflected in the replies from many instructors. The cooperation by most institutions was more than had been expected. A number of persons who were interviewed expressed considerable interest in this study and requested a summary of the results. Some expressed satisfaction with the fact that such a study was being made from the standpoint of physics rather than education and emphasized the need for greater cooperation between departments. The feeling that was gained during interviews was that liberal arts colleges recognize that the graduate departments are doing a good job, but they feel that improvements can be made in the preparation of prospective physics teachers. They are ready to do their part in helping to accomplish this.
Conclusions

We are living in a scientific or technological age which has developed within recent years.¹ This scientific development has been paralleled by economic, educational, industrial, and social progress which, in many cases, has been the result of the scientific development. Because of the importance of science and technology in modern culture much emphasis is being placed on the need for more science in education at all levels, not only for the future scientist but also for the non-scientist. But with the rapid development of physics and the demand for physicists for research and industry since World War II, there has been an insufficient supply of physicists to meet the demands of industry and educational institutions. Since industry has been in a position to pay higher salaries than the privately endowed educational institution the shortage has been more pronounced in liberal arts colleges than elsewhere.² If present trends continue, this shortage will become much more acute within the next decade when enrollments in colleges reflect the increase in the number of college age youth.³

Not only are liberal arts colleges faced with the problem of finding enough physics instructors to meet their needs, but also they find it difficult to obtain instructors who are prepared specifically to

¹Supra, pp. 4-6. ²Supra, p. 70. ³Supra, p. 10.
teach in their institutions, where the objectives are different from
those of the large university and where little if any research is carried
on. The physics instructor in the liberal arts college is faced with
the triple function of providing physics instruction for non-science ma-
jors, for science majors in other sciences, and for prospective physi-
cists. General education is currently being given much emphasis to over-
come the specialization which has developed in higher education during
recent years. Liberal arts colleges, which have had as one of their ob-
jectives the furtherance of a well-rounded education, are giving more
emphasis to this phase of higher education than they did in previous
years. Some engineering schools have entered into programs which permit
their engineering graduates to obtain a part of their education in the
liberal arts college. The development of atomic energy and the inter-
national implications which have resulted from its possible use in war-
fare, as well as the development of automation in industry have caused
greater emphasis to be placed upon the social implications of science
and technology. Thus the prospective physics instructor is faced with
the additional problem of being prepared to teach in a general education
program as well as in a technical program where his physics courses are
highly developed. This means that the prospective physics instructor
should be prepared in areas other than physics. In other words, he
should know why he is teaching physics as well as what he is teaching.

This study was undertaken in an effort to determine what is being
done to prepare physics instructors for the liberal arts college; what
are some of the qualifications most desired in prospective physics in-
structors for liberal arts colleges; what should be the difference, if
any, in the preparation of the prospective physics instructor in a liberal arts college and the prospective research physicist; and what can be done to improve the preparation of prospective physics instructors for liberal arts colleges. The study has been made with the assumption that prospective physics instructors will benefit from a graduate program for the acquisition of the Ph.D. degree which differs in some respects from the program which is followed by the prospective physicist who plans to enter research work or graduate teaching in a large university. Also, the study has been made with the hope that a graduate program which is planned to prepare prospective physics instructors will help to alleviate the shortage of physics teachers in liberal arts colleges during the next few years. A total of eighty-two institutions which stress a liberal arts college program, located in the states of Indiana, Kentucky, Michigan, Ohio, Pennsylvania, and West Virginia were contacted, and a total of seventy-one, or 87 percent of these, participated in the study. One hundred and seventy-three physics instructors were contacted, ninety of whom, or 52 percent, participated in the study.\(^4\) The investigation was divided into three phases. First, a survey was made of the literature to determine what is being done to prepare physics instructors specifically for liberal arts colleges. Next, questionnaires were submitted to deans, chairmen of physics departments,

\(^4\)Table 2, p. 72.
and physics instructors to obtain information on the preparation of prospective physics instructors in the following areas:

1. Qualifications, strength and weaknesses
2. Academic preparation
3. Professional preparation
4. Research training

A third phase of the study was devoted to interviews with representative deans, chairmen of physics departments, and physics instructors. Approximately forty interviews were held, at which such problems as the qualifications administrators desire in their physics instructors, the academic and professional preparation they should have, and the nature of their research work were discussed.

The survey of the literature revealed that, while some spasmodic efforts have been made to improve the preparation of college physics instructors, no concerted efforts have been made on the part of many graduate physics departments. This situation has been recognized in several studies made by such groups as the President's Commission on Higher Education, the National Education Association, the Chicago Conference in 1949, and the American Institute of Physics Committee on the Preparation of College Teachers. Quotations from the reports of two of these studies give a good summary of the current situation. The American Institute of Physics Committee stated in part:

In considering the preparation of students for the college teaching profession, the committee is inclined to believe that the teaching outlet for graduate students is, at some place, given scant or disparaging attention. Nevertheless

---

5Supra, p. 13. 6Supra, p. 22.
7Supra, p. 45. 8Supra, p. 83.
it is everywhere recognized that without college teaching—
good college teaching — we would fail to maintain or
strengthen the source of our scientists.9

The President's Commission on Higher Education made the following com-
ment on the amount of preparation given prospective college teachers:

The most conspicuous weakness of current graduate programs
is the failure to provide potential faculty members with the
basic skills and the art necessary to impart knowledge to
others. College teaching is the only major learned profes-
sion for which there does not exist a well defined program
of preparation directed toward developing the skills which
it is essential for the practitioner to possess. The ob-
jectives which higher education seeks to achieve cannot be
reached unless there is realism in the program for preparing
teachers.10

The preparation of college teachers was recognized as one of the
functions of the graduate school when Johns Hopkins University was
founded.11 However, since early graduate schools were patterned after
the German university, training for research became one of their major
objectives.12 With the development of research during the two world
wars graduate programs in physics became largely research centered and
were planned to meet the needs of the research physicist.13 Three peri-
ods have occurred in which efforts have been made to improve the prepa-
ration of college teachers, but except for the fact that these spasmodic
movements did cause a few colleges to establish programs for the prepa-
ration of college teachers, their effects were short-lived.14 With a
few exceptions the programs which have been developed have emphasized
the humanities or social studies.15 The present status of the training

\[ ^{9}\text{Supra, p. 83.} \quad ^{10}\text{Supra, p. 13.} \quad ^{11}\text{Supra, p. 34.}\]
\[ ^{12}\text{Supra, p. 31.} \quad ^{13}\text{Supra, p. 19.} \quad ^{14}\text{Supra, p. 15.}\]
\[ ^{15}\text{Supra, p. 64.}\]
of prospective physics teachers for liberal arts colleges is summed up in the following statement:

One must conclude from the criticism and from the abundance of the literature that something has been amiss in the last half century and that probably the art and science of teaching have been neglected. It is not surprising that this is true when one considers the almost complete dedication to specialization and to scientific research in American higher education during the last half century.\(^1\)

Not only has very little been done toward professional preparation of physics instructors, but also a problem exists in the preparation of prospective teachers for general education programs in liberal arts colleges. The Committee of Fifteen recognized this situation in its report.\(^2\) The young physicist who has pursued a highly specialized course is normally not prepared to carry out the objectives of a general education program in science as outlined in a recent study.\(^3\) The physics instructor must be prepared to present the fundamentals of a science which has mushroomed in the past twenty-five years to non-science liberal arts students who may have no great enthusiasm for its study. The survey of the literature has revealed that very little has been done specifically to prepare the prospective physics instructor for teaching in general education science programs, or to make his students aware of the historical and social implication of developments in physics. The major complaints or criticisms of present graduate programs are that (1) too much emphasis is placed on research, (2) the graduate student is given a limited cultural outlook, and (3) little or no provision is made for preparation for teaching in a liberal arts college.\(^4\)

\(^1\)Supra, p. 19. \(^2\)Supra, p. 102.
\(^3\)Supra, p. 104. \(^4\)Supra, p. 16
Some steps have been taken toward improving the situation. Several organizations such as the National Science Foundation,\(^{20}\) the Woodrow Wilson National Fellowship Foundation,\(^{21}\) and the Danforth Foundation\(^{22}\) have made substantial grants for college teachers and prospective teachers. Initially many of these grants placed emphasis upon the humanities and the social studies, but recently they have been extended to include the sciences.\(^{23}\) The Fund for the Advancement of Education is sponsoring an internship program in a number of liberal arts colleges.\(^{24}\) Leading physicists have demonstrated they feel some action should be taken by the interest which has been shown in problems pertaining to teaching. Several conferences, such as the one at Northwestern University\(^{25}\) on laboratory instruction, and the meeting at White Sulphur Springs, West Virginia\(^{26}\) on problems in physics education, indicate that physicists are aware something must be done to meet the impending crisis in physics education.\(^{27}\) Although the formation of the Physical Sciences Study Committee at Massachusetts Institute of Technology was established to formulate a modernized course in physics at the secondary level it is indicative of the need and of what could be done at the college level.

Various publications and studies reveal that some very good programs for the training of college teachers are in operation. However, most of these programs are departmental in nature and are not planned for the physics student. Some typical programs that are in operation

\(^{20}\) Supra, p. 63. \(^{21}\) Supra, p. 61. \(^{22}\) Supra, p. 60.

\(^{23}\) Supra, p. 62. \(^{24}\) Supra, p. 59. \(^{25}\) Supra, pp. 77-82.

\(^{26}\) Supra, p. 67. \(^{27}\) Supra, pp. 67-68.
which provide for the preparation of college science teachers are at Vanderbilt University, Syracuse University, Oregon State College, and Michigan State College. The programs at these institutions have some very commendable features. The great disadvantage is that not many graduate physics students have participated in these programs. Those students who have are enthusiastic about them, and are rated as very effective liberal arts college teachers by administrators. However, there seems to be a reluctance on the part of students to vary from the conventional Ph.D. degree because it requires a longer period of study, or it requires a mastery of three sciences, or the degree will not have the prestige accorded the conventional Ph.D. An excellent program is sponsored by the staff at the Pennsylvania State University Physics Department, but those in charge of the program realize it needs more sympathetic cooperation with other departments particularly the Department of Education. The Northwestern Conference found that the laboratory instruction in which graduate students participate varies from a well planned program which is well supervised and supplemented with conferences and seminars as at Pennsylvania State University to little or no supervision.

In summary, a survey of the literature has revealed that graduate schools have developed with primary emphasis on research. At the pres-
ent time not many graduate physics departments make a concerted effort to prepare prospective physics instructors to teach in a liberal arts college or for general education programs. Physicists have had a large part in developing a technological age, but have done very little to help society adjust to these technological developments.

