DEPARTMENT OF THE INTERIOR
BUREAU OF EDUCATION

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IN SEVEN PARTS

THE PUBLIC SCHOOL SYSTEM OF MEMPHIS, TENNESSEE

REPORT OF A SURVEY MADE UNDER THE DIRECTION OF THE COMMISSIONER OF EDUCATION

PART 4

SCIENCE

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
BUREAU OF EDUCATION,
Washington, September 25, 1919.

SIR: I am transmitting herewith for publication as a bulletin of the Bureau of Education the report of a survey of the schools of the city of Memphis, Tenn., made under my direction. I am asking that it be printed in the following seven parts:

Part 1. Chapter I. An Industrial and Social Study of Memphis.
Chapter II. School Organization, Supervision, and Finance.
Chapter III. The Building Problem.
Part 2. Chapter I. The Elementary Schools.
Chapter II. The High Schools.
Part 3. Civic Education.
Part 4. Science.
Part 5. Music.
Part 6. Industrial Arts, Home Economics, and Gardening.
Part 7. Health Work.

Respectfully submitted.

P. P. CLAXTON,
Commissioner.

The SECRETARY OF THE INTERIOR.

THE PUBLIC SCHOOL SYSTEM OF MEMPHIS, TENNESSEE.

INTRODUCTION.

In April, 1919, at the request of the Board of Education of Memphis, Tenn., the United States Commissioner of Education submitted the conditions on which the Bureau of Education would make a survey of the public school system of that city. These conditions, as stated by the Commissioner of Education, follow:

(1) That the board of education, the superintendent of public schools, and all other public officers and teachers connected with the schools will give me and the persons detailed to make the survey their hearty cooperation, to the end that the survey may be made most effectively and economically.

(2) That the survey committee be permitted to find the facts as they are, and, in so far as may seem advisable, to report them as they are found.

(3) That the findings of the survey committee and such recommendations for the improvement of the schools as may seem to be desirable may be published as a bulletin of the Bureau of Education at the expense of the Federal Government for distribution, first, among the citizens of Memphis and, second, among students of education throughout the country.

(4) That the necessary expenses of the survey, including expenses for travel and subsistence for employees of the bureau detailed for this work, and the honorariums and expenses of the one or more additional persons whom it may be necessary to employ to assist in the work will be paid by the board of education. It is understood, however, that the board will not be obligated for expenses beyond $5,000.

It is my purpose to begin the survey on or before May 12 and to have the field work of it finished in June. The final report will be submitted and printed as early as possible after the 1st of July. Such portion as may be needed by the board in determining their building policy for next year will be submitted as much earlier than the 1st of July as possible.

On May 5 the commissioner was notified that all the conditions named had been agreed to. To assist him in making this study the commissioner appointed the following commission:

THE SURVEY COMMISSION:

Frank F. Bunker, *Specialist in City School Systems, Bureau of Education, director of the survey.*

Thomas Alexander, *Professor of Elementary Education, Peabody College for Teachers, Nashville, Tenn.*

William T. Bawden, *Specialist in Vocational Education, Bureau of Education.*

Hiram Byrd, *Specialist in Health Education, United States Public Health Service.*

Elmer W. Christy, *Supervisor of Industrial Education, Public Schools, Cincinnati, Ohio.*
Fletcher B. Dresslar, *Specialist in School Architecture, Sanitation, Buildings, and Equipment, Bureau of Education.*
Arthur W. Dunn, *Specialist in Civic Education, Bureau of Education.*
Will Earhart, *Supervisor of Music, Public Schools, Pittsburgh, Pa.*
Alice Barrows Fernandez, *Specialist in Social and Industrial Problems, Bureau of Education.*
Florence C. Fox, *Specialist in Primary Grade Education, Bureau of Education.*
Ada Van Stone Harris, *Director of Elementary Practice Teaching, Public Schools, Pittsburgh, Pa.*
Carrie A. Lyford, *Specialist in Home Economics, Bureau of Education.*
F. A. Merrill, *Specialist in School and Home Gardening, Bureau of Education.*
John L. Randall, *Specialist in School and Home Gardening, Bureau of Education.*
Willard S. Small, *Specialist in School Hygiene and Physical Education, Bureau of Education.*
George R. Twiss, *Professor of Secondary Education and State High School Inspector, Ohio State University.*

The field work began May 12 and was completed June 7, except that two members of the staff remained two weeks longer.

