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OTIS W. CALDWELL

HIGH SCHOOL SCIENCE SURVEY OF VIRGINIA*

CONTENTS

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1. INTRODUCTION

This survey was undertaken primarily to discover the facts regarding high school science instruction in Virginia today. It seemed to be worth while also in this paper to compare present practices in Virginia with those of other states, and to observe the results of recent researches in the teaching of science.

The data for this study were secured from the Annual Report of the Superintendent of Public Instruction of Virginia, 1928-29; from the preliminary reports of the principals of accredited high schools; from the O'Shea Survey Report,[1] and from a science survey questionnaire sent out by the High School Division of the State Board of Education.

The survey questionnaire was sent out to the principals of the 405 accredited high schools in the state, and replies were received from 226.

The data obtained in this survey should prove useful to science teacher-training classes, also to science teachers, superintendents, principals, and others interested in the application of science to various fields in the state, viz., agriculture, medicine, industry, engineering, and hygiene.

The O'Shea Survey Report[2] stated clearly that, in the commission's judgment, much more attention should be paid in the future to instruction in science. The survey staff recognized that in the past emphasis had been placed on history, languages, literature, and related subjects, but that now in a scientific age it is particularly desirable that more emphasis be placed on science courses in all grades of the elementary and high schools. The recent advent of a large number of industries in Virginia makes this all the more necessary.

Since changes in content and method of science instruction can be made wisely only

[1]Report of the Educational Commission of Virginia, by M. V. O'Shea. Richmond, Va., 1928, hereinafter called "O'Shea Survey Report."

[2]*Ibid,* p. 9 and 11.

when present practices are accurately known, and the causes therefore are clearly appreciated, it was decided to proceed with the present survey.

2. *Virginia's Predominant Type of High School*

Of the 405 high schools accredited by the State Department of Education[3] 63 have an enrollment of less than 50; 195 have an enrollment ranging from 51-100; 66 have an enrollment ranging from 101-150. The remaining 81 have an enrollment above 151. From these figures, it is evident that a large proportion of the schools (65%) have an enrollment lying between 50 and 150.

In deciding on the content of the science courses for the small town or the rural community, the predominant type will need to be kept in mind.

3. *The Typical Four Year Accredited High School*[4]

The typical county accredited four year high school in Virginia, as found in this survey, by taking averages, has an enrollment of about 80 students, and is situated in a town having a population of about 900.It has from three to four teachers, about three-quarters of whom have four years of college training.[5] The median value[6] of laboratory equipment in county high schools is $709.62, while that of city high schools is $4,100. The median number of volumes in the libraries of the counties is 595 volumes, while that for the libraries of the cities is 1.875 volumes. The median salary for the county teachers is I128.95 per month, while that for city teachers is $148.75.

It might be worth while to compare the typical high school in Virginia with that in South Dakota where the small high school also predominates. According to Jensen,[7] the typical accredited four year South Dakota high school is situated "in a town having a population of 500 and has an enrollment of about 65. This typical school has from three to four teachers, usually with from one to two years of teaching experience and 31 percent are serving as superintendents or principals, of which 20 percent have from five to six recitations per day with a three subject combination. The average value of equipment is about $275 with an average of $140 spent for new equipment each year. The least money spent for equipment purchased is $15, the most, $1200, based on 51 schools."

4. *Virginia High Schools Accredited by the Southern Association*

Of the 405 high schools in Virginia accredited by the state[8], 80 are members of the Association of Colleges and Secondary Schools of the Southern States, the leading accrediting agency of the South.[9] Each year this latter number is increasing rapidly. Of the 80 high schools 61 are public and 19 are private. The requirements for membership are: first, that 75% of teachers teaching academic subjects shall have a B. S. degree from an approved college; second, that the maximum teaching load of any teacher shall be 750 pupil-periods per week with not more than six daily recitations; third, that laboratory and library facilities shall be adequate for the needs of instruction in courses taught; fourth, that at least four teachers shall give full time to high school instruction; fifth, that the maximum number of pupils per teacher shall be 30;

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[3]Annual Report of the Superintendent of Public Instruction, 1928-29. Pp. 28-45.