Information which was obtained from questionnaires that were completed by participants in the study and from interviews with participants further corroborates the fact that a problem exists in the preparation of physics instructors for liberal arts colleges, and gives some suggestions for improving the situation. Replies from deans and chairmen of physics departments in participating institutions indicate that they most frequently desire the following qualifications in physics teachers whom they employ:

1. A thorough preparation in physics
2. An excellent preparation in mathematics and other sciences
3. A good liberal education
4. An excellent scholastic record
5. An enthusiasm for and a dedication to teaching
6. A sympathetic understanding of college age youth
7. The ability to develop reflective thinking on the part of students
8. The ability to raise the level of accomplishment of students
9. An appreciation for and an understanding of the place of physics in higher education
10. An interest in maintaining and improvising equipment

Replies further disclosed that the majority of the beginning physics instructors in participating institutions have many of the academic qualifications which are desired. On the other hand a large percentage of

---

\(^{40}\) Supra, pp. 125-127.  \(^{41}\) Supra, p. 126.
the recent Ph.D. graduates had exhibited weaknesses in several areas.

The areas of weakness and percentages are listed:

1. An interest in maintaining equipment 40%
2. The ability to adapt instruction to the needs of students 40%
3. The ability to adapt graduate training to undergraduate teaching 40%
4. An adeptness in counseling and advising students 40%
5. A good liberal or general education 27%
6. The ability to speak and enunciate well and with the proper modulation 27.3%

Instructors also recognized certain deficiencies in their preparation when they began college teaching. Several areas in which difficulties were encountered by recent graduates in the order of their occurrence are noted:

1. The development of reflective thinking by students
2. The development of student interest in and the enthusiasm for physics
3. The adaptation of graduate preparation to undergraduate teaching
4. The utilization of films, demonstration equipment and other teaching aids
5. The adaptation of instruction to the needs of students
6. A proficiency in methods of testing and grading students
7. Adeptness in counseling and advising students
8. An adequate preparation in allied sciences

A study of this information reveals that present programs for the acquisition of the Ph.D. degree give prospective teachers excellent preparation in the subject matter of physics and in research work. There are certain areas, however, in which there are weaknesses or deficiencies in the preparation of physicists for teaching in liberal arts colleges. These pertain largely to problems of instruction, and include such factors as (1) teaching for reflective thinking, (2) adaptation of

\[ \text{supra}, \text{pp. 131-32. supra, pp. 135-36.} \]
instruction to the needs of students, (3) the use of audio-visual aids, (4) testing and evaluating, and other problems of a pedagogical nature.

A rather striking observation is that competence in research ranked twenty-one in a list of twenty-two qualifications which are desired by administrators in physics instructors whom they employ. This was found to be one of the seven areas in which physics instructors were best qualified. This should not be interpreted to mean that administrators do not desire prospective physics instructors to have experience with research, but that there is not a great need for competence in research in the liberal arts college. The implication which may be drawn from this is that more emphasis is placed on research in the graduate school than liberal arts colleges find the need for in physics instructors who teach in their institutions. It will be recalled that only 10 percent of the deans and chairmen of physics departments who made a distinction in characteristics or qualifications they desire in their physics instructors included competence in research as one of these qualifications.

It will be noted also that a large percentage of the administrators in participating institutions desire physics instructors who have the ability to develop reflective thinking by students. Yet over 50 percent of all reporting instructors found this to be the area of their greatest difficulty. In fact, this difficulty was encountered by more than double the number of instructors who encountered difficulty in the

---

area which ranked second. When it is realized that very little change has occurred in the teaching of intermediate physics courses during the past fifty years it can be seen why this difficulty occurs. As stated by one physicist:

As now set up, the best that one can get apart from mere accumulation of factual information, is a degree of quantitative analytical discipline.

Replies from respondents indicate that both administrators and physics instructors prefer graduate preparation that emphasizes physics and mathematics, with specialization in some field of physics. They feel that the inclusion of other sciences in the preparation of prospective physics teachers is desirable, but that there is hardly time for these courses at the graduate level. Most respondents indicated that these courses should be taken at the undergraduate level. The same response was given to the inquiry regarding allied sciences. Generally all respondents expressed a desire for prospective teachers to have courses at least on the undergraduate level in astronomy, chemistry and the history of science. The same response was received for interdepartmental programs which would stress the economic, social, or historical implications of developments in physics. Respondents frequently expressed the feeling that these courses would be very desirable, but that they should be taken at the undergraduate level, or at least no graduate credit should be given for them. A significant observation which may

---

49 Supra, pp. 67-69.
51 Supra, p. 139. 52 Supra, p. 143. 53 Supra, p. 146.
be made is that instructors who had such courses at the graduate level had found them to be very valuable in their teaching. This was particularly true of courses in the history and philosophy of science. While only 11 percent of the responding instructors had such courses, approximately 75 percent of these had found the courses very valuable. Also, when instructors were asked to indicate those courses they did not have in their graduate program, but which they felt would have helped them, approximately one-third of all instructors mentioned a course in the history and philosophy of science. It would appear that the nature and content of such courses is not fully understood by personnel in liberal arts colleges. The fact that instructors who have had such courses find them valuable, and one out of three who have not had them find a need for them is an indication that some consideration should be given to their inclusion in the graduate program.

Deans and chairmen of physics departments were more in favor of seminars and methods courses generally than were physics instructors. Of the four types of seminars which respondents were asked to evaluate a greater percentage favored a seminar or methods course which would be taught by a well-qualified physics professor. The most frequent rating given a seminar taught by a well-qualified physics professor was desirable. The ratings given seminars taught by science education professors, seminars devoted to other sciences as well as physics, and seminars devoted to higher education was neutral. However, instructors who had such courses generally found them to be very desirable. It would seem

\[5\text{th supra, p. 155.}\]  \[55\text{th supra, p. 139.}\]
that the most desirable arrangement would be to have a seminar taught by a well-qualified physics professor, but as one departmental chairman who preferred science education professors remarked, it is questionable whether physics professors are qualified for this.\textsuperscript{56} The fact that those instructors who had seminars generally found all of them very desirable indicates that the neutral answers which were obtained were due largely to a lack of information as to their nature or a prejudice against methods courses. The number of instructors who had seminars in higher education, 8 percent, was insufficient to arrive at any conclusions. The most frequent rating of this seminar was neutral.

Not many respondents favored a program in which the graduate student taught class or laboratory sections with little or no supervision. In fact, the majority indicated that it would be undesirable. Some instructors who had such an experience found that it was desirable.\textsuperscript{57} Such a method of teaching gives the instructor an opportunity to take full responsibility for a class. It also provides opportunity for the instructor to acquire bad habits which could be corrected if he taught under proper supervision.

Teaching experience with supervision by physics professors in class and laboratory sections was most frequently given a rating of very desirable by instructors.\textsuperscript{58} However, only 56 percent of all instructors had the experience, 80 percent of whom rated it very desirable and 18 percent desirable, or 98 percent rated it desirable or higher. The overall rating of this experience was very desirable. Yet only a little

\textsuperscript{56}\textsuperscript{57}\textsuperscript{58}
over 50 percent of the instructors included in the study had such experience. This does not mean that only about 50 percent of the graduate schools provide such training, but since a number of instructors had over eleven years experience, many of them had not had an opportunity for this experience.\textsuperscript{59} Almost 70 percent of recent Ph.D. graduates indicated that they had the experience.\textsuperscript{60} The significant fact is that 98 percent of those who had the experience found it desirable. The same situation existed in regard to an experience in which the prospective teacher observed a well qualified physics instructor teach. The most frequent rating given such an experience by all respondents was desirable but nine-tenths of the 65 percent of instructors who had the experience rated it as very desirable.\textsuperscript{61} While some instructors who had the experience felt that seminars which were devoted to current problems the student faced or work in an industrial plant were very desirable experiences, the majority of all respondents felt that these experiences would be desirable.\textsuperscript{62} The general feeling of respondents regarding teaching experience may be summed up in the following comment by a physics department chairman:

Items 3, \( h \), and \( 5^3 \) would represent a real contribution to one of the most glaring needs of many graduate programs. Perhaps the worst feature of the present system is not the lack of such experience but the fact that often the young Ph.D. in physics, for example, feels more sense of 'virtue in this lack of \([E]dication.\textsuperscript{64}

Another interesting development disclosed in the response to the inquiry about seminars and methods courses was that when asked if there were a

\footnotesize\textsuperscript{59} Supra, p. 187. \textsuperscript{60} Supra, p. 176. \textsuperscript{61} Supra, p. 178. \textsuperscript{62} Supra, p. 181. \textsuperscript{63} Supra, p. 173. \textsuperscript{64} Supra, p. 180.
combination of such courses they would desire over 40 percent of all beginning instructors indicated that they preferred the above combination.65

Of four types of dissertations which respondents were asked to rate those which called for (1) original research in a restricted phase of physics, (2) research which would overlap other sciences and broaden the student's knowledge of experimental procedures, and (3) original research which was planned to meet the specific needs of a person preparing for college teaching, rather than research, were each given a desirable rating.66 It is rather interesting to note that only 34 percent of all respondents felt that the first type of dissertation was very desirable. Apparently there was very little difference in the preference for the three dissertations. Less than 15 percent felt that any one of the dissertations was undesirable. Generally deans and experienced instructors tended to give the second and third types of dissertation a higher rating than did beginning instructors. This difference may be accounted for in two ways. It may be an indication that the experienced instructors had a better conception of the needs of the liberal arts college than the beginning instructors. Also, the beginning instructors were in a position to recall more readily their own graduate work. The fourth type of dissertation, which was of an interpretive nature, was most frequently given a neutral rating. Although 45 percent of the respondents felt that it would be at least undesirable67 only 20 percent felt that it would be desirable. From comments, it is believed that some who gave a

65 Supra, p. 184. 66 Supra, pp. 190-93. 67 Supra, p. 194.
rating of neutral or undesirable were not fully aware of the nature of this type of dissertation, and that under some conditions it would be considered favorable by them. Comments generally were that the dissertation should represent original research, and should be of value to the individual doing the research. Also, comments that it should be aimed at improving the teaching of physics were predominant.

As a further check on the nature and value of the dissertation, instructors reported that their dissertations generally were of one of three types: (1) theoretical; (2) experimental; and (3) teaching or demonstration. Of these, the first had been used by about 20 percent of the instructors for further research. The same was true for the second type. The third type had been utilized by about one-third of the instructors performing the research. Only 35 percent of all instructors indicated that they felt the Ph.D. was essential for college teaching. Of those who did not feel that it was essential, 85 percent felt that a rigorous M.S. degree with a thesis in pure or applied physics would be sufficient.