While the time for the examination of conditions was short, the schools closing for the year on June 13, nevertheless, through careful organization of the work and through frequent meetings of the staff for the discussion of every phase of the problem, definite and positive conclusions in which all concurred were quickly reached. Although the commission as a whole considered every important activity of the work of the system, each member was assigned to the particular field of his interest. The reports of the members of the commission were organized by the director of the survey and transmitted to the Commissioner of Education for his approval. The report is issued in separate parts for general circulation.

THE PARTS TO BE ISSUED.

Part 1. Chapter I. An Industrial and Social Study of Memphis.
Chapter II. School Organization, Supervision, and Finance.
Chapter III. The Building Problem.
Part 2. Chapter I. The Elementary Schools.
Chapter II. The High Schools.
Part 3. Civic Education.
Part 4. Science.
Part 5. Music.
Part 6. Industrial Arts, Home Economics and Gardening.
Part 7. Health Work.

This study of the Memphis schools is intended to be a study of policies and of practices; not of persons. The commission has con-

sciously avoided either praising or blaming, crediting or discrediting, individuals. The matter of placing an estimate upon the value of the services which individuals are rendering is the duty of local authorities; it falls outside the province of the survey commission and has not been attempted.

The commission desires to express its appreciation of the courtesy and consideration shown its members by citizens of Memphis, the members of the board of education, the secretary's office, the superintendent and his clerks, and the entire school corps. Without exception, all cooperated to make the investigation as thorough and as efficient as the time would permit.

A special word of appreciation is due the management of the Young Men's Christian Association for providing office rooms and equipment for the staff, without charge, and to the local company handling the Burrough's Adding Machine, which very kindly loaned one of these machines to the staff.

A summary of conclusions and recommendations will be found at the end of each chapter.

PART 4. SCIENCE.

CONTENTS.—1. Science in the elementary schools—Science related to other subjects; supervision needed. 2. Science in the Central High School—In the curriculums; pupils taking science; sequence of courses; quality of teaching; more teachers needed; the science equipment. 3. Science in the Vocational High School—Quality of teaching; a plan of science work needed. 4. Science in the Kortrecht High School (colored).

1. SCIENCE IN THE ELEMENTARY SCHOOLS.

According to replies made to our inquiries by numerous officials and teachers, there is no science or nature study work in any of the elementary grades. With respect to this feature, Memphis is perhaps like the majority of school systems with which it may fairly be compared, but distinctly behind those that are most progressive. Science and nature study lessons in some form constitute a part of every really progressive elementary school curriculum.

SCIENCE RELATED TO OTHER SUBJECTS.

Such lessons should not attempt to present science in the form and order in which it is presented in high school and college textbooks. The lessons should be largely concerned with simple facts of a scientific nature that the children can learn by direct observations or from simple experiments that they can understand and even make for themselves. The lessons should grow naturally out of the other lessons and projects at which the pupils are working from day to day. For example, if they are learning about weights and measures in arithmetic, they ought at the same time to learn by use and experiment the simple principle of the equal arm balance and many easily understood facts about balancing, center of gravity, and stability that are related to this principle. In connection with their lessons in hygiene which should be given in every grade, the children should learn some of the simpler facts of physiology on which our knowledge of hygienic laws are based. Alongside their lessons in music and singing, they ought to learn some of the simple facts about sounds, about how musical tones are produced, and what are the physical causes of the differences in loudness, pitch, and tone quality upon which the musical properties of sounds depend.

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School gardening, poultry keeping, bird study, the care of house plants and animal pets, and the suppression of harmful insects and other pests should furnish a rich assortment of projects and problems out of which profitable science lessons may grow.

Geography, in the elementary grades is another subject that bristles with facts affording opportunities for firsthand learning of simple principles of physics, chemistry, and biology through observations and experiments that can easily be made by young children under suitable guidance.

Science lessons in the elementary grades, though closely connected with the other studies and growing naturally out of them, ought not to be merely incidental and without plan. There should be a well-conceived and well-balanced development of a body of scientific facts, through first-hand experiences with them, but with very little theory, from the lowest grades up to the seventh. In the seventh and eighth grades there should be a systematic course in general or introductory science, based on one of the best of the recent textbooks on that subject, to be used as a guide by the teacher, but not as a basis of set book lessons by the pupils. The book should be used by the pupils as a basis for systematic reviews and as a guide to systematic organization of principles and the facts which they describe.

SUPERVISION NEEDED.