[4]Date secured from reports of 361 accredited high schools listed in the 1927-28 Annual Report of Public Schools, Richmond, Va.

[5]Beginning in September, 1929, graduation from a four-year coollege course is required for teaching in an accredited high school in the state.

[6]Annual Report of Public High Schools of Virginia for 1927-28, Richmond, Va., October, 1928, p. 17.

[7]High School Science Survey of South Dakota, by J. H. Jensen. *Journal of Chemical Education,* Vol. 4, No. 7, 1927, p. 897.

[8]Annual Report of the Superintendent of Public Instruction, 1928-29. Pp. 28-45.

[9]Smithey; Virginia Secondary Schools Accredited by the Association of Colleges and Secondary Schools of Southern States. *Virginia Journal of Education,* May, 1929.

sixth, that $1,000 shall be a minimum salary for teachers.

5. *Source, Preparation, Teaching Load, and Average Salary of the Teacher*

A detailed account of the source of science teachers was not available, but data for all teachers for the state as a whole may be found in the annual report.[10] The state relies chiefly on her own institutions for the training of teachers. Of the total number of teachers employed in 1928-29 67% of them were trained in state institutions; 23% in private Virginia schools; 9% in out-of-state institutions; and 1% were without any college or normal school training.

There is no reason to suppose that the source of science teachers was different from that of the teachers of the state as a whole, as shown above.

6. *Value of Science Equipment, 1928-29*

TABLE I. ESTIMATED VALUE OF EQUIPMENT

Subject	Average	Median	Q_1	Q_3	Range	No. Schools Reporting
		In 31 City High Schools				
Gen. Science	$ 406	180	150	500	50-2000	20
Biology	$ 894	650	300	975	100-3547	20
Physics	$ 856	1037	700	1600	315-4120	24
Chemistry	$1759	1350	235	2000	50-9000	31
		In 374 County High Schools				
Gen. Science	$ 136	120	120	175	10- 500	320
Biology	$ 181	160	160	200	15- 900	338
Physics	$ 283	150	99	300	10-3300	71
Chemistry	$ 292	200	150	300	10-2000	284

Virginia is to be commended on the improvement of the academic and professional preparation of her high school teachers.[11] The minimum qualifications for those persons beginning to teach in an accredited high school is the baccalaureate degree from a standard four-year college. "Applicants for certificates who satisfy all other requirements and present credit for 12 session hours' work (equivalent to 24 semester hours or 36 quarter hours) distributed equally among not more than three sciences may teach the sciences for which credit is presented. If, however, credit is presented for four session-hours' work each in biology, chemistry, and physics, the applicant may teach all branches of science offered in the high schools."[12] It has been recommended that no person be legally qualified to teach who has not at least a minimum professional preparation for the work he is undertaking to do. These minimum requirements as proposed consist of fifteen semester hours of professional preparation including observations and practice teaching.

The preparation of all the high school science teachers in two counties in the Shenandoah Valley was studied in detail. Of a total of 27 science teachers, 9 (33%) held an A. B. degree, 8 (about 30%) held a B. S. degree, 1 (3.7%) held both a B. S. and M. A. degree, and 9 (33%) held no degrees.

In Virginia we find the load is not excessive.[13] Few teachers teach more than 5 or 6 periods a day, or more than 150 pupils a day. This means the average size of the class is not over thirty pupils.

The average salary for the city high school teacher is $150 per month, or on a basis of a 9 month school term it is $1,350 a year. The county high school teacher's salary is $130 per month or $1,170 a year.[14]

The results of a distribution or distribution curve of equipment values is shown by the above table.[15] The average value of

[10] Annual Report of the Superintendent of Public Instruction. 1928-29. P. 59.

[11] *O'Shea Survey Report,* 1928, p. 186.