68 Supra, p. 193. 69 Supra, p. 197.
Recommendations

There is such a wide variation in the areas of physics which are emphasized and the graduate policies which are followed by graduate physics departments that it would be difficult to plan a detailed graduate program in physics which would be suitable for all graduate physics departments to follow in the preparation of prospective college physics teachers. Furthermore there is a great variation in the needs and interests of prospective college physics teachers. Also most graduate physics departments have taken some steps from a purely pedagogical standpoint to help prepare college teachers in the mechanics of teaching. The amount of attention which is given this varies with the institution. Some of the most frequently employed procedures in the order of the frequency of occurrence are the following:

1. The supervision of laboratory instruction by a senior staff member
2. The participation by graduate assistants in regularly scheduled conferences with senior staff members
3. The supervision of recitation and classroom instruction periods by senior staff members
4. The attendance at a teaching seminar where teaching methods and allied topics pertaining to the teaching of physics are discussed
5. The attendance at a formal course in which provisions are made for attending students to make a presentation for criticism and discussion by fellow students and senior staff members

In view of these conditions it is felt that any recommendations which are made for the improvement of the preparation of prospective college physics teachers should be sufficiently general for them to be incorporated in existing programs. At the same time they should be sufficiently specific to insure that prospective physics teachers for liberal
arts colleges will be prepared to do effective teaching at the undergraduate level. Consequently, on the basis of the above findings and observations, recommendations are being made with the hope that they will insure greater emphasis on the preparation of college physics teachers for their specific duties, and that they will partially alleviate the present and future shortage of qualified physics instructors for our liberal arts colleges. As a concomitant result it is hoped that improvement in physics instruction at the undergraduate level will increase the number of undergraduate students who enter the field of physics. Furthermore it is realized that generally graduate physics departments provide very excellent specialized preparation in physics which should be fully utilized to the extent needed to give thorough preparation in the fundamental fields of physics and to train the prospective physics teacher as a physicist as well as a teacher-scholar.

1. Graduate physics courses of study for prospective college physics instructors in liberal arts colleges should be sufficiently flexible to prepare them to teach any undergraduate and intermediate senior-graduate level course offered in undergraduate physics departments.

Liberal arts physics instructors should be prepared to teach all intermediate physics courses. The physics staff is generally limited to two or in some instances one instructor. It is essential that the prospective teacher have an excellent foundation in the fundamentals of basic physics. This should include a sound foundation at the intermediate graduate level in all areas of classical as well as modern physics and electronics. Advanced laboratory work should be taken in all basic fields of physics to insure that the prospective college teacher is thoroughly familiar with laboratory techniques and procedures which may
be used in senior undergraduate courses in the liberal arts college. These courses should be taught by the best graduate instructors on the staffs of graduate physics departments and preferably should be taught by instructors who have a vital interest in and a concern for the preparation of college physics teachers. The student should be constantly reminded of aspects of the graduate study which are applicable to undergraduate teaching or have a direct bearing upon undergraduate teaching. Conscious efforts should be made to exemplify excellent teaching and the utilization of various methods of teaching in these intermediate graduate courses where appropriate. At least one question on the examination should be devoted to the teaching of the course to make students aware of the problems of college physics teaching.

2. Sufficient study should be required in mathematics to enable the prospective college physics instructor to have a grasp of the fundamental mathematical principles involved in intermediate graduate physics courses.

Mathematics courses pursued by the prospective undergraduate physics teacher should include all basic undergraduate and senior-graduate courses in the areas of calculus, differential equations and matrix algebra which are needed for a study of modern physics. Any courses in mathematics beyond the senior-graduate level should be planned primarily for the needs of physics students who plan a career in undergraduate teaching rather than a career in research or engineering. Sufficient mathematics courses should be included to insure an understanding of the basic principles involved in fundamental fields of physics and to prepare the prospective teacher for teaching courses in undergraduate mathematics. Generally physics departments require sufficient mathematics
for all graduate students. Consideration should be given to the elimination of more advanced courses in mathematics for the prospective college physics teachers who plan on teaching careers at the undergraduate level.

3. Beyond requiring a broad understanding of the major subdivisions of advanced courses in physics and a general understanding of the fundamental principles of mathematics there should be no rigid course requirements for graduate study of prospective college physics teachers.

Sufficient flexibility in the academic preparation of prospective physics teachers should be permitted for those students who have a need for it to take courses in allied sciences such as chemistry and astronomy if the student does not have a sufficient background in these areas. The interdepartmental programs at Michigan State University and the University of Syracuse are good examples of provision for a broadened education in the sciences. The Committee on the Preparation of Teachers at the University of Chicago in 1948 made recommendations for a broader preparation in the prospective college teacher's field of concentration. As previously indicated several studies have advocated a broader preparation for the teacher who will be responsible for the teaching of science in a general or liberal arts education program.

4. The preparation of prospective college physics teachers should be planned to provide a broad liberal education.

This recommendation is made as a corollary to Recommendation 3. Prospective instructors for the liberal arts college should have a liberal arts background. Many industries and engineering firms are encour-

---

70 Supra, p. 56. 71 Supra, p. 53.
72 Supra, p. 48 73 Supra, pp. 8, 73, 103.
aging their prospective employees to obtain at least part of their education in an environment where a broad cultural background is provided. It is just as essential, if not more so, that prospective faculty members for an institution which has this as one of its objectives be provided with a broad cultural background. Several steps can be taken to accomplish this. In the first place physics instructors for the liberal arts college should have an undergraduate preparation in a liberal arts college. In order to insure this steps should be taken to determine early in the physics major's career whether he has the aptitude and the qualifications for college physics teaching. Other professions such as medicine and engineering have developed aptitude tests which in some cases are administered during the early part of the student's undergraduate training. If a policy of recruitment and selection were established it would make it possible for the prospective physics instructor to plan his undergraduate program to broaden his training. Additional broadening courses could be taken during the junior and senior years. Many administrators and physics instructors who participated in this study indicated that they recognize the need for such training, but they feel that such courses should be taken on the undergraduate level. In cases where the graduate student plans on an undergraduate teaching career in physics but has not had sufficient preparation in allied areas to give him a broad preparation in sciences other than physics a minimum of such courses should be taken in the graduate program.

\[\text{Supra, p. 143.}\]
Prospective college physics teachers should take at least one course at the graduate level in the general area of the history, philosophy, or social implications of physics.

Very few undergraduate physics departments are prepared to offer such courses and it is doubtful if the undergraduate student is sufficiently mature scholastically to grasp such a course sufficiently at the undergraduate level to be proficient at teaching it himself. A course of this nature should be taken after the graduate student has completed much of his graduate work. The student will gain a much better perspective of the implications of scientific or technological developments. One method of providing such training would be through post-doctoral summer institutes at such schools as Harvard University and the University of Wisconsin, both of which institutions have strong departments in the history and implications of scientific developments. In some cases the individual graduate student may make a study of the social and historical problems in physics in a seminar course. However, a definite program such as that followed at Syracuse University should be given consideration in planning for the provision of the social implications of physics. This is an area in which very little has been done, but one which should be given definite consideration rather than being left to chance. As shown earlier, a large percentage of the instructors who had not had such courses found a need for them in their liberal arts college teaching; those who had such courses found them very valuable in their teaching.

---


Supra, p. 155.
6. Prospective college physics instructors should be required to include a study of the problems and methods of teaching college physics. This work should include the following:

   a. The purposes and nature of higher education and the place of physics in higher education
   b. The importance of personal relationships with faculty members, students and the administration, with particular emphasis on student needs and the problems of college youth
   c. The employment of effective speech and enunciation
   d. The development of laboratory, lecture and demonstration skills.
   e. An understanding of techniques for testing and measurement
   f. The utilization of audio-visual aids and demonstration and laboratory techniques.
   g. An understanding of the basic principles of counseling and advising.
   h. A knowledge of the social psychology of the classroom insofar as it pertains to motivation, and securing a high working morale

In order to obtain the above objectives several types of courses should be organized or developed on the basis of courses or seminars which are now being taught in physics departments or other departments in the graduate school. One area in which a number of instructors have suggested the inclusion of a course is intermediate between elementary physics and beginning senior-graduate courses. Such a course would permit the incorporation of many of the above objectives. It is, therefore, suggested that an advanced general physics course which covers all fields of fundamental physics be required at the beginning of the graduate program for the prospective physics instructor. The course should be taught by one or more senior members of the physics department who are recognized for their skill in teaching. The objectives of such a course should be the following:

   a. To afford the prospective teacher an opportunity to observe a physics course being taught by a skilled teacher or teachers who use all methods and techniques of effective teaching
   b. To give the student a thorough foundation in all basic fundamentals of physics
c. To afford the student an opportunity to teach under conditions where he would be subject to the sympathetic criticism of fellow students and senior staff members.

d. To provide an opportunity for the prospective teacher to learn the techniques and methods which may be used in a general physics laboratory.

If this course was properly organized it would do much to provide for sections c, d and f and to a limited extent sections e and h of Recommendation 6. If this course were made sufficiently thorough, historical applications could be included as part of the additional study.

The primary purpose of the course should be to study the methods and techniques of effective college teaching. However, the course should be sufficiently thorough that it would insure a strong foundation in basic "sophomore" physics for the beginning graduate student.

The conventional general physics laboratory should not be included with this course. Instead, there should be a laboratory seminar in which various methods of conducting a laboratory are discussed and demonstrated by class members and staff personnel in charge of the course. One of the primary purposes of this laboratory seminar would be to develop ways of conducting general physics laboratory sections so that students would be led to do reflective thinking rather than to follow routine instructions.

Students should be expected to make at least three class presentations during the year and preferably five, in the recitation section of the course. The first of these presentations should be short but the final one should include an entire class period. Sufficient time should be provided during the period for a discussion and criticisms of the student-instructor's presentation. A rating sheet should be utilized
for appraising the effectiveness of the presentation. Such factors as
voice control, enunciation, mannerisms, class contact, the use of visual
aids, enthusiasm and other problems of a pedagogical nature should be
considered in the rating and discussions. An after-class conference
with one of the faculty instructors should be arranged when this is con­
sidered wise. While this course should be in charge of a member of the
physics department the assistance of members of the science education
department or other interested staff members in the education department
should be solicited. Where dual professors or science education profes­
sors are qualified to teach college physics courses at the advanced un­
dergraduate level they should assist in the instruction of the course.
All prospective physics instructors should be urged to take such a course.
It should be open to other graduate physics students on a voluntary ba­
sis. Graduate credit should be given all prospective physics teachers
for the course.