Such a scheme of science lessons in the grades is a very vital and important part of public education; but if left to the teachers to develop and conduct, it will not be a success. There should be a supervisor of elementary science instruction whose business it would be to plan the scheme of lessons, to teach the teachers how to teach it, to give model lessons in the various grades, and to supervise and test the work of instruction done by the teachers. *We recommend that such a science supervisor be employed, who shall immediately begin the gradual introduction of such a scheme of lessons, perfecting and extending the course as fast as teachers can be trained properly to do the work.*

2. SCIENCE IN THE CENTRAL HIGH SCHOOL.

SCIENCE IN THE CURRICULUMS.

From the table below, which has been compiled from the chart showing the curriculums of the Central High School, one can learn what sciences are offered, in what grades each may be taken, in what curriculums each may be taken, and whether in any curriculum it is required or elective or not offered.

TABLE 1.—*Science studies required and elective in the eight curriculums of the Central High School.*

Science studies.	Latin.			History.			Scientific.			Modern language.			Commercial.			Technical.		
	Grade.	Required.	Elective.	Grade.	Required.	Elective.	Grade.	Required.	Elective.	Grade.	Required.	Elective.	Grade.	Required.	Elective.	Grade.	Required.	Elective.
General science	9	....	e	9	....	e	9	r	....	9	....	e	....	....	....	9	....	e
Botany and zoology	10	....	e	{[1] 11	....	e	10	r	....	10	....	e	....	....	....	....	....	....
				{[1] 11	....	e												
Physical geography	11	....	[2]e	12	....	[2]e	12	....	e	11	....	e	....	....	....	10	....	e
Physics	11	....	[2]e	12	....	[2]e	11	r	....	11	....	e	....	....	....	11	r	....
Chemistry	12	....	e	12	....	[2]e	12	r	....	12	....	e	....	....	....	12	r	....
Household chemistry	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Number of sciences required	0	....	....	0	....	....	4	....	....	0	....	....	0	....	....	2	....	....
Number elective	....	....	4	....	....	4	....	....	1	....	....	5	....	....	0	....	....	2
Total offerings	....	....	4	....	....	4	....	....	5	....	....	5	....	....	0	....	....	4

Science studies.	Home economics.			Elective.			Required in.	Per cent of all.	Elective in—	Per cent of all.	Not offered in—	Per cent of all.	Total.	Per cent of all.
	Grade.	Required.	Elective.	Grade.	Required.	Elective.								
General science	9	....	e	9	....	e	1	12.5	6	75	1	12.5	7	87.5
Botany and zoology	....	....	....	{[1] 10	....	e	1	12.5	4	50	3	37.5	5	62.5
				11	....	e								
				12	....	e								
Physical geography	....	....	....	11	....	e	0	0	6	75	2	25	6	75
Physics	....	....	....	12	....	e	2	25	4	50	2	25	6	75
Chemistry	12	....	e	12	....	e	2	25	5	62.5	1	12.5	7	87.5
Household chemistry	11	r	....	....	....	....	1	12.5	0	0	7	87.5	1	12.5
Number of sciences required	....	1	....	....	0	....	....	....	....	....	....	....	....	....
Number elective	....	....	2	....	....	5	....	....	....	....	....	....	....	....
Total offerings	....	....	3	....	....	5	....	....	....	....	....	....	....	....

[1] Either botany or zoology may be elected.
[2] Either physical geography or physics must be elected.
[3] Either physical geography or physics or chemistry must be elected.

The first and second columns taken together are to be read as follows:

In five of the eight curriculums no science studies are required; in one of them only one is required; in another two are required; none of them require three, one requires four; and none require five, or more than five. The first and third columns and the first and fourth are read together in a similar manner.

This table becomes rather startling to anyone who is impressed with the importance of the spread of scientific education; when it impresses upon him the fact that in this great high school, where a great and growing city needing science for its future development is training its future leaders, the pupils who choose any one of five

out of the eight curriculums can get by without studying any science whatever, and that in only two of the eight curriculums, the scientific and the technical, are the students obliged to take more than one science study.

The case looks a little better when we examine the last column, and find that six out of the eight curriculums offer either four or five sciences either required or elective; and one more offers three sciences. In the one remaining, however, the commercial curriculum, the pupils can get no science training at all.

For example, in the first line of this table we read that "general science" is offered in the ninth grade of the Latin curriculum, as an elective, in the ninth grade of the history curriculum as an elective, and in the ninth grade of the scientific curriculum as a required study. It is also elective in the ninth grade in all the other curriculums excepting the commercial, in which it is not offered. In the synopsis at the end of the line we read that it is required in only one, or 12.5 per cent of the eight curriculums, but is offered as an elective six, or 75 per cent, of them, and is not offered at all in one, or 12.5 per cent of them.