[12] *Regulations Governing the Certification of Teachers in Virginia.* Bulletin, State Board of Education, Richmond, Va., January, 1930, p. 6.

[13] *O'Shea Survey Report,* p. 188.

[14] *Annual Report of Superintendent of Public Instruction,* 1928-29, pp. 28-45.

[15] Data for this study were kindly furnished by Mr. Thos. D. Eason, and Mr. David Peters of the State Board of Education, Richmond, Va.

equipment for the number of schools that reported is given in the first column. Taking chemistry as an example, we see that for the 284 county high schools reporting that they teach chemistry the average value of the equipment was $292. The second column shows that the median or the measure of central tendency of the chemistry equipment for the county high school is valued at $200. This means that 50% of the schools have equipment valued above this amount and 50% are below this amount. Skipping to the fifth column, we have the range of the curve showing both the lowest and highest value of equipment. For Chemistry in the 284 county high schools reporting, the lowest value is $10 and the highest is $2,000. Column three gives Q_1, meaning the first quartile. This shows that 25% of the 284 county high schools reporting have chemistry equipment valued at less than $150. The Q_3 column shows that 25% of these schools have chemistry valued at more than $300.

(Data for this section and also for sections 8 and 9 were secured from the replies to the survey questionnaire.)

The amount of money expended annually for replacement and breakage, and for new equipment is shown in Table II.

The number of schools reporting is small because many schools do not spend money each year for new equipment.

Table III shows the principal's estimate of the amount needed to complete the apparatus in each of the sciences in order to do efficient work. It would be well to make a study later on of the individual schools taking into account the enrollment in each science, value of apparatus on hand for each science, the values in Table III, also the state requirements as set forth in the Bulletin entitled "Laboratory Equipment for Science Instruction in High Schools of Virginia," State Board of Education, Richmond, 1924.

TABLE II. AMOUNT EXPENDED ANNUALLY

Subject	Average	Median	Q_1	Q_3	Range	No. Schools Reporting
		For Replacement and Breakage				
Gen. Science	$25.08	$15	$10	$30	$2-150	149
Biology	33.24	15	10	25	2-200	132
Physics	31.64	25	15	50	3-150	37
Chemistry	38.29	25	12	50	3-325	137
		For New Equipment				
Gen. Science	25.46	20	10	25	1-410	132
Biology	24.45	20	10	25	2-125	117
Physics	31.77	25	10	50	4-200	35
Chemistry	30.29	20	12	30	3-125	121

TABLE III. ESTIMATED NEED TO PROVIDE SUFFICIENT APPARATUS

Subject	Average	Median	Q_1	Q_3	Range	No. Schools Reporting
Gen. Science	$ 87.40	$ 50	$25	$100	$ 5- 750	132
Biology	126.96	50	25	150	5-1500	116
Physics	218.48	150	50	400	12-1000	33
Chemistry	137.64	50	40	150	5-1000	101

7. *Laboratory Finances*

In the 221 schools which reported, the science laboratories in 157 schools are financed by local funds (taxes) alone, 11 by laboratory fees alone, 6 by state funds, and 47 by local funds and laboratory fees.

8. *Laboratory Work*

Data were secured on various aspects of laboratory work as shown below:

a. Size of groups

The average size of the groups working together in general science is 3 (pupils) in biology, 3; in physics, 2; and in chemistry, 3.

b. Number of experiments performed per year

The average number of experiments performed during the year in general science

is 78.4; in biology, 81; in physics, 48; and in chemistry, 78.

c. Number of demonstrations performed per year

In 193 schools demonstrations performed during the year in general science range from 3 to 215; in biology from 2 to 125; in physics from 2 to 100; and in chemistry from 2 to 200.

d. Number of complete sets of apparatus

In the schools reporting, the average number of complete sets of apparatus in general science is 7, in biology 6, in physics 2, and in chemistry 7, and the range for general science is 1-85; for biology 1-50; for physics, 1-100; and for chemistry 1-50.

e. Number of rooms used for laboratory exclusively

The results indicate that in 193 schools 124 have a room used exclusively for laboratory purposes.

f. Number of rooms used for laboratory and classroom

Results indicate that in 193 schools 230 rooms are used both for laboratory and classroom purposes.