In order to provide for the other objectives which were enumerated
in the sixth recommendation77 a seminar type course, including several
topics, should be organized, preferably on a university basis with the
cooperation of other departments and in conjunction with the department
of education:

a. The purpose and nature of higher education and the place of
physics in higher education
b. The relationship of the prospective faculty member to other
faculty members, administrative officers and students with particular
emphasis on problems of student interests and needs
c. The principles of testing and measurement
d. The duties of counseling and advising
e. The principles of psychology as applied in the classroom

77 Supra, p. 236.
If this course is organized to include several departments it should be under the control of the graduate school with a well qualified member of the graduate faculty who is particularly interested in college teaching, or a faculty committee in charge of the course. If the course is organized by the physics department it should be in charge of a member of the department. Instruction in various topics should be under the direction of specific departments or individuals who are well qualified in the specific area. Registration for this course should be on a voluntary basis but all prospective physics instructors should be strongly urged to take it. Graduate credit should be given for this course.

7. The prospective physics teacher for the liberal arts college should have research training of such a nature and scope that it will lead him to utilize a variety of the techniques and materials which he eventually will employ in teaching physics, and it should develop skills and interests which will be of value to him as an instructor in a liberal arts college.

The responses to questionnaires indicated that the greater percentage of deans and physics instructors who participated in the study made very little distinction in a dissertation that was devoted to a restricted field of physics, one that was interdepartmental in nature, or one that was experimental but suited to the needs of the individual. The majority of all replies indicated that the dissertation should be experimental and should call for original research. However, the fact that many deans indicated that a dissertation which is suited to the needs of the individual would be desirable gives evidence that its purpose should be to benefit the individual. The Committee of Fifteen in its study of the graduate preparation of college teachers made a similar

78 Supra, pp. 190-92.
recommendation. Interviews with college deans revealed that generally they would prefer a dissertation which could be utilized by the instructor in the liberal arts college. Few respondents had any definite convictions as to what should be the nature of such a dissertation. It will be recalled that competence in research ranked twenty-one in a list of twenty-two qualifications desired by administrators in physics teachers whom they employ. It would seem that further study should be made to determine what should be the nature of a dissertation that would meet the needs of the instructor who plans to enter undergraduate college teaching.

On the basis of the utilization which instructors reported they had made of the work they pursued in their research training it is recommended that the dissertation be of such nature as to utilize equipment that is standard or can be improvised at reasonable cost. This will permit the prospective physics instructor to continue research to a limited extent along with his teaching duties if he desires. The subject of the research work should not be so restricted or so extensive in a restricted field that it will develop the prospective physics instructor as a specialist in a restricted field of physics. It should normally not require more than one year of full-time intensive study. The requirement that the dissertation be a definite contribution to knowledge should be considered largely in the sense that it is a contribution to the knowledge of the individual. The actual subject of the dissertation is not of as much importance as the training it gives the researcher.

---

Some of the major objectives of research training for college physics instructors are the following:

a. It should develop skill in research methods.

b. It should develop a source of future interest in experimental work.

c. It should require the collection, synthesis and interpretation of a reasonable amount of information of a scientific value.

d. It should make a definite contribution to the graduate training of the prospective college physics teacher.

The dissertation should be selected with the above objectives in mind and it should be considered not as an end in itself but as one of the steps in the training of the undergraduate physics instructor. The future needs and interests of the prospective physics instructor should be given consideration in the selection. In a limited number of cases where the individual has had sufficient experience in experimental work for effective undergraduate physics instruction a dissertation of an interpretive nature may be of greater value to the individual and to physics in general than a purely experimental research topic. In all cases the dissertation should be supervised by faculty members who have a definite interest in the preparation of college physics instructors.

8. All prospective physics instructors with the possible exception of those who have had extensive prior teaching experience, should be required to teach class and laboratory sections under the supervision of qualified physics staff members who are accomplished undergraduate teachers, preferably through class visits and conferences.

This form of preparation is the one most commonly found in graduate physics departments. The amount of supervision varies from practically none to the organized supervision which is provided at schools like Pennsylvania State University. The apprentice teaching should

80Supra, p. 79.
come after the completion of the training in Recommendation 6 has been completed. All recitation and laboratory instructors should report for an orientation period at which time they would be familiarized with the general policies and procedures of the department. They should also meet with the regular staff when appropriate. Qualified staff members who are also teaching similar class or laboratory sections should be assigned supervisory duties with the student instructors with an equivalent reduction in their teaching load as is the practice for faculty members who supervise graduate research. The supervision should consist of class visits and group as well as individual conferences.

It is recognized that from a scientific standpoint it is difficult, if not impossible, to have class visitation without altering the class situation. The student instructor should be informed in advance of the first visits and efforts made to maintain the normal conditions of the classroom. No recognition should be given to the fact that a visitor is present in the classroom. An excellent procedure would be for student instructors to visit each other's classes for the purpose of making helpful criticism of the teaching. Subsequent visitation by the staff supervisor should be unannounced. All visitation should be preceded and followed by group and individual conferences. Instead of class visits an objective rating sheet prepared by the supervising staff members and the student instructors could be utilized for objectively evaluating the teaching performance of each instructor. The supervising instructor should discuss the results of the rating with the instructor to commend good points and to indicate measures which should be taken to
improve the class or laboratory instruction. Efforts should be made to create an atmosphere of sympathetic understanding and helpfulness on the part of the supervising staff member in order that he may be of maximum help to the student-instructor.

All visits should be followed by an individual conference even though the student-instructor exhibited excellent teaching. The individual conference should be a time when the student-instructor is commended as well as cautioned on improvements he should make. In many cases pointing out commendable qualities may be more valuable than calling attention to deficiencies, many of which are already known by the instructor. The group conferences should be devoted to discussions of such topics as (1) procedures and techniques for effectively teaching physics, (2) special laboratory and demonstration techniques, (3) the preparation and grading of tests and other measuring devices, and (4) problems encountered by instructors in their class or laboratory sections, or other problems pertaining to the teaching of physics.

9. Graduate physics departments which have not done so should make a study of their own situation and formulate definite plans for the preparation of college physics instructors.

The study made by the Committee on the Preparation of Teachers at the University of Chicago or the programs at the Pennsylvania State University, Syracuse University or Oregon State College are good examples of adaptation of a program to the particular institution. The most important feature in the preparation of prospective undergraduate physics teachers is that a definite plan should be formulated and definite

---

81 Supra, p. 79. 82 Supra, pp. 48, 53, 58.
attention given to this. No single plan will work in all departments or with all faculty members. However, it is a problem which should be given more attention by physics departments than it is now given by many of them. Most physics departments have a physics colloquium at which departmental research projects are discussed. This could be extended to include a discussion of college physics teaching problems as is done at one physics department. Outstanding physicists, educators, and psychologists could be asked to lead in such discussions. Administrators in employing institutions should also be included in the discussions. In this way members of the department will become much more conscious of the problems of the physics instructors in the liberal arts college and will be much more sympathetic toward efforts to establish an effective program for the preparation of college teachers.

10. Consideration should be given to the possibility of improving the present Master of Science degree so that it will prepare prospective physics instructors for institutions which do not make a fixed requirement of the Ph.D. degree.

The increased enrollment within the next few years, the decrease in the number of available physicists with the Ph.D. degree at a time when enrollments have increased, and the increase in the number of junior colleges will inevitably cause a number of physicists with only a Master of Science degree to be employed in the smaller liberal arts colleges. At least 85 percent of those respondents who indicated the Ph.D. degree is not essential for college undergraduate physics teaching indicated further that a rigorous Master of Science degree should be sufficient. Such a degree should include the fundamental courses in all basic fields
of physics. In addition, it should include an experimental dissertation in pure or applied physics. Sufficient courses or seminars and training of a professional nature should be included to prepare the student for teaching physics at the undergraduate level. Approximately two years of concentrated study should be required for the completion of such a degree program. The essential difference in this degree and the Ph.D. degree would be in the elimination of the time required for the completion of a dissertation.

While it is realized that the above recommendations can hardly be applied in all physics departments it is believed that many of them can be utilized to good effect. They will do much to correct certain deficiencies that now exist in some graduate physics departments in the training of physics instructors for liberal arts colleges. This is particularly true for prospective physics teachers who may teach in a general education program.
Recommendations for Further Study

This study has not included several important phases of the preparation of prospective college physics teachers. It has been restricted to a study of programs which lead to the acquisition of the Ph.D. degree. Further study should be made of (1) recruitment, (2) selection, and (3) in-service training. College teaching is one of the professions for which no formalized method of selection has been developed. Medicine and engineering, for example, have aptitude tests as one means of selecting recruits for training for these professions. Their training is then planned for the profession. A study should be made to ascertain what steps should be taken in the selection and recruitment of prospective physics instructors for liberal arts colleges. The results of such a study should lead to an improvement in the training of college physics instructors and should increase the interest of undergraduate physics students in a possible career in teaching. Very little consideration has been given to in-service training. The National Science Foundation and the Fund for the Advancement of Education have taken steps to encourage this. Participating individuals and institutions are enthusiastic about the programs they are sponsoring.

This study has revealed that one of the greatest difficulties encountered by instructors included in the participating institutions when they first began teaching was the inability to develop reflective

84 Supra, pp. 62-63.
Administrators indicated this was one of the top seven qualifications they desire in their physics instructors.® This study has not endeavored to determine methods of accomplishing this in the liberal arts college. It does lead to the suggestion that a study should be made of undergraduate college physics somewhat of the nature of the study being made of secondary school physics by the Physical Sciences Study Committee.®®

A number of deans indicated that a dissertation which was suited to the needs of the individual would be desirable for a prospective college instructor. Not many of the deans indicated that competence in research is an essential qualification for teaching in their institutions. In view of this, further study should be made to determine the type of dissertation that will meet the needs of the prospective physics instructor in the liberal arts college. The Chicago Conference on the Preparation of College Teachers recommended that further studies be made of the use of the dissertation for continued research.®®® A study of the type of research needed by the prospective college physics teacher could be correlated with the above recommendation.


BIBLIOGRAPHY

Books

Addresses at the Inauguration of Daniel C. Gilman as President of The Johns Hopkins University. Baltimore: John Murphy and Company, 1876.


Articles and Periodicals


Buxton, Claude E. "Teacher Training in the Graduate School," American Journal of Physics, XVII (December, 1959), 571-76.


Buxton, Claude E. "Teacher Training in the Graduate School," American Journal of Physics, XVII (December, 1959), 571-76.

The Congressional Globe, 35th Congress, 1st Session, 1857, New Series No. 3.


Cutten, George B. "The College Professor as Teacher," School and Society, LXXXVI (October, 1958), 372-75.


"Federal Budget Sets Research and Development Funds at $5.5 Billion with Emphasis on Space Activities," Science, CXXIX (February 6, 1959), 135.


Morris, R. B. "Administering In-Service Education in the College," School and Society, LXXVII (May 23, 1953), 327-29.


Rockwell, Leo L. "Whence and Whither the Ph.D.?" *School and Society*, LXXXIV (September 29, 1956), 107-09.


