REPORT

OF THE

DIRECTOR OF PHYSICAL TRAINING.

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REPORT

OF

DR. EDWARD M. HARTWELL,

Director of Physical Training.

To the Superintendent of Public Schools:

DEAR SIR: Agreeably to your letter of request, dated Jan. 30, 1895, I respectfully submit the following report as Director of Physical Training. My last report, which was made to the School Committee, was published as School Document No. 8, 1894. It covered the period Jan. 1, 1892, to June 30, 1894. In that report the general condition and policy of this department were outlined as follows:

In general terms it may be said that there has been healthy growth and expansion in the department of physical training during the interval since my last report in December, 1891. The policy of holding frequent normal classes for the teachers of the grammar and primary schools has been followed with good results, and will be continued. Toward the close of the school year 1891–92 the experiment was made of examining and marking the grammar-school classes throughout the city, and of furnishing the master of each school with a detailed statement as to the proficiency and rating of the several classes under his charge. The results of this experiment were so stimulating and helpful that the practice has become a fixed policy.

The novelty of the situation, due to the introduction of an orderly, progressive system of instruction in gymnastics, has worn off for the most part; and the ancient misleading notion that physical training is chiefly useful to afford an easy and inexpensive vent for the ticklesome "animal spirits" of tired and restless children and to enhance the liveliness and attractiveness of school exhibitions has been dissipated to a considerable degree, and bids fair to disappear utterly — at least among the teachers — as time goes on. Increased experience on the part of the teachers in conducting class-exercises in gymnastics at the word of command, and their growing familiarity with the aims and methods peculiar to the Swedish school-gymnastics, have led to marked improvement in the manner and results of their instruction. This improvement has taken place all along the line, but has been particularly marked

and gratifying in certain schools and classes in which comparatively feeble interest in the new gymnastics was manifested at the outset.

My main aim is to secure steady, sustained, and increasingly intelligent effort on the part of the class-teachers, so that gymnastics shall become a regular, inevitable part of the daily course of instruction, receiving due attention, no more, no less. To this end, now that the mass of the teachers have acquired a fair amount of technical skill in conducting gymnastic instruction, I propose to throw greater stress than seemed advisable at first upon the principles of physical training and its relations to other branches of instruction.

The full and lasting success of Boston's present tentative effort to profit by the example and experience, in the field of physical training, of other cities and countries will depend very largely upon the character of the support given to the department of physical training in the Boston Normal School. This school is conspicuous, in its class, by reason of the fact that its managers have taken measures to provide its pupils with theoretical and practical instruction in Swedish school-gymnastics, which measures have been cheerfully seconded hitherto by the School Committee. But the department is still in embryo, and its expansion and efficiency have been hampered by the crowded state of the curriculum and the insufficient resources of the school. Provision has been made, however, in framing the new course of study for the Normal School for better instruction in gymnasties than was formerly practicable. Gymnastics has been placed in the list of electives, and twelve members of the class of 1893–94 availed themselves of the opportunity to elect it as a special study. Experience shows that the corridors of the Normal School are a poor substitute for a well-fitted gymnasium. It is wisely proposed to include such a gymnasium in the projected extension of the Normal School building. At the suggestion of the head-master of the school, I have prepared sketch-plans for such a gymnasium. If a well-equipped gymnasium be provided it will add greatly to the usefulness and efficiency of this department, especially if the recently authorized experiment in developing departmental teaching in the grammar schools shall prove a success, and lead to a new departure in the management of those schools.

At the invitation of Dr. Dunton, the principal of the Normal School, and with the consent of the Committee on Hygiene and Physical Training, I have helped to frame the elective course of study in gymnastics, already alluded to, and have taken part in the instruction given in accordance with it.

Considerable progress has been made in the past two years towards unifying and simplifying the practice of gymnastics in the classes as regards the times set for exercise, the amount of time de-

voted to instruction and practice, and the number and selection of the "Days' Orders" attempted. There is now much less diversity in these matters than obtained at first. Having, by periodical circulars of inquiry, practically determined what may fairly be expected and exacted of the several classes, I propose to promulgate a provisional course in gymnastics for the guidance of the teachers during the ensuing year, or so long as it may be found to work.