From a study of Table IV we see that of the total science enrollment in the schools reporting in the state, general science enrolls 45.2%, or almost half. Similarly, the percentages for the other three sciences are: biology, 35.7%; physics, 3.6% and chemistry, 15.4%. Why, in such a scientific age as ours, should so few take physics?

Table V shows that the average size of the sections for the whole state for the various sciences is as follows: general science, 27.6; biology, 24.8; physics, 16.9; chemistry, 17.4, the range being from 10 to 45. In a similar way the average size of sections is shown for the county and city high schools. We notice that the largest sections occur in general science in the cities. We also notice that in all the sciences the largest sections are in the cities. It should be remembered that while the city schools have larger sections, statistics show that they usually have better apparatus which offsets to some extent the disadvantage of large sections.

9. *Enrollment and Size of Classes*

TABLE IV. ENROLLMENT IN THE SCIENCE COURSES

Location	No. Schools Reporting	General Science	Per Cent	Biol.	Per Cent	Physics	Per Cent	Chemistry	Per Cent	Total No. Pupils
State	226	9316	45.2	7346	35.7	745	3.6	3178	15.4	20,585
County	215	6138	41.9	5644	38.4	381	2.6	2499	17.1	14,662
City	11	3178	53.6	1702	28.8	364	6.7	679	11.4	5,923

TABLE V. AVERAGE SIZE OF CLASSES AND SECTIONS

Location	No. Schools Reporting	General Science	Biology	Physics	Chemistry
State	226	27.6	24.8	16.9	17.4
County	215	24.4	23.5	16.5	16.6
City	11	35.3	30.3	17.3	21.2

It is interesting to note that of 859 sections studying the sciences in the state, 380 sections have an enrollment larger than 24, which number is regarded by many teachers as the maximum for efficient work.

The average size of these sections was obtained by dividing the total number of pupils taking the science by the total number of sections.

10. *Chemistry in the Rural High School*

While there has been great improvement in the methods of teaching and in the sub-

ject matter of chemistry during the past half century, there has been relatively little growth in its popularity as a high school subject in rural communities. This is largely due to the prevailing notion that it costs too much to install and replace material and requires a special room for the laboratory work of the course. Too, there has been an insufficiency of competent chemistry teachers available for rural schools.

The vital significance of chemistry in the lives of rural students conclusively establishes its importance in their course of study. Chemical processes are the foundation of all living, and, only as he conforms to them, can a person become a happy, healthy, efficient member of a community. The rural student's contact with the natural world necessitates an understanding of the chemistry of air, water, salts, acids, and alkalies. The predominance of his interests in food, fuel, shelter, and clothing enhances the value of a knowledge of the compounds of carbon, hydrogen, oxygen, nitrogen, etc.

The organization of a course in chemistry for rural students would probably differ from that in larger schools, for the reason that a smaller percentage of them would be specializing in the subject. Therefore, it should be an inclusive unit, developed psychologically rather than logically bearing in mind that the majority of students would not go to college. Its aims should point towards the appreciation and interpretation of the truths of chemistry and to the intelligent usage of these truths in farm life.