Van Note, W. G. "College Faculty Crisis -- What the College Can Do," *School and Society*, LXXXV (January 5, 1957), 4-7.

Publications of the Government, Learned Societies and Other Organizations


The *Bulletin of Vanderbilt University, The Graduate School, 1957-58.* Nashville, Tenn.: The University.


Graduate Programs for the Science Teacher. *School of Education, College of Liberal Arts, University Division of the Summer Sessions, Syracuse University, 1957.*


Unpublished Material


1. Institution ____________________________________________________________

2. Person preparing report ___________________________ (title or position)  

3. Number of graduate degrees awarded by the physics department during the period September, 1955-June, 1958

   Ph. D. _______  M. S. ________

4. Graduates included in item 3 who entered academic work

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Please describe any features of your graduate program which emphasize preparation for college teaching. Please include a brief description of the staff supervision which is given graduate students who teach class and laboratory sections. You may use the reverse of this page if you desire.
Much emphasis is being placed on the scientific training not only of future scientists but also of laymen who should have a general knowledge of science in a scientific age. One of the problems involved in the advancement of science is the preparation of college physics instructors for undergraduate teaching. This is of particular importance in the small college where the staff is limited and the physics instructor is faced with the triple function of giving non-science majors an appreciation for science, providing prospective scientists in other fields with an adequate background in physics, and preparing prospective physicists for continued study on the graduate level. Thus the physics professor in the small college should be prepared to teach all undergraduate physics courses offered and also he should have a good liberal education in other fields. Another very acute problem is the shortage of qualified physics instructors who are available for small colleges. I am requesting your help by means of the enclosed questionnaire in a research study which is being made at The Ohio State University, in an attempt to determine the desirability of certain practices in the preparation of college physics teachers and to suggest methods of improving this preparation. The study is restricted to the evaluation of graduate programs which lead to the acquisition of the Ph. D. degree.

This questionnaire is being sent to faculty deans and chairmen of physics departments in selected colleges which do not offer a graduate program in physics. Another questionnaire is being sent to instructors in these colleges. May I suggest that the Dean of the Faculty complete the questionnaire unless there are several members in the physics department. In the latter case the Chairman of the Physics Department may complete it. If it is desired the Dean of the Faculty and the Chairman of the Physics Department may each complete appropriate sections.

It is my desire to discuss problems pertaining to the preparation of physics instructors with faculty deans or departmental chairmen in some of the colleges to which questionnaires are being sent. I will appreciate it if you will indicate on the last page of the question-
aire whether or not you or some member of your institution will be available for an interview during the next few weeks. I will furnish you with more specific information if it is possible for us to make mutual arrangements for an interview.

I wish to thank you for your time and consideration. An early return of the questionnaire in the enclosed envelope will be appreciated.

Yours sincerely,

George W. Crawford
Assistant Professor of Physics

Enclosures
July 3, 1958

To: Deans of Colleges and Chairmen of Departments of Physics

Gentlemen:

You will find enclosed a questionnaire prepared by one of my graduate advisees. Mr. George Crawford, a member of the staff of the Department of Physics of Davidson College, is pursuing a doctoral program jointly based in the fields of physics and science education. Professor Wave Shaffer of the Department of Physics of this institution and I are two members of the doctoral committee.

Mr. Crawford is currently conducting an investigation concerned with the preparation and qualifications of college teachers of physics and with means of improving the program for their preparation. We shall be most appreciative if you are able to find time to complete his questionnaire. In a limited number of instances, Mr. Crawford will seek a personal interview. Your assistance in this endeavor will contribute to the improvement of the teaching of physics at the college level.

Sincerely yours,

(s)John S. Richardson

John S. Richardson
Professor of Education
I. Qualifications, Strengths and Weaknesses of Physics Teachers

Below are listed some of the qualifications which are desired by many college administrators in teachers they employ. Please check those qualifications which you would particularly like to find in physics teachers whom you employ.

1. ___ High degree of scholarship
2. ___ Excellent preparation in fundamental fields of physics
3. ___ Good background in other physical sciences
4. ___ Good background in general mathematics
5. ___ Good liberal or general education
6. ___ Competence in research
7. ___ Interest in maintaining equipment and improvising apparatus
8. ___ Ability to adapt instruction to the needs and interests of students
9. ___ Ability to raise the level of accomplishment of students
10. ___ Ability to develop reflective thinking on the part of students
11. ___ Ability to adapt graduate training to undergraduate teaching
12. ___ Deep and sustained enthusiasm for physics
13. ___ Dedication to teaching and leading others in scientific thought
14. ___ Constructive or affirmative philosophy of life (not cynical or sarcastic)
15. ___ Respect for efforts to advance the frontiers of knowledge and ability to infect students with the delight of exploring the boundaries of knowledge
16. ___ Sympathetic understanding of college-age students
17. ___ Appreciation for and understanding of the place of physics in higher education
18. ___ Appreciation for the obligation of science and the scientist to society
19. ___ General understanding of practical and industrial applications of physics
20. ___ Adeptness in counseling and advising students
21. ___ Ability to integrate into college and community life

Other qualifications

(Space for additional comments is provided on the last page.)
Beginning college teachers quite frequently have outstanding strengths and/or weaknesses. In column 1 please check those qualifications which your beginning physics teachers (three years or less of college teaching) have exhibited to a marked degree. In column 2 check those qualifications in which you have observed that your beginning physics teachers were extremely weak or deficient. Use a separate sheet for reporting on each instructor. Please do not include the name of the instructor.

<table>
<thead>
<tr>
<th>Instructor's highest academic degree</th>
<th>academic rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. strong 2. weak</td>
<td></td>
</tr>
<tr>
<td>1. High degree of scholarship</td>
<td></td>
</tr>
<tr>
<td>2. Excellent preparation in fundamental fields of physics</td>
<td></td>
</tr>
<tr>
<td>3. Good background in other physical sciences</td>
<td></td>
</tr>
<tr>
<td>4. Good background in general mathematics</td>
<td></td>
</tr>
<tr>
<td>5. Good liberal or general education background</td>
<td></td>
</tr>
<tr>
<td>6. Competence in research</td>
<td></td>
</tr>
<tr>
<td>7. Interest in maintaining and improvising equipment</td>
<td></td>
</tr>
<tr>
<td>8. Ability to adapt instruction to the needs of students</td>
<td></td>
</tr>
<tr>
<td>9. Ability to raise the level of accomplishment of students</td>
<td></td>
</tr>
<tr>
<td>10. Ability to lead students to do reflective thinking</td>
<td></td>
</tr>
<tr>
<td>11. Ability to adapt graduate training to undergraduate teaching</td>
<td></td>
</tr>
<tr>
<td>12. Deep and sustained enthusiasm for teaching physics</td>
<td></td>
</tr>
<tr>
<td>13. Constructive and affirmative philosophy of life</td>
<td></td>
</tr>
<tr>
<td>14. Respect for efforts to advance the frontiers of knowledge and ability to infect students with the delight of exploring the boundaries of knowledge</td>
<td></td>
</tr>
<tr>
<td>15. Adeptness in counseling and advising students</td>
<td></td>
</tr>
</tbody>
</table>
Qualifications or proficiencies which apply specifically to instruction and which show that the instructor—

16. ______ organizes the course well.
17. ______ conducts the class in such a manner that it involves the interest of all students present.
18. ______ speaks clearly, with good pronunciation and with a well modulated and adequate voice.
19. ______ is fair in the length and the difficulty of assignments, and in methods of testing and grading and shows no favoritism to students.
20. ______ correlates real problems with theory.
21. ______ affords students adequate opportunity for participation in discussions.
22. ______ employs different methods of teaching.
23. ______ spends a significant amount of time in the study of new developments in physics.
24. ______ encourages independent thinking and correct scientific procedures rather than memorization and adherence to set procedures in the laboratory.

Other outstanding strengths and weaknesses exhibited by beginning physics teachers
II. Academic Preparation of College Physics Teachers

The President's Commission on Higher Education in its report suggested inclusion of studies for broadening the graduate preparation of college teachers. Some schools have introduced interdepartmental graduate programs to meet the needs of college teachers. Please indicate the desirability of each of the programs given below for preparing physics teachers whom you may employ. Please rate each program on its merits and without respect to other programs.

1. Thorough preparation in all fundamental fields of physics and general mathematics with specialization in a particular field of physics
   - very desirable
   - neutral
   - undesirable
   - very desirable
   - undesirable

2. Thorough preparation in all fields of physics and general mathematics with inclusion of courses in allied areas as follows:
   a. Astronomy  yes  no
   b. Biology  yes  no
   c. Chemistry  yes  no
   d. Geology  yes  no
   e. History of science  yes  no
   f. Meteorology  yes  no
   g. Photography  yes  no
   h. Other

   - very desirable
   - neutral
   - undesirable
   - very desirable
   - undesirable

3. Interdepartmental program with a major area in physics and minor areas in mathematics, chemistry and/or other sciences
   - very desirable
   - neutral
   - undesirable
   - very desirable
   - undesirable
II. Academic Preparation of College Physics Teachers (cont.)

4. Interdepartmental program with a major area in physics, a minor area in mathematics, a minor area in chemistry and/or other sciences and a minor area in one of the following:
   a. Economic, historical and social implications of developments in science
      __ very ___ desirable ___ neutral ___ undesirable __ very desirable undesirable

   b. Philosophy with particular emphasis on its relation to physics
      __ very ___ desirable ___ neutral ___ undesirable __ very desirable undesirable

   c. Humanities
      __ very ___ desirable ___ neutral ___ undesirable __ very desirable undesirable

   d. Social studies
      __ very ___ desirable ___ neutral ___ undesirable __ very desirable undesirable

   e. Other

   Comments on any of the above programs

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
III. Professional Preparation of College Physics Teachers

A. Professional Courses

Some graduate schools have introduced methods courses and seminars in an attempt to improve the preparation of college teachers. Please indicate the desirability of each of the courses or seminars below for inclusion in a graduate program for the preparation of physics teachers whom you may employ. Consider each course on its merits and independently of the others.

1. Seminars or methods courses taught by well qualified physics professors and devoted to the improvement of class and laboratory instruction
   - very desirable __ neutral __ undesirable __ very desirable __ undesirable

2. Seminars or methods courses taught by well qualified professors of science education as well as by physics professors
   - very desirable __ neutral __ undesirable __ very desirable __ undesirable

3. Methods courses or seminars devoted to general methods of teaching at the college level in other sciences as well as physics
   - very desirable __ neutral __ undesirable __ very desirable __ undesirable

4. Courses or seminars in which a study is made of the administration, organization, and purposes of higher education
   - very desirable __ neutral __ undesirable __ very desirable __ undesirable

5. Please indicate other courses in which you would like for physics instructors whom you may employ to receive training.