The summary at the bottom of the table gives the number of required science studies, the number elective, and the total number offered, in the case of each curriculum. This summary becomes more instructive if we distribute the figures in a slightly different way, as shown in Table 2.

TABLE 2.—*Number of curriculums that offer each number of science studies.*

Numbers of science studies.	Number of curriculums offering—		
	Required.	Elective.	Total required and elective.
No science studies	5	1	1
One science study	1	1	0
Two science studies	1	2	0
Three science studies	0	0	1
Four science studies	1	2	3
Five science studies	0	2	3

We have seen that there are ample opportunities, on paper, for the pupils of Central High School to study science. How many of them are studying it? As many as ought to be? What sciences are they studying? Are the teachers overloaded? Table 3, made up from the teachers' organization reports, enables us to answer these questions.

TABLE 3.—*Distribution of science studies by subjects, grades, and sex of pupils.*

Name of science.	Grade.	Semester.	Boys.	Girls	Total.
General science	9	1	21	7	28
Do	9	1	15	7	22
Do	9	1	11	8	19
Do	9	2	19	6	25
Do	9	2	13	15	28
Do	9	2	8	3	11
Botany and zoology	10	1	9	19	28
Do	10	1	16	5	21
Do	10	1	10	14	24
Do	10	2	7	2	9
Physiography	11	1	4	7	11
Do	11	2	2	13	15
Physics	12	1	14	4	18
Do	12	2	14	7	21
Chemistry	11	1	21	21	42
Do	11	2	17	12	29
Do	11	2	13	11	24
SUMMARY.					
General science	9	1	47	22	69
Do	9	2	40	24	64
Total	9	1,2	87	46	133
Botany and zoology	10	1	35	38	73
Do	10	2	7	2	9
Total	10	1,2	42	40	82
Physiography	11	1	4	7	11
Do	11	2	2	13	15
Total	11	1,2	6	20	26
Physics	12	1	14	4	18
Do	12	2	14	7	21
Total	12	1,2	28	11	39
Chemistry	11	1	21	21	42
Do	11	2	30	23	53
Total	11	1,2	51	44	95
Total, general science	9	1,2	87	46	133
Total, botany and zoology	10	1,2	42	40	82
Total, physiography	11	1,2	6	20	26
Total, physics	12	1,2	28	11	39
Total, chemistry	11	1,2	51	44	95
Total, all science	All.	1,2	214	161	375

[1] Both in one section.

TABLE 4.—*Ratio of pupils taking science in each grade to enrollment in that grade, and ratio of pupils to teacher-hours in each grade.*

Sciences.	Number pupils per teacher-hour.	Number teachers.	Pupils in science.	Pupils in grade.	Per cent of pupils in grade who take science.	Grade in which science is taken.	Number of sections.	Sections per teacher.
General science	22.2	1.2	133	576	23.1	9	6	.5
Botany and zoology	20.5	.8	82	357	22.9	10	4	.5
Physiography	26.0	.2	26	221	11.8	11	1	.5
Chemistry	31.6	.6	95	221	43.0	11	3	.5
Physics	19.5	.4	39	154	25.3	12	2	.5
Total science	23.4	3.2	375	1,808	28.7	All.	16	.5

PERCENTAGE OF PUPILS TAKING SCIENCE.

In order to bring together the most significant facts of this table and compare them with the enrollment data, Table 4 has been made. This assists in the quick interpretation of Table 3. From Table 4, column 5, we can see what per cent of the pupils in each grade are taking science and what science they are taking. The answer for the first two years and the last year of the high school is that about one-quarter of them are, and for the third year about one-half. Evidently science is not unusually popular in the school, for only 28.7 per cent of the pupils enrolled in this school are taking any. This is about the percentage that would have to take it on account of the graduation requirement of a minimum of credit of one unit in science. *A far larger number of these pupils ought, in our opinion, to be studying science, and as free election does not bring this about we suggest that more of it be required, as outlined and explained in Part II, Ch. II, on the science sequence in the curriculums.*

SEQUENCE OF SCIENCE COURSES.