In January, 1891, as appears from a statistical inquiry made at the time, only 79.2 per cent. of the grammar and primary school teachers professed to teach Swedish gymnastics in 1,065 classes, while 20.7 per cent. taught "mixed" forms of gymnastics. In January, 1893, mixed gymnastics had practically disappeared, and 1,098 teachers were returned as teachers of the required Swedish gymnastics. The following table affords a comparative view of the results of each inspection and rating of the 55 grammar schools, by schools and divisions. The epithets "excellent," "good," etc., are based on the average mark of the school, which is obtained by dividing the sum of the division-marks by the number of the division-marks. Each division-mark is also an average of marks touching five distinct particulars, viz., position, steadiness, precision, correctness, commands.

TABLE I.

SHOWING COMPARATIVE RATING OF THE FIFTY-FIVE GRAMMAR SCHOOLS, IN PHYSICAL TRAINING, 1891-1894.

		First Inspection in 1891.		Second Inspection in 1891.		Third Inspection in 1892.		Fourth Inspection in 1893.		Fifth Inspection. in 1894.	
		Number.	Per cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
By Schools.	Old Scale.										
	Excellent, 1.00-2.00..	8	14.5	8	14.5	39	70.9	53	96.3	54	98.1
	Good, 2.01-2.50..	18	32.7	20	36.3	16	29.0	2	3.6	1	1.8
	Passable, 2.51-3.00..	17	30.9	20	36.3	0	.....	0			
	Poor, 3.01-6.00..	12	21.8	7	12.7	0	.....	0			
		55		55		55		55		55	
	Present Scale.										
	Excellent, 1.00-1.50,	.....	.....	.....	.....	5	9.0	15	27.2	20	36.3
	Very good, 1.51-1.85,	.....	.....	.....	.....	19	34.5	31	56.4	25	45.4
	Good, 1.86-2.20,	.....	.....	.....	.....	24	43.6	9	16.3	10	18.1
	Passable, 2.21-3.00,	.....	.....	.....	.....	7	12.7	0	.....	0	
	Poor, 3.01-6.00,	.....	.....	.....	.....	0	.....	0	.....	0	
By Divisions.						55		55		55	
	Old Scale.										
	Excellent, 1.00-2.00..	.....	.....	.....	.....	342	61.5	466	83.2	499	85.7
	Good, 2.01-2.50..	.....	.....	.....	.....	179	32.0	85	15.1	75	12.8
	Passable, 2.51-3.00 ..	.....	.....	.....	.....	29	5.2	6	1.07	6	1.0
	Poor, 3.01-6.00 ..	.....	.....	.....	.....	6	1.7	3	0.53	2	0.3
						556		560		582	
	Present Scale.										
	Excellent, 1.00-1.50,	.....	.....	.....	.....	104	18.7	217	38.9	260	44.6
	Very good, 1.51-1.85,	.....	.....	.....	.....	150	26.9	145	26.2	169	29.0
	Good, 1.86-2.20,	.....	.....	.....	.....	186	33.4	163	29.1	120	20.6
	Passable, 2.21-3.00,	.....	.....	.....	.....	110	19.7	30	5.3	30	5.1
	Poor, 3.01-6.00,	.....	.....	.....	.....	6	1.0	2	0.3	3	0.5
						556		560		582	

In 1892 the average school mark was 2.05, and 42 schools were rated above the average and 13 below. The average mark was 1.65 in 1893, when 27 schools were rated above and 28 below the average, all 55 schools being above the average of 1892. In 1894 the average school-mark was 1.60, which mark was exceeded in the case of 26 schools, and unattained by 29 schools. In 1894 31 schools were rated above the average for 1893 and 54 above the average for 1892; while 24 schools were rated below the average for 1893 and one below the average for 1892. These results warrant the conclusion there has been marked improvement in gymnastic instruction in the grammar schools during the last two years. The progress made in the primary schools, though less marked for obvious reasons, has been fairly satisfactory.

GYMNASTIC INSTRUCTION MORE GENERAL AND EFFICIENT.

The "provisional course in gymnastics for the guidance of teachers," alluded to above, was promulgated early in this year and is working so satisfactorily that it is likely to continue in force indefinitely. It consists of a schedule of "Required and Optional Days' Orders," varied in number and difficulty according to the grade and class of the pupils for whom they are prescribed. Since assuming charge of this department, it has been my custom to call for a statistical return showing the amount and character of the gymnastic instruction given in each class during the month of January of each year. The returns for January, 1895, are most satisfactory, since they show that Swedish "free standing movements" are now taught and practised throughout the primary and grammar grades, and that the requirements of the schedule of Days' Orders are very generally complied with. In this I find encouraging evidence of progress. And I take pleasure in expressing my high appreciation of the readiness with which the principals of schools have seconded my efforts and recommendations and of the zeal and fidelity shown by the class-teachers in giving gymnastic instruction.