   __________________________________________________________

6. If there is a combination of the above which you would prefer please indicate by circling the appropriate numbers below.

   1 2 3 4 5

Comments on above courses ______________________________________

   __________________________________________________________
B. Teaching and Internship Training of College Teachers

A number of practices which are similar to those given below are being followed by colleges and graduate schools in an attempt to improve college teaching. Please indicate the desirability for physics teachers whom you may employ to have training during their graduate program in which they do the following:

1. Teach class and laboratory sections with little or no supervision
   _ very _ desirable _ neutral _ undesirable _ very desirable _ undesirable

2. Teach class and laboratory sections under the supervision of well qualified physics professors
   _ very _ desirable _ neutral _ undesirable _ very desirable _ undesirable

3. Teach class and laboratory sections under the supervision of well qualified professors of science education as well as physics professors
   _ very _ desirable _ neutral _ undesirable _ very desirable _ undesirable

4. Observe well qualified physics professors teach class and laboratory sections
   _ very _ desirable _ neutral _ undesirable _ very desirable _ undesirable

5. Attend seminars devoted to discussions of techniques and special methods applicable to a class the student is teaching
   _ very _ desirable _ neutral _ undesirable _ very desirable _ undesirable

6. Work in an industrial or research plant
   _ very _ desirable _ neutral _ undesirable _ very desirable _ undesirable

7. Other ______________________________________________________________________
   _ very desirable _ desirable

8. Please indicate any combination of the above which you would prefer by circling the appropriate numbers below.
   1 2 3 4 5 6 7

Comments _______________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
IV. Research and the Dissertation

The Committee of Fifteen, sponsored by the Fund for the Advancement of Education, suggested in its report that the dissertation should be primarily a contribution to the knowledge of its author. In view of this suggestion please indicate the desirability for the preparation of physics teachers whom you may employ of a dissertation which --

1. emphasizes original research in a restricted phase of pure or applied physics.
   very desirable neutral undesirable very desirable undesirable

2. overlaps other sciences and broadens the student's knowledge of experimental procedures in other sciences as well as physics.
   very desirable neutral undesirable very desirable undesirable

3. is devoted to original research but is planned to meet the specific needs of a person who is preparing for college teaching rather than for research and/or graduate teaching.
   very desirable neutral undesirable very desirable undesirable

4. is devoted to a study of problems concerned with social effects of scientific developments, teaching of college physics, or other problems of an interpretive nature.
   very desirable neutral undesirable very desirable undesirable

5. Comments on the nature of the dissertation and the time that should be spent on it

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
V. Miscellaneous

1. Do you feel that the Ph. D. degree is essential for undergraduate physics teaching?
   — yes  — no

2. If you do not feel that the Ph. D. degree is essential do you think that a rigorous Master of Science degree with an experimental thesis in pure or applied physics would be sufficient preparation for undergraduate physics teaching?
   — yes  — no

3. Does your institution stress the Ph. D. degree for professional advancement?
   — yes  — no

4. Comments ____________________________________________________________

5. I would like to arrange for an interview with you or some member of your institution preferably before August 25, 1958. Please indicate a convenient time for an interview if it can be arranged.

6. A modified questionnaire is being sent to professors in selected colleges. If I may include members of your staff I will appreciate it if you will furnish me with their names and addresses.

   Name    Address
   ________________  ________________
   ________________  ________________
   ________________  ________________
   ________________  ________________

   Signature ____________________________
   ________________

Please return the completed questionnaire to the following address:

George W. Crawford
379 West 8th Avenue
Columbus, Ohio
Dear

Several weeks ago I forwarded a questionnaire to your office for completion by you or the chairman of your physics department. It was concerned with the graduate preparation of college physics instructors for small liberal arts colleges. This questionnaire is part of a research study which is being made at The Ohio State University under the direction of Dr. Wave H. Shaffer of the Department of Physics and Dr. John S. Richardson of the Department of Education at that institution.

I have been very gratified with the responses that I have received from the schools to which questionnaires were sent even though it was during the vacation period and many administrators and chairmen of physics departments were absent. I plan to consolidate the responses obtained on the questionnaires within the next few weeks and would like to include your institution in the study. I shall appreciate it if you will complete the enclosed card and return it to me. In the event you did not receive the questionnaire or if it was misplaced during your absence I will be glad to send you another copy.

Yours sincerely,

George W. Crawford
Assistant Professor of Physics
COPY OF FOLLOW-UP CARD

College_________________________
Address_________________________
Date _____________________

1. Questionnaire received ............ yes ( ) no ( )

2. Expect to complete questionnaire by________________

3. If questionnaire has not been received or has been misplaced may I send another one? yes ( ) no ( )

Signature_______________________
Position_______________________
Much emphasis is being placed on the scientific training not only of future scientists but also of laymen who should have a general knowledge of science in a scientific age. One of the problems involved in the advancement of science is the preparation of college physics instructors for undergraduate teaching. This is of particular importance in the small college where the staff is limited and the physics instructor is faced with the triple function of giving non-science majors an appreciation for science, providing prospective scientists in other fields with an adequate background in physics, and preparing prospective physicists for continued study on the graduate level. Thus the physics professor in the small college should be prepared to teach all undergraduate physics courses offered and also he should have a good liberal education in other fields. Another very acute problem is the shortage of qualified physics instructors who are available for small colleges. I am requesting your help by means of the enclosed questionnaire in a research study which is being made at The Ohio State University, in an attempt to determine the desirability of certain practices in the preparation of college physics teachers and to suggest methods of improving this preparation. The study is restricted to the evaluation of graduate programs which lead to the acquisition of the Ph. D. degree.

This questionnaire is being sent to physics professors in selected colleges which do not offer a graduate program in physics. Another questionnaire is being sent to faculty deans and chairmen of physics departments of selected colleges. It is my desire to visit some of these colleges during the coming weeks. In the event I visit your institution I will be happy to meet you and discuss not only problems regarding the preparation of physics instructors but also other problems with which instructors in small colleges are faced.

I wish to thank you for your time and consideration. An early return of the questionnaire in the enclosed addressed envelope will be appreciated.

Yours sincerely,

George W. Crawford
July 3, 1958

To: Instructors of Physics in Selected Colleges

Gentlemen:

You will find enclosed a questionnaire prepared by one of my graduate advisees. Mr. George Crawford, a member of the staff of the Department of Physics of Davidson College, is pursuing a doctoral program jointly based in the fields of physics and science education. Professor Wave Shaffer of the Department of Physics of this institution and I are two members of the doctoral committee.

Mr. Crawford is currently conducting an investigation concerned with the preparation and qualifications of college teachers of physics and with means of improving the program for their preparation. We shall be most appreciative if you are able to find time to complete his questionnaire. In a limited number of instances, Mr. Crawford will seek a personal interview. Your assistance in this endeavor will contribute to the improvement of the teaching of physics at the college level.

Yours sincerely,

John S. Richardson

(s)John S. Richardson
Professor of Education

JSR:dl
I. Problems Encountered by Beginning Physics Teachers

Below are listed some areas in which beginning college physics teachers have difficulties because of a lack of training for college level teaching. Please check those areas in which you encountered your greatest difficulties in teaching undergraduate college physics after you had obtained your highest degree.

1. ___ Preparation in fundamental fields of physics
2. ___ Preparation in allied sciences
3. ___ Competence in research
4. ___ Skill in improvising equipment
5. ___ Preparation in general mathematics
6. ___ Adaptation of graduate preparation to undergraduate teaching
7. ___ Application of principles of physics to scientific developments
8. ___ Adaptation of instruction to the needs of students
9. ___ Adaptation of instruction to raise the level of accomplishment of students
10. ___ Counseling and advising students
11. ___ Organization and presentation of subject material
12. ___ Development of student interest in and enthusiasm for physics
13. ___ Methods of testing and grading students
14. ___ Student-teacher relationships
15. ___ Employment of various methods of teaching
16. ___ Laboratory instruction
17. ___ Utilization of films, demonstration equipment and other teaching aids
18. ___ Instruction in the use of special laboratory equipment and techniques
19. ___ Extracurricular and committee assignment duties

Other difficulties

_______________________________________________________________________________________

_______________________________________________________________________________________

_______________________________________________________________________________________
II. Academic Preparation and Subjects Taught

The President's Commission on Higher Education in its report suggested the inclusion of studies for the broadening of graduate preparation of college teachers. Some universities have introduced interdepartmental graduate programs which lead to the acquisition of the Ph. D. degree. Please indicate the desirability of each of the programs below for preparing prospective teachers to teach undergraduate college physics. Rate each program or area of a program on its merits and independently of the other programs or areas although you may not have followed the program or obtained the Ph. D. degree.

1. Thorough preparation in fundamental fields of physics and general mathematics with specialization in a particular field of physics
   - very desirable
   - neutral
   - undesirable

2. Interdepartmental program with a major area in physics and minor areas in mathematics, chemistry and/or other sciences
   - very desirable
   - neutral
   - undesirable

3. Thorough preparation in fundamental fields of physics and general mathematics with inclusion of courses in allied areas such as:
   a. Astronomy yes no
   b. Biology yes no
   c. Chemistry yes no
   d. Geology yes no
   e. History of science yes no
   f. Meteorology yes no
   g. Photography yes no
   h. Other

4. Interdepartmental program with a major area in physics, a minor area in mathematics, a minor area in chemistry and/or other sciences and a minor area in one of the following: (Please rate each area independently of the others.)
   a. Economic, historical and social implications of developments in science
   - very desirable
   - neutral
   - undesirable
   b. Philosophy with particular emphasis on its relation to physics
   - very desirable
   - neutral
   - undesirable
   c. Humanities
   - very desirable
   - neutral
   - undesirable
   d. Social studies
   - very desirable
   - neutral
   - undesirable

   "very desirable" means that the program or area of study is very desirable for preparing prospective college physics teachers. "neutral" means that the program or area of study is neither very desirable nor undesirable. "undesirable" means that the program or area of study is undesirable for preparing prospective college physics teachers.
Comments on above programs

(Space for additional comments is provided on the last page.)

5. What were the major and minor areas of graduate study for your highest degree?

6. List any courses in physics, mathematics, other sciences and other areas of study which you did not have but which you think would have helped prepare you to teach undergraduate college physics.

7. Please list any graduate courses you have had which you feel have been of little value to you in preparing you to teach undergraduate college physics. Please rate each course on its merits and not on the basis of the instructor who taught the course. Also please comment on your reasons for feeling the course (or courses) was of little value to you.
8. Please list those courses in physics and other subjects which you have taught on the undergraduate level.


9. If you had graduate courses dealing with the historical and social implications of science please indicate the value such courses have been to you in your physics teaching.