Tables 3 and 4 show the sequence of courses in science. The order might be justified by the argument that it is substantially the same as that in many good high schools. We believe, however, that "general science" should be placed in the seventh and eighth grades and required of all pupils. Every argument that is made in behalf of general science is made stronger by placing it in these grades instead of in the ninth, where it now is. The only valid argument that we know of against placing it there is that there are so very few elementary teachers who are qualified to do the work. The answer to this argument is contained in our recommendation in the first section of this chapter. If the work ought to be done, and we believe most emphatically that it ought to be, then a sufficient number of promising teachers should be picked out and trained for it. Then let these few teach all of it and nothing else. This might easily be worked out under a special supervisor, as we have already recommended. With general science where it belongs, we recommend civic biology for the ninth grade in all curriculums (to be optional with community civics), general geography in the tenth, physics in the eleventh, and chemistry in the twelfth. This science is justified and explained in *Part II, Ch. II*, on the high school.

Tables 3 and 4 show that the classes in science, with the exception of two classes in chemistry, are not too large, and that the science teachers are not seriously overloaded on the basis of the number of pupils each must teach per hour. However, the time schedule shows

that each one is occupied with science classes or other classwork during each of the five hours of the school day. This leaves them no time within school hours for setting up and putting away apparatus that is used for demonstration and for pupils' experiments. At least one hour per day should be allowed each of them for such work and for the examination of notebooks. To provide for this the full time of an additional teacher is needed now for science. The teacher of physics and chemistry and the teacher of general science are especially in need of relief.

THE QUALITY OF SCIENCE TEACHING.

We come now to the question as to how well the sciences are taught. On this point our observations and inquiries led us to the conclusion that to most of those who take it general science is being made attractive and interesting. There was evidence of this both in the class work observed and in the pupils' replies to our questionnaire. There seems, however, to be very little of individual laboratory work by the pupils and not much of experimental demonstration by the teacher. There is too much straight recitation work from the textbook and far too little of appeal to direct observation and experiment, which constitute the very foundation of science. There was no evidence of inductive teaching or of training in the scientific method of thinking and of attacking problematic questions. The course was almost wholly informational and bookish in character. We were informed by the teacher, however, that some valuable class excursions were made, and that boys interested in making wireless-telegraph experiments and model airplanes outside of school were encouraged to bring them in and explain them to the class. This is good, so far as it goes, for arousing interest and stimulating initiative.

The administrative expedient has been resorted to of giving one section of this subject to a Latin teacher, who is not specially trained in science. Her work in this subject is much more bookish than that of the other teacher, and apparently far less effective. It is more probable that this lady should be commended for her willing spirit in doing her best with a subject in which she is not well prepared than that she should be criticized for not doing better. The remedy lies in our recommendation that an additional science teacher be employed. This teacher could then be relieved of science work.

What has been said of this teacher's work applies also to the teaching of zoology and botany in the tenth grade. The teaching observed and the condition of the equipment in the room where these subjects are taught were sufficient to convince the observer

that, though her spirit and enthusiasm are commendable, her special training in that particular line is inadequate for the kind of work that should be done in biology in a modern high school. Nothing of discredit should be attached to these teachers if, as we recommend, they be assigned to other work for which they are better prepared as soon as the conditions which made it expedient to ask them to take science work can be removed. Rather they should receive the thanks of the administration for putting their shoulders to the wheel when there was need and doing as well with the work as they have done.

Another condition which does not make for the best type of science work exists in connection with the eleventh-grade physiography. The first-semester class and the second-semester class in this subject are so small that it was found expedient to combine them in one section. Thus there were in one section, working together, one group of pupils who had studied the subject for a half year longer than the other group. Such a class is very difficult to handle in a way that is fair and satisfactory to both groups. Furthermore, the teacher of this one class has for the remainder of her work four sections in first-year algebra, so that in the case of the Latin teacher above referred to her science class is, as it were, a mere side line. This teacher has had some good special college preparation in physiography, in which she evidently took much interest and did good work. There was, however, the same apparent tendency to bookishness and lack of breadth in the teaching here as noted in the other two sciences. There was also a similar lack of system in caring for and using the somewhat meager equipment provided for this department. We have recommended a broader course—general geography—for the second year in all curriculums, which would require the organization in 1920–21 of about 13 or 14 sections in this important subject. In our opinion this teacher should be encouraged to go on with further preparation in geography with a view to giving her full time to the work. With this as her only work and her chief interest and with further training in the method and content of general geography we believe that she would develop into an excellent teacher of the subject.