No new subject or new method of instruction in an old subject can be injected into a course of study after the manner in which Swedish school-gymnastics were introduced into the Boston schools by the School Committee of 1890, without

causing more or less disturbance and jar. It has been my object from the outset to adapt the work of this department so far as possible to existing conditions, and to derange and jostle the existing school machinery as little as possible. I believe that my efforts in this direction have met with a fair measure of success. It is certain that there has been marked and steady improvement in the conduct and performance of our school-gymnastics during the past four years. But the necessity for giving normal instruction to the teachers, and for aiding them by means of suggestion and criticism in the school-room still exists, and must continue to exist so long as the corps of teachers is largely made up of persons who have passed through the normal school course without being called upon to learn or apply even the elementary principles of physical training. Comparatively few city and State normal schools offer courses in genuine physical training. Hence the multiplication of summer and private adventure schools in this field.

INSTRUCTION OF TEACHERS.

The results of the annual inspection and rating in gymnastics of the classes in the grammar schools, made towards the close of 1894, have been used as heretofore by Mr Nissen, the assistant in this department, as the basis for giving special help and criticism in the class-room to the teachers standing in greatest need of such aid. As during last year, so this year Mr. Nissen has devoted a considerable amount of time to the special assistance of primary teachers in their class-room work. Since the Christmas holidays normal classes have been resumed. At present primary school teachers are not required to attend them. With a view of giving variety to the gymnastics practised by the first and second classes of the grammar grade, and to improving the style of marching and filing in the halls, corridors, and yards, I have instituted for certain selected teachers a special normal class in marching and floor work, which is at present conducted by Mr. Nissen

in the drill hall of the English High School; the class meets for an hour once a fortnight. Six meetings have been scheduled; teachers attending these classes are excused from attending such normal classes in gymnastics as may occur during the period Feb. 15 to April 26, 1895.

PHYSICAL TRAINING IN THE HIGH SCHOOLS.

In my last report I called attention to the fact that physical training in the high schools for girls had been largely left to take care of itself, and had not been respected, in most cases, as a coördinate branch in the required course of study, which provides that high school girls shall devote the same amount of time to gymnastics that the boys give to military drill; viz., two hours weekly. My relations to physical training in the high schools were referred to as follows:

As Director of Physical Training I am directly responsible to the Committee on Hygiene and Physical Training; but inasmuch as the jurisdiction of that committee over physical training in the high schools appears not to be altogether clearly defined, my relation to physical training in those schools is somewhat anomalous, not to say embarrassing. I make it a rule, however, to inspect the classes from time to time, and to comply as far as possible with all requests from the headmasters for aid or advice with regard to instruction in gymnastics, though I do not consider myself responsible for the work done in the high schools to the same extent as for that done in the lower schools over which the Committee on Hygiene and Physical Training exercise undisputed jurisdiction.

It seems to me to be extremely desirable, and in most cases practicable, that the instruction given in gymnastics in the high schools should be thorough and varied; that it should be adapted to the peculiarities and adequate to the needs of adolescents; and that it should constitute a distinct advance beyond the grammar-school course in gymnastics, which has hitherto been confined to free standing movements. It is impossible to secure these ends without proper apparatus and competent teachers.

The conditions alluded to above remain unchanged in most respects. I would respectfully repeat the following sug-

gestions made on page 107 of my last report, as tending to improve the efficiency of physical training in the high schools:

(1) That the Committee on Hygiene and Physical Training and the Committee on High Schools take measures to arrive at an understanding with regard to the nomination and supervision of teachers of physical training in the high schools; (2) that the Committee on Hygiene and Physical Training and the Committee on High Schools take concerted action towards preparing a programme for each high school, in accordance with the course of study, so far as the requirements of the same in regard to physical training are concerned.

Speaking generally as regards the high school for girls, it may be said that less time is devoted to gymnastics this year than last in those schools. The explanation of this is to be found in the unusually congested state of certain schools, and in the makeshifts which it necessitates, *e.g.*, in the Dorchester and West Roxbury High Schools. But I am convinced that in certain other cases more effectual measures might be taken to comply with the course of study. The completion of the new building for the Brighton High School will doubtless enable the principal of that school to secure two hours of instruction in gymnastics per week, if, as I presume, the City Architect has planned a gymnasium for the girls in addition to a drill-hall for the boys. It was found necessary, early in the year, to turn a large part of the hall of the Dorchester High School into recitation-rooms, by the putting up of partitions; consequently gymnastics have been suspended for the present in that school. I am informed that the Committee on High Schools has decided to appoint a special teacher of gymnastics in the Roxbury High School for the ensuing year. I venture to express the hope that adequate measures will be taken also to put this important school, which has not far from three hundred girls among its pupils, on an equality with the Charlestown High School, in respect to facilities for apparatus gymnastics.