Had courses  yes no
III. Professional Preparation of College Physics Teachers

A. Professional Courses

Some graduate schools have introduced methods courses and seminars in an attempt to improve the preparation of college teachers. Please indicate whether or not you have had the courses listed below. Also indicate the desirability of each course for inclusion in a graduate program for preparing college teachers to teach undergraduate physics. Consider each course, although you may not have had it, on its merits and independently of the others.

<table>
<thead>
<tr>
<th>Course Description</th>
<th>Yes/No</th>
<th>Very Desirable</th>
<th>Neutral</th>
<th>Undesirable</th>
<th>Very Undesirable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Seminars or methods courses taught by well qualified physics professors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and devoted to the improvement of instruction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Methods courses devoted to general methods of teaching other sciences as well</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>as physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Seminars or methods courses taught by well qualified science education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>as well as physics professors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Courses or seminars in which a study is made of the administration, organization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and purposes of higher education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Please indicate other professional courses which you may have had or would</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>like to have had in your graduate preparation for teaching college physics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. If there is a combination of the above which you would prefer please indicate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>by circling the numbers below.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 2 3 4 5
B. Teaching and Internship Training for College Teachers

Practices similar to those given below are being followed by some colleges and graduate schools in an attempt to improve college teaching. Please indicate whether or not you have had the training described. Also indicate the desirability of such training in preparing prospective college teachers for teaching undergraduate college physics. Please rate each practice on its merits and independently of the other practices although you may not have had the training described.

1. Taught class and laboratory sections with little or no supervision
   - very desirable  neutral  undesirable  very desirable  undesirable

2. Taught class or laboratory sections under the supervision of well qualified physics professors
   - very desirable  neutral  undesirable  very desirable  undesirable

3. Observed well qualified physics professors teach
   - very desirable  neutral  undesirable  very desirable  undesirable

4. Taught class and laboratory sections under the supervision of well qualified science education as well as physics professors
   - very desirable  neutral  undesirable  very desirable  undesirable

5. Attended seminars devoted to a discussion of techniques and special methods applicable to a class you were teaching
   - very desirable  neutral  undesirable  very desirable  undesirable

6. Worked in an industrial or research plant
   - very desirable  neutral  undesirable  very desirable  undesirable

7. Other
   - very desirable  desirable
8. Please indicate any combination of the above which you would prefer by circling the appropriate numbers below.

1 2 3 4 5 6 7

Comments _________________________________________________

__________________________________________________________

Please indicate the number of years of experience you had in one or more of the following fields before you obtained your highest degree and comment on the value this experience was to you in preparing you for college teaching.

9. Instructor in secondary schools . . . . . . . . . . years______

10. Instructor in junior college . . . . . . . . . . years______

11. Instructor in senior college . . . . . . . . . . years______

12. Other ________________________________________ years______

Comments ________________________________________________

__________________________________________________________

__________________________________________________________

IV. Research and the Dissertation

The Committee of Fifteen, sponsored by the Fund for the Advancement of Education, suggested in its report that the dissertation should be primarily a contribution to the knowledge of the author. In view of this suggestion please indicate the desirability, in the preparation of prospective undergraduate college physics teachers, of a dissertation which—

1. emphasizes original research in a restricted phase of pure or applied physics.
   _very__ desirable __neutral__ undesirable __very__ desirable __neutral__ undesirable

2. overlaps other sciences broadening the student's knowledge of experimental procedures in other sciences as well as physics.
   _very__ desirable __neutral__ undesirable __very__ desirable __neutral__ undesirable
is devoted to original research but is planned to meet the specific needs of a person who is preparing for college teaching rather than for research and/or graduate teaching.  
very desirable _ neutral _ undesirable _ very desirable _ neutral _ undesirable

is devoted to a study of problems concerned with social effects of scientific developments, teaching college physics, or other problems of an interpretive nature.  
very desirable _ neutral _ undesirable _ very desirable _ neutral _ undesirable

Comments on the nature of the dissertation and the time that should be spent on it _____________________________

What was the nature of your dissertation or thesis? _____________________________

To what extent have you utilized the research of your thesis or dissertation for further research and publication? _____________________________

V. Miscellaneous

Do you feel that the Ph. D. degree is essential for undergraduate physics teaching? yes_ no

If you do not feel that the Ph. D. degree is essential do you think that a rigorous M. S. degree with an experimental thesis in pure or applied physics would be sufficient preparation for undergraduate physics teaching? yes_ no

Comments _____________________________

______________________________

______________________________

______________________________
3. What aspects of your graduate training have contributed least to your preparation for college teaching? ______________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

4. What aspects of your graduate training have contributed most to your preparation for college teaching? ______________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

5. What suggestions can you offer for improvement of the Ph. D. degree program for prospective undergraduate physics teachers?

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

Additional comments ____________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

Signature ____________________________

Date ________________________________

Please return the completed questionnaire to the following address: George W. Crawford 
379 West 8th Avenue 
Columbus, Ohio
Dear

Several weeks ago I forwarded a questionnaire to you for completion at your convenience. It was concerned with the graduate preparation of prospective college physics professors for small liberal arts colleges. This questionnaire is part of a research study which is currently being made at The Ohio State University under the direction of Dr. Wave H. Shaffer of the Department of Physics and Dr. John S. Richardson of the Department of Education at that institution.

I have been gratified with the responses that I have received from physics professors to whom questionnaires have been sent even though it was during the vacation period and many faculty members were absent. I plan to consolidate the responses obtained within the next few weeks and would like to include your comments in my study if I may. I shall appreciate it if you will complete the enclosed card and mail it to me. In the event you did not receive the questionnaire or if it was misplaced during your absence I will be glad to send you another copy.

Yours sincerely,

George W. Crawford
Assistant Professor of Physics
I. PARTICIPATING INSTITUTIONS

Graduate Physics Departments

Carnegie Institute of Technology, Pittsburgh, Pa.
Case Institute of Technology, Cleveland, Ohio
Indiana University, Bloomington, Ind.
John Carroll University, Cleveland, Ohio
Lehigh University, Bethlehem, Pa.
Michigan State University, East Lansing, Michigan
Ohio State University, Columbus, Ohio
Pennsylvania State University, University Park, Pa.
Purdue University, West Lafayette, Ind.
University of Cincinnati, Cincinnati, Ohio
University of Detroit, Detroit, Mich.
University of Michigan, Ann Arbor, Mich.
University of Notre Dame, Notre Dame, Ind.
University of Pittsburgh, Pittsburgh, Pa.
Wayne University, Detroit, Mich.
Western Reserve University, Cleveland, Ohio

Colleges

*Albion College, Albion, Mich.

*Institution was visited.

286
*Allegheny College, Meadville, Pa.
Alma College, Alma, Mich.
*Antioch College, Yellow Springs, Ohio
Baldwin-Wallace College, Berea, Ohio
*Ball State Teachers College, Muncie, Ind.
Beaver College, Jenkintown, Pa.
*Berea College, Berea, Ky.
Bethany College, Bethany, W. Va.
*Bluefield State College, Bluefield, W. Va.
*Bowling Green State University, Bowling Green, Ohio
*Bucknell University, Lewisburg, Pa.
Calvin College, Grand Rapids, Mich.
*Capital University, Columbus, Ohio
Central State College, Wilberforce, Ohio
*Centre College, Danville, Ky.
*College of Wooster, Wooster, Ohio
*Denison University, Granville, Ohio
*Dickinson College, Carlisle, Pa.
*Earlham College, Richmond, Ind.
*Eastern Kentucky State College, Richmond, Ky.
Evansville College, Evansville, Ind.
Fairmont College, Fairmont, W. Va.
Fenn College, Cleveland, Ohio

*Institution was visited.
Franklin College, Franklin, Ind.
Geneva College, Beaver Falls, Pa.
*Gettysburg College, Gettysburg, Pa.
Goshen College, Goshen, Ind.
Grove City College, Grove City, Pa.
Hanover College, Hanover, Ind.
*Heidelberg College, Tiffin, Ohio
Hiram College, Hiram, Ohio
Hope College, Holland, Mich.
Indiana State Teachers College, Terre Haute, Ind.
*Indiana Central College, Indianapolis, Ind.
*Kalamazoo College, Kalamazoo, Mich.
Kenyon College, Gambier, Ohio
*Kent State University, Kent, Ohio
*Kentucky State College, Frankfort, Ky.
Lafayette College, Easton, Pa.
*Lycoming College, Williamsport, Pa.
Marygrove College, Detroit, Mich.
Manchester College, North Manchester, Ind.
Marietta College, Marietta, Ohio
Muhlenburg College, Allentown, Pa.

*Institution was visited.
Ohio Northern University, Ada, Ohio
Ohio Wesleyan University, Delaware, Ohio
Otterbein College, Westerville, Ohio
Rose Polytechnic Institute, Terre Haute, Ind.
St. Joseph's College, Collegeville, Ind.
State Teachers College, Bloomsburg, Pa.
State Teachers College, California, Pa.
State Teachers College, East Stroudsburg, Pa.
State Teachers College, Edinboro, Pa.
State Teachers College, Kutztown, Pa.
State Teachers College, Millersville, Pa.
Western College for Women, Oxford, Ohio
West Liberty State College, West Liberty, W. Va.
Western Michigan University, Kalamazoo, Mich.
West Virginia Institute of Technology, Institute, W. Va.
West Virginia Wesleyan College, Buckhannon, W. Va.
Wilmington College, Wilmington, Ohio
Wittenberg College, Springfield, Ohio
Xavier University, Cincinnati, Ohio

*Institution was visited.
II. INDIVIDUAL PARTICIPANTS

Deans and Chairmen of Physics Departments

*Archer, Lawrence H., Dean, Ohio Northern University, Ada, Ohio

*Arnett, Denver F., Dean, West Liberty State College, West Liberty, W. Va.

Bailey, Frank E., Dean, Kenyon College, Gambier, Ohio

Barker, E. F., Chairman, Physics Department, Alma College, Alma, Mich.

Barrett, Lawrence, Dean, Kalamazoo College, Kalamazoo, Mich.


Beeky, Cyrus E., Dean, State Teachers College, Kutztown, Pa.

*Bell, Raymond M., Chairman, Physics Department, Washington and Jefferson College, Washington, Pa.

Boyer, Robert A., Chairman, Physics Department, Muhlenburg College, Allentown, Pa.

*Bradford, David H., Dean, Kentucky State College, Frankfort, Ky.

Breidenstine, A. G., Dean, State Teachers College, Millersville, Pa.

Burkhardt, Richard W., Dean, Ball State Teachers College, Muncie, Ind.

Cheek, Mary Ashby, Dean, Western College for Women, Oxford, Ohio

*Cramer, Robert E., Dean, Indiana Central College, Indianapolis, Ind.