As for the costs of teaching chemistry in small rural schools, let us quote C. E. Osborne's paper[16] on making high school chemistry worth while: "Chemistry in the small rural and all rural high schools is of great importance. When the state supervisor of high schools asked me to tell him the minimum of equipment to teach chemistry that I considered necessary to make it worthwhile, in a small high school, I said, "a bucket of water for water supply, an empty water bucket for a waste jar, a kitchen table, a spirit lamp, and a ten dollar supply of chemicals." The only other absolute necessity, according to Mr. Osborne, is "a teacher who must know definitely what he is trying to do." The minimum requirements for high school chemical laboratory equipment in Virginia are set forth in the manual of the State Board of Education.[17]

11. *Comparison of Science Instruction in Virginia With That of Other States and With National Tendencies*

In the preceding pages several comparisons have been made already between Virginia and South Dakota. There are two reasons why South Dakota was used for comparison: first, because in both states the small type of high school predominates, and second, because data on South Dakota was available in Professor Jensen's clear, concise article.[18]

Another item may be mentioned, namely that the average value of equipment in the different sciences in these two states is nearly the same, e. g., $136 for general science equipment in Virginia and $134 in South Dakota. The average salary of teachers, however, in the two states is different. The salary of the rural high school teacher in Virginia was $1,170 in 1928-29, while in South Dakota the salary in 1924-25 was $1,425.

In a study made by George W. Hunter[19] concerning the curricular tendencies with respect to science as indicated by a study of curricular practices in 357 representative American high schools, he found that dur-

[16] *Making High School Chemistry Worth While,* C. E. Osborne, Head of Chemistry Department, Oak Park-River Forest Township High School, Oak Park, Ill. *Journal of Chemical Education,* Vol. 1, No. 5, May, 1924, p. 104.

[17] *Laboratory Equipment for Science Instruction in High Schools of Virginia,* Bulletin, State Board of Education, Richmond, Va. 1924.

[18] J. H. Jenson—High School Science Survey of South Dakota; *Journal of Chemical Education.* Vol. 4, No. 7, p. 897.

[19] George W. Hunter, *School and Society,* Dec. 13, 1924, Vol. XX, pp. 762-766.

ing fifteen years (1908-1923) the "course in general science, biology, chemistry, and physics increased in the four year secondary school; while those in physiography, botany, zoology, human physiology, and scattering courses in science have decreased." Virginia has by far a larger enrollment in general science, biology, chemistry and physics than in any of the other sciences, and thus is in line with the national tendency.

In a survey of the status of general science in California made by Will S. Kellogg[20] the statistics gathered from 337 high schools show that 92% of the high schools offer a course in general science. Virginia also has a high percent of high schools teaching general science.

Trafton[21] and others investigated the general science situation in Minnesota. Their work included a study of the changes of enrollment in the high school sciences from 1915 to 1920. The most conspicuous feature shown is the phenomenal growth of general science.

Further comparisons of science instruction in Virginia with that of other states are being worked out, and the results will be published later.

12. *Recent Researches in Science Instruction*

It is difficult to give an adequate abstract of these researches in a brief space, but, at least, the reader will be impressed with the fact that improvement investigations are being carried out in a scientific way, and that the results are of interest and value to science teachers in Virginia.

Francis D. Curtis[22] found (1) "General science on the whole is poorly taught because it is intrusted to teachers who are unprepared. (2) A general science teacher should have a knowledge of physics, chemistry, botany, zoology, astronomy and geology. (3) General science is better omitted than given as a reading course. (4) Because of lack of equipment and qualified teachers in most cases, educational agencies of every sort should discourage the tendency to introduce general science in the 8th grade of elementary schools.

The Research Bulletin[23] of the National Education Association (Sept., 1929) published a summary of Research in High School Science with references which is exceedingly valuable. Its contents are so valuable that it would be well for readers to send for it. Send twenty-five cents in stamps to the National Education Association, 1201 Sixteenth St., N. W., Washington, D. C. The article includes a modern view of the aims of science, a synopsis of various curricular studies in the field of science, and a review of recent learning studies in the field of science. Space forbids any but the briefest mention of some generalizations arrived at, which are given herewith: (1) One of the greatest needs of today is to have science instruction really prepare for rational scientific living, and thinking in our day when frauds, fads, cults and superstitions are so much in evidence. (2) The scientific attitudes should be definitely taught. (3) Studies in interest in scientific subjects on the part of adults, and girls showed that astronomy was the predominant interest. Next came the radio and various phases of electricity, followed by earthquakes, volcanoes, weather, air, airplanes, etc.