The teaching of chemistry, though not free from some of the faults that have been noted in *Part II, Ch. II*, on the work of the teachers of all departments, appears to be very successful. This is probably due largely to the fact that the teacher has specialized strongly in the subject, and has also had good all-round training in science, and is a man of maturity and experience in the work. His teaching load, however, is too heavy, and we recommend that he be relieved by employing another man to conduct the work in physics and build

up the classes in this subject until it reaches and maintains the prominence in the school that it should have.

At present there are two extra classes in chemistry that are run on the schedules of two of the regular classes, thus dividing the attention and effort of the teacher of physics and chemistry. One of these is a voluntary class of four girls in household chemistry, and the other a voluntary class of boys in analytical chemistry. These are both successful, though for the teacher they represent voluntary work undertaken in the service of pupils who have developed special interest in chemistry. There is a fine field in this school and community for the development of some special advanced classes in chemistry for those pupils who are aiming at employment in agriculture, pharmacy and the cotton and lumber industries; and the teacher of this subject is anxious to develop them. In order to do this, it is essential that he be relieved of the physics classes as suggested above.

MORE SCIENCE TEACHERS NEEDED.

If the science program that we have recommended should be adopted by the board, it will be necessary gradually to increase the number of science teachers as the classes successively swing into the new curriculums. The number of classes to be provided for would probably be approximately as follows:

Number of classes to be provided in the science program recommended.

Subject.	Number of pupils.	Number of classes.	Number of teachers.	Grade.
Civic biology	300	11	2.2	Ninth.
General geography	350	14	2.8	Tenth.
Physics	75	3	.6	Eleventh.
Household physics and chemistry	50	2	.4	Do.
Art reproduction	20	1	.2	Twelfth.
Chemistry, general	80	3	1.0	Do.
Chemistry, advanced	30	2		
Total	905	36	7.2	

This is only a rough estimate, based on such meager data for prediction as are now available, but it is believed to be not far from what would be true if the new curricula were in operation. Allowance has not been made for increased numbers of pupils in the school, the prediction being based on present enrollment. Some allowance should be made for an annual increase in attendance, which, if the recommendations of the survey are carried out, will probably be greater than the normal increase due to growth in population. As the full time of three teachers is now engaged and two-tenths of the time of a fourth, the curriculum changes recom-

mended would probably involve engaging four additional teachers for science. This does not necessarily mean four additional teachers for the school, as fewer would be needed for some of the other subjects, such as foreign language, mathematics, and English. If the survey commission's recommendation of establishing junior high schools is adopted, the surplus of teachers in these departments could be assigned to the junior high schools. The ninth-grade science teachers would of course be assigned there also.

THE SCIENCE EQUIPMENT.

The science equipment in the Central High School is of a substantial character, and indicates that the school board in the past has been disposed to provide generously for science. There is a laboratory for chemistry, and one for physics, and a large classroom with opera chairs; demonstration table and apparatus cabinets adjoining these laboratories and available for class work in either subject. There is ample storage room conveniently arranged for both physical and chemical apparatus and supplies. For both of these subjects the kinds and amounts of equipment that are needed are to a large degree on hand and are well cared for and systematically arranged. The table space and room space provided for physics and chemistry are sufficient for the classes as they now are, but with the new curriculums, combined laboratory and classroom will be needed (for physics, household physics and chemistry, and art reproduction).

The room in which physiography is now taught has a demonstration table and specimen cabinet which are very satisfactory, but no place to store maps and charts, and no tables for individual laboratory work. For modern instruction in general geography, or even in physiography, the furniture and equipment here are very inadequate. If general geography is required in all curricula, as we recommend, there will be from 13 to 15 sections in this subject. This will require one laboratory room and two classrooms to be in constant use throughout each day of the week and a minimum laboratory and classroom equipment of apparatus for 30 pupils working together at one time. The amount and kind of equipment needed for a laboratory in general geography and the manner of using, storing, and caring for it are fully described in Twiss's Principles of Science Teaching, Chapter XVI (Macmillan, N. Y., 1917).

For botany and zoology there are 36 good microscopes, with an excellent specially-built cabinet in which to store them. Twelve of these microscopes were out of commission, the reason given being that they were in need of repairs. There was also a large aquarium, also out of commission and badly out of repair. The room was sup-

plied with a good demonstration table and a storage case, occupied mostly with a miscellaneous collection of specimens and utensils arranged according to no recognizable system, and in poor condition. The room and its contents fall far short of what a modern high-school laboratory for biological studies should be.