Under Miss Towne, in the school last named, the gymnastic course continues to improve and is characterized by increas-

ingly good results, which is in some measure due to the fact that the time-requirement of the course of study is carried out. The recent order of the School Committee regulating the character of the lunches offered for sale in the high schools owed its initial impulse to Miss Towne, who called my attention to the fact that pies, pickles, and candy constituted too large a proportion of the edibles exposed for sale in that school. Deeming the matter of some importance, I brought it to the attention of the Board of Supervisors, and of the Committee on Hygiene and Physical Training, by whom the School Board was induced to provide a remedy.

In September last Miss Ruth B. Whittemore, a graduate of the Dorchester High School and of the Boston Normal School of Gymnastics, was appointed, on the nomination of the Committee on High Schools, special teacher of vocal and physical culture in the Girls' Latin School. Since Jan. 28, 1895, Miss Whittemore, by permission of the Committee on High Schools, has also had charge of the girls' gymnastics in the East Boston High School, and with manifestly good results.

SUPERVISORS' EXAMINATIONS.

For the last three years physical training has been placed by the Board of Supervisors in the list of electives open to candidates for certificates of qualification. Thus far but one person, a candidate for a certificate of the third grade, at the examination in August, 1894, has chosen physical training as an elective subject. The candidate in question was strictly examined in the theory and principles of the subject, and, as is my custom in such cases, was also required to conduct a class in Swedish exercises, with apparatus, in the gymnasium of the Charlestown High School. I found her qualified "to pass." The fact of her being a graduate of the State Normal School, at Bridgewater, Mass., is worthy of special mention.

At the request of the Board of Supervisors I prepared the

questions in required and elective biology, botany, and zoölogy for the examinations conducted in August and September, 1894, marked all the papers handed in on these subjects, and interviewed such of the candidates as came up for special examination in those subjects. Several of the candidates were of unusual promise, and showed that they had been trained to give better instruction in their subjects than is at present provided for or allowed in our high schools and normal school.

THE NORMAL SCHOOL.

The general and special work in physical training in the Normal School continues in the faithful charge of Miss Laura S. Plummer, who does as effective work as the restricted resources of that school will permit. The pupils of that school cannot be as well trained in gymnastics as in kindergartening and Sloyd so long as the school has no laboratory or gymnasium, and is not provided with an adequate supply of illustrative apparatus for teaching purposes. The number of pupils in that school who have chosen physical training as a special elective study is the same as last year; viz., twelve. My lectures to this class began on Feb. 4, 1895, and will continue till the close of the year at the rate of one a week. The character and purport of these lectures is indicated by the following list of topics: The Modern Doctrine of the Human Body; School Hygiene; The Physiology of Nerve and Muscle, and its Bearing upon the Education of Children and Adolescents; The Nature and Effects of Physical Training; Comparative View of the Principal Systems of Physical Training; Practical Hints on Teaching School Gymnastics.

Early in the current year the teachers in charge of physical training in the Normal School and the Charlestown and West Roxbury High Schools expressed the desire to make certain measurements in connection with the physical examination of their pupils. As the undertaking met with the approval

of the principals of the schools in question, and the pupils' participation in it was wholly voluntary, I have encouraged its prosecution. There is abundant evidence that such procedures serve to awaken a livelier interest on the pupil's part in personal hygiene and physical training, and are helpful to teachers as an aid in the guidance and admonition of their pupils.

PHYSICAL EXAMINATIONS.

Thanks to the ready kindness of Dr. H. P. Walcott, chairman of the Massachusetts Board of Health, three sets of measuring appliances, including scales, were put at my disposal. Two of these sets have been put to good use in the schools above named, and the third set has been assigned to Mr. Ripley, principal of the Bigelow School, to enable him to carry out his plan of periodically weighing and measuring the boys in the Bigelow School. If by repeated observations on the same individuals during a series of years Mr. Ripley shall be able to determine the annual growth-rates of so large a number of boys as are found in his school, his results will be of great practical value, and will constitute a genuine contribution to