Investigations in the Teaching of Science in Secondary Schools by Francis O. Curtis (P. Blakiston's Son and Co., 1926), contains a digest of 70 different learning and curricular studies by such writers as Cunningham, Meister, Hunter, Webb, Beauchamp, Cooprider, Persing, Curtis, Finley,

[20]W. S. Kellogg, Survey of the Status of General Science, *General Science Quarterly* VI 1921, p. 373.

[21]Trafton and Others, General Science in Minnesota. Outline of Course, *General Science Quarterly*, Vol. V. p. 207-219. November 1920.

[22]Francis D. Curtis, University of Michigan School of Education Bulletin, p. 18, November, 1929.

[23]Research Bulletin, N. E. A. September, 1929, page 218-22.

Watkins, Caldwell, and Powers. Progressive teachers would do well to secure this very worth while book.

In conclusion the writer desires to express his sincere thanks to Mr. Eason and Mr. Peters of the State Board of Education in Richmond for their hearty co-operation in this survey.

FRED C. MABEE

VIRGINIA SCIENTISTS AND INVENTORS

VIRGINIA'S roll of honor includes several scientists and inventors with whose lives and work every science teachers of our state ought to be familiar. Of these, five were selected: Maury, Mallet, McCormick, Walter Reed, and Richard Byrd. A study of the life and work of these men cannot fail to stimulate the deep interest of the teacher in the splendid work of these men, and such interest almost inevitably spreads by contagion to the pupils.

The historical background provided by these biographies, together with the recognition of the need[1] in Virginia of a *far more* intensive education on the *scientific* side, ought to produce a more stimulating type of teaching.

Dr. John C. Metcalf,[2] Dean of the Graduate School of the University of Virginia, recently called attention to the profound educational values inherent in well-written biography. He stated furthermore that in recent years biographical reading has been increasingly in vogue, and that fortunately good material has been available. It is hoped that the five brief biographies submitted herewith will serve to whet the appetite of science teachers for additional reading relating to these "science heroes"—an appetite which may be satisfied in part, at least, by the appended brief bibliographies.

[1]O'Shea Survey Report, 1928, p. 9, 11.
[2]Founder's Day address at the State Teachers College, Harrisonburg, March 24, 1930.

MATTHEW FONTAINE MAURY

Matthew Fontaine Maury was born in Spottsylvania County, Virginia, on January 14, 1806.

At the age of eighteen he joined the Navy, where he stayed until 1839, leaving because of an accident which made him a cripple for life. Soon after the accident he was put in charge of the Hydographic office in Washington. In 1861 he left this to join the Confederate Navy. Here he began the establishment of the Naval Submarine battery service at Richmond. After beginning this work Maury went to Europe, where he worked on the torpedo, trying to perfect its use. In 1868 he became professor of physics at V. M. I., Lexington, Va.; he remained there until his death in 1873. He was buried in Hollywood cementery, Richmond, Virginia.

Maury's contributions to science were concerned chiefly with the Navy, but were of far-reaching significance in several fields, *viz.,* Oceanography, Meteorology, Georgraphy. He explored the depth of the ocean and in 1855 published his *Physical Geography of the Sea and its Meteorology.* He advocated for many years the establishment of a national weather bureau especially for farmers. He conducted a systematic observation of the rise and fall of water in the Mississippi River. His life and work stand as a tremendous inspiration to any one pursuing studies in science, and should be especially stimulating to all Virginians.

Evidence that Virginians, at least, are not unmindful of his splendid service to mankind is found in buildings named in his honor, such as the High School in Norfolk, Maury-Brook Hall at V. M. I., Lexington, Va., and Maury Hall (the science building) at the Harrisonburg State Teachers College; also in a number of monuments, especially the one erected in his honor at Goshen Pass, and the one recently unveiled on Monument Avenue in Richmond.