If, according to our recommendation, civic biology be placed in all curriculums and made optional with community civics, it is fair to estimate that about 300 pupils will be studying it, making 11 sections, and requiring constant use of at least two rooms, each systematically furnished and equipped as a combined laboratory and classroom. This would require a considerable amount of additional equipment in charts, specimens, and biological apparatus and materials. It would be useless, however, to install this unless at least one of the two necessary teachers is to have the training and experience in biological work that will guarantee its proper care and efficient use.

The equipment of biological rooms is discussed fully in Twiss's Principles of Science Teaching, Chapters X and XIII, in Lloyd and Bigelow's Teaching of Biology (Longmans & Co.), and in Ganing's The Teaching Botanist (Macmillan).

A special room is provided for general science, and is furnished and well equipped for demonstration and individual laboratory experiments. If, as we have recommended, general science is transferred to the seventh and eighth grades, practically all the equipment of this room might be used for the course in household physics and chemistry, which we have recommended for the home economics, music, and art curriculums.

Some additions to the equipment that are needed immediately, whether the recommended curriculum changes are to be made or not, are as follows: Some additional apparatus for physics, especially in sound and light; a good screw-cutting lathe, drill press, grinder, and wood and metal bench tools for the equipment of a physics shop, the purpose of which is to make and repair apparatus; lantern slides and microscopic slides, stout opaque curtains for darkening all science rooms when the projecting lantern is used; electric connections in each of these rooms for the lantern; charts, wall maps, and blackboard outline maps for geography, and storage cabinets for these; charts, skeleton, specimens, and biological glassware for biology.

3. SCIENCE IN THE VOCATIONAL HIGH SCHOOL.

This is a vocational high school in which shopwork is prominent; and one would naturally expect to find here strong and well-developed courses in physics, especially mechanics and electricity in chemistry, for students fitting themselves for industrial occupations,

and civic biology or at least physiology and hygiene for all pupils. It was somewhat surprising, therefore, to find nothing of the sort. There are no laboratories equipped for work in science, and no teachers in the corps, so far as the observer could learn, who are competent to teach science. Such apparatus as there was gave no evidence of being properly used or cared for, and though there was in one room a demonstration table, there was no such thing as a laboratory table at which pupils could experiment.

There were found three subjects which were said to be science, viz, "General science," "wood technology and timber physics," and "printing design."

QUALITY OF THE TEACHING.

What was designated as general science was given in the room where the demonstration table was. There was no evidence of pupil experimentation and very little that any effective experimenting was done by the teacher before the pupils. The subject matter was mainly on home gardening and agriculture. Examination of the pupils' notebooks showed that they were all alike, being merely dictation from the teacher, taken down word for word excepting when the teacher was misunderstood, when the pupil would get down something that made no sense. The teacher's method was first to "lecture" to the pupils, while they sat passive; then the next day he dictated an abstract of the "lecture" which they copied verbatim; then on the third day he questioned the pupils on this dictation. The observer heard one of his "recitations." It was in eighth-grade physiology; and the topic was "Common diseases." The questions were mostly purely factual, calling for no thought whatever. Relations among facts were not sought. The pupils' responses were about as frequently incorrect as correct. Their attitude was apathetic. There was nothing in the entire procedure that could rightfully be called education.

The course in "wood technology and timber physics," as outlined by its teacher, looked well and promising, but the classroom work did not confirm this impression. The class work observed in this subject was memoriter recitation from a very elementary textbook about wood technology. The book was of about the grade that would be suitable for a supplementary reader in the seventh grade. The method of the teacher was to have the class study a part of the lesson for 5 or 10 minutes while he did the same. He would then call them to attention, and with his finger on the page ask them two or three questions in a halting, hesitating manner. Then would follow another brief period of study by teacher and pupils and two or three more questions, and so on. The questions were mostly of a rather trivial sort,

and the answers were given usually by several pupils together, each answering in his own way, so that nothing in particular could be distinctly heard. The teacher is said to be an excellent woodshop man. At the exposition grounds is a well-built bungalow booth, which the observer was told had been built by some pupils under his direction. Evidently this man's time should be given to shop instruction.

In further search for scientific instruction the room where the class in "printing design" was working was visited. This was a small drawing room occupied by the teacher and three or four boys. The observer had been told that in this class the physics and chemistry of color, pigments, and paper were taught. He was not able to elicit from the teacher, the students, or the little textbook of design that was in use any scrap of evidence that scientific instruction or experimenting of any sort had been carried on in connection with this class. The work in printing design as such, however, appeared to be efficient.