*Doescher, W. O., Dean, Capital University, Columbus, Ohio

Garver, Earl S., Dean, Manchester College, North Manchester, Ind.

Glathart, Jay, Chairman, Physics Department, Albion College, Albion, Mich.

Grise, F. C., Dean, Western Kentucky College, Bowling Green, Ky.

Harris, Fred E., Dean, Baldwin-Wallace College, Berea, Ohio

*Included a personal interview.
*Hartsell, Karl D., Dean, Bucknell University, Lewisburg, Pa.

Hock, John A., Dean, State Teachers College, Bloomsberg, Pa.

Hunt, George R., Dean, Fairmont State College, Fairmont, W. Va.

Hunt, Lucian F., Chairman, Physics Department, Northern Michigan College, Marquette, Mich.

Ignatia, Sister M., Chairman, Physics Department, Marygrove College, Detroit, Mich.

*Jackson, Lewis A., Dean, Central State College, Wilberforce, Ohio

Kleis, Clarence, Chairman, Physics Department, Hope College, Holland, Mich.

Kreider, Carl, Dean, Goshen College, Goshen, Ind.

Larsen, Karl D., Chairman, Physics Department, Lafayette College, Easton, Pa.

*Lempke, Frederick D., Dean, Heidelberg College, Tiffan, Ohio

Lichtenstein, Parker E., Dean, Denison University, Granville, Ohio

Lutz, Arthur L., Chairman, Physics Department, Wittenberg College Springfield, Ohio

McGarry, Francis B., Dean, State Teachers College, East Stroudsburg, Pa.

McIsaacs, John S., Dean, Geneva College, Beaver Falls, Pa.

McKown, E. M., Dean, Evansville College, Evansville, Ind.

*Mara, Richard T., Dean, Gettysburg College, Gettysburg, Pa.

*Martin, Donald C., Chairman, Physics Department, Marshall College, Huntington, W. Va.

*Maxwell, Howard N., Chairman, Physics Department, Ohio Wesleyan University, Delaware, Ohio

Maziary, Rev. Edward A., Dean, St. Joseph's College, Rensselaer, Ind.


Moench, Herman, Dean, Rose Polytechnic Institute, Terre Haute, Ind.

*Included a personal interview.
Moore, W. J., Dean, Eastern Kentucky State College, Richmond, Ky.

Morgan, H. E., Chairman, Physics Department, Fenn College, Cleveland, Ohio

Offner, H. L., Dean, State Teachers College, Edinboro, Pa.

Patterson, Merrill R., Dean, Marietta College, Marietta, Ohio

*Potipher, Father, Chairman, Physics Department, Xavier University, Cincinnati, Ohio

Primm, James M., Dean, Hiram College, Hiram, Ohio

*Rackham, Eric N., Dean, Kent State University, Kent, Ohio

Richtmeyer, Cleon C., Dean, Central Michigan College, Mount Pleasant, Mich.

*Ritchie, Earland, Chairman, Physics Department, Centre College, Danville, Ky.

Roadman, George, Dean, State Teachers College, California, Pa.

*Rood, Paul, Chairman, Physics Department, Western Michigan University, Kalamazoo, Mich.

Ross, Julian L., Dean, Allegheny College, Meadville, Pa.


Ryskamp, Henry J., Dean, Calvin College, Grand Rapids, Mich.

Schoolcraft, A. A., Dean, West Virginia Wesleyan College, Buckhannon, W. Va.

Scrabbord, E. J., Dean, Bluefield State College, Bluefield, W. Va.

Shuck, Emerson, Dean, Bowling Green State University, Bowling Green, Ohio

*Stewart, Albert, Chairman, Physics Department, Antioch College, Yellow Springs, Ohio

Swezey, W. W., Dean, Grove City College, Grove City, Pa.

*Taeusch, William, Dean, College of Wooster, Wooster, Ohio

Tate, E. Mowbray, Dean, Hanover College, Hanover, Ind.

*Included a personal interview.
Thompson, Kenneth H., Associate Dean, Berea College, Berea, Ky.

Van Dyke, George D., Chairman, Physics Department, Earlham College, Richmond, Ind.

Van Ness, Frederick W., Dean, Dickinson College, Carlisle, Pa.

Vance, F. J., Dean, Otterbein College, Westerville, Ohio

Vellenea, S. J., Chairman, Natural Sciences, Muskingum College, New Concord, Ohio

Wallace, Herbert A., Chairman, Science Division, Franklin College, Franklin, Ind.

Wirtenberger, Henry J., Dean, Xavier University, Cincinnati, Ohio

Yaple, Grayson, Dean, Wilmington College, Wilmington, Ohio

Yeagley, Henry L., Chairman, Physics Department, Dickinson College, Carlisle, Pa.

Physics Instructors

Abele, Ernests, Ohio Northern University, Ada, Ohio


Benedict, A. A., Ohio Northern University, Ada, Ohio

Bowman, Donald W., Bowling Green State University, Bowling Green, Ohio

Bradley, George, Western Michigan University, Kalamazoo, Mich.


Burling, Richard L., Antioch College, Yellow Springs, Ohio


Coburn, H. H., New Mexico College of Agriculture and Mechanical Arts, State College, N. M.

Conklin, Richard L., Hanover College, Hanover, Ind.

*Included a personal interview.
Cooke, Francis W., Northern Michigan College, Marquette, Mich.
Cowan, Raymond, Franklin College, Franklin, Ind.
Cutler, Paul H., Pennsylvania State University, University Park, Pa.
Derby, Stanley, Western Michigan University, Kalamazoo, Mich.
Dewitt, Jacob B., Western Michigan University, Kalamazoo, Mich.
Dillman, L. Thomas, Ohio Wesleyan University, Delaware, Ohio
Dreiling, Rev. Boniface, St. Joseph's College, Collegeville, Ind.
Ellis, Roy, Centre College, Danville, Ky.
Engle, Dan, State Teachers College, Millersville, Pa.
Erich, Lester C., Lafayette College, Easton, Pa.
Faber, Roger, Jr., Calvin College, Grand Rapids, Mich.
Flamm, Merle, Bowling Green State University, Bowling Green, Ohio
Foote, Nathan M., Baldwin-Wallace College, Berea, Ohio
Ford, William F., John Carroll University, Cleveland, Ohio
Frissel, Harry F., Hope College, Holland, Mich.
Hart, John B., Xavier University, Cincinnati, Ohio
Houston, Robert Edgar, Jr., University of New Hampshire, Madison, N.H.
*Hummel, A. D., Ball State Teachers College, Muncie, Ind.
Gailar, Norman, University of Tennessee, Knoxville, Tenn.
Gould, Robert K., Muskingum College, New Concord, Ohio

*Included a personal interview.
Kolitschew, K. D., Indiana Central College, Indianapolis, Ind.
Kremser, Thurman R., Albright College, Reading, Pa.
Kruglak, H., Western Michigan University, Kalamazoo, Mich.
Lane, George H., Jr., Franklin and Marshall College, Lancaster, Pa.
Lantermar, Harold H., State Teachers College, Bloomsburg, Pa.
Loudin, Harold H., Kent State University, Kent, Ohio
McGrath, J. W., Kent State University, Kent, Ohio
McNees, Herbert W., State Teachers College, Edinboro, Pa.
Marburger, Walter G., Western Michigan University, Kalamazoo, Mich.
Martin, Donald C., Marshall College, Huntington, W. Va.
Meyer, Albert J., Goshen College, Goshen, Ind.
Miller, Robert B., Western Michigan University, Kalamazoo, Mich.
Morris, Charles S., Manchester College, North Manchester, Ind.
Nichols, Nathan L., Western Michigan University, Kalamazoo, Mich.
Noll, Waldemar, Berea College, Berea, Ky.
Owen, G. E., Antioch College, Yellow Springs, Ohio
Page, George V., Western Kentucky College, Bowling Green, Ky.
Parker, Paul M., Michigan State University, East Lansing, Mich.
Raub, Harry L., Muhlenberg College, Allentown, Pa.
Reynolds, Leon M., Ball State Teachers College, Muncie, Ind.

*Included a personal interview.
*Ritchie, Earland, Centre College, Danville, Ky.

Robson, John W., University of Arizona, Tucson, Ariz.


Ruschau, Ambrose A., St. Joseph's College, Rensselaer, Ind.

Sandefur, P. L., Western Kentucky State College, Bowling Green, Ky.


Schoepfle, G. K., Kent State University, Kent, Ohio

 Schroeder, C. M., Arizona State College, Tempe, Ariz.

Schuele, Donald E., John Carroll University, Cleveland, Ohio

Scovil, G. W., Allegheny College, Meadville, Pa.

Sharp, Amos A., State Teachers College, Kutztown, Pa.

Shirer, Donald L., Valparaiso University, Valparaiso, Ind.

Silvidi, Anthony A., Kent State University, Kent, Ohio

Sis, Richard M., Dickinson College, Carlisle, Pa.

Smith, Leon E., Denison University, Granville, Ohio

Snider, John W., Miami University, Oxford, Ohio

Snyder, Evan S., Ursinus College, Collegeville, Pa.

Stearns, Robert H., Vassar College, Poughkeepsie, N. Y.

Stenchcomb, T. G., Heidelberg College, Tiffin, Ohio

Stone, Alexander P., Dickinson College, Carlisle, Pa.

Strickler, Thomas D., Berea College, Berea, Ky.

Strother, G. K., Pennsylvania State University, University Park, Pa.

Sutton, Traver C., Evansville College, Evansville, Ind.

Telfair, David, Earlham College, Richmond, Ind.

Warren, Kenneth L., Kent State University, Kent, Ohio

*Included a personal interview.

*Wheeler, S. C., Denison University, Granville, Ohio

Whittle, Charles E., J., Western Kentucky State College, Bowling Green, Ky.


*Included a personal interview.
I, George William Crawford, was born in Statesville, North Carolina, October 21, 1906. I received my secondary school education in the public schools of North Carolina and my undergraduate training at Davidson College, Davidson, North Carolina, which institution granted me the Bachelor of Science degree cum laude in 1929. From the University of North Carolina I received the Master of Science degree in 1949 with a major in physics and a minor in mathematics.

In 1934 I married Frances Knox from Mecklenburg County, North Carolina. Mrs. Crawford teaches in the Mooresville City Schools, Mooresville, North Carolina.

Prior to World War II I taught physics and chemistry in the public schools of North Carolina. I was called to active duty in the United States Army as a commissioned officer in December, 1940, and released with the rank of lieutenant colonel in July, 1946. I served two years in the European Theater of Operations and participated in the Normandy Invasion. At the present time I am a member of the United States Army Reserve. From 1946-1950 I was on the staff of the Physics Department at North Carolina State College, Raleigh, North Carolina. At the present time I am a member of the Physics Department at Davidson College, Davidson, North Carolina.