The plain fact, then, with regard to this school is that no science instruction whatever is given in it that is worthy of the name, and that aside from a very few microscopes and magnifying glasses and some few pieces of physical apparatus and bottles of chemicals there is little of a material sort with which to teach sciences.

A PLAN OF SCIENCE WORK NEEDED.

To continue the pretense of teaching science that now exists would certainly be unwise. Whatever is done in the future should start with a policy and a plan and be built from the ground up. The plan at the beginning should carry with it at least two trained and competent science teachers and two laboratories—one for physics and the other for chemistry—both modern and fully equipped for individual experiments by the pupils and demonstration experiments by the teacher. The apparatus for physics should be as largely as possible such as is used in actual practice in the industries, and the science principles should be introduced through the working out of practical projects and problems connected with the industries, especially those of Memphis and the vicinity.

We recommend for this school the same sequence of scientific studies that has been recommended for the Central High School, namely, ninth grade, civic biology; tenth grade, general geography; eleventh grade, physics; twelfth grade, chemistry, and for the same reasons. Looking toward the future, however, the school eventually should offer a number of short intensive courses in the various phases of physics and chemistry that are needed in direct application to the industrial and commercial vocations for which the pupils are pre-

paring. The subjects for the ninth and tenth grades and general science in the seventh and eighth should be taught, not primarily for vocational purposes, but rather for the purposes of citizenship and individual development. The aims and methods should be the same as for the pupils attending Central High School. The teachers and equipment, of course, should be of the very best and most practical character.

In the opinion of the observer very little can be done to improve the condition of the science or any of the academic work in the Vocational High School until either a new school plant is erected or the crowded condition is relieved and the building is considerably remodeled. It is dark, dingy, unwholesome, and mostly poorly lighted and ventilated. Furthermore, not much can be done until the school is changed from its present unorganized, almost chaotic condition as to administration into an efficient organization with a definite and well-planned assortment of curriculums suited to the needs of the various groups of pupils who attend it. Consideration of such changes as these should precede any changes planned for science.

4. SCIENCE IN THE KORTRECHT HIGH SCHOOL (COLORED).

The condition of this high school for the colored children is even worse than that of the Vocational High School. In fact, it is nothing short of pitiable. The school building is unclean, unsafe, insanitary, poorly arranged, badly lighted, and unsuitably located. Furthermore, it is badly congested. The office room is so small as to be almost useless; there is nothing that might justly be called a library; and there is no laboratory, and no science equipment whatever, excepting a few bottles and test tubes and a few broken pieces of antiquated physical apparatus. It is impossible to do anything but textbook and recitation work; and even such work, on account of the constant overcrowding of the room, must be done under the greatest of difficulties.

The teacher of science is intelligent and well trained. He has very sensible and clear ideas as to the needs of the Negro children and as to what and how they should be taught. He is trying to train them through elementary science in habits of neatness, industry, and exactitude, and is endeavoring to teach them how to think. He has no delusions as to their capacities, and he believes in educating them for the occupations which they must follow. He was particularly clear as to the necessity of picking out those few who excel the others in intellect, teaching them how to think, and instilling into them ideals of service and citizenship, in order that they may become wise and safe leaders of their race. His training in science

has evidently been such that if given adequate facilities he could give these colored children the kinds and amounts of training in the sciences that they are most capable of profiting by. The immediate need here is for simple, economical science equipment for physiology and hygiene, for elementary physics, and for botany and gardening. Ample closets are needed in which to keep these. No money should be spent in laboratory furniture for this building. There is no place to install it.

The aims of this school should be two. The first is industrial and commercial—to fit the great bulk of those children for citizenship and for the occupations that are open to them. For the most of this group a two years' course beyond the eighth grade should be ample. The second is preparatory—to select the few who have considerably more than the average endowment of intellect and ambition, and prepare them for the higher institutions for colored youth where they can be trained as teachers, lawyers, ministers, and physicians for the service of their people. The proper training of this material for leadership among the Negroes seems to the writer one of the most important factors in the ultimate solution of the race problem both in the South and the North. Is there any way in which money—and lots of it—can be spent more profitably for the public safety than in the moral, religious, and civic education not only of those Negro youth but the youth of all the other various races that make up our people, who are destined to become the leaders of the race groups to which they belong? A well-located, modern high-school plant, housing a well-organized, ably administered, and carefully supervised Negro high school is an investment that would yield large dividends in safety and prosperity for Memphis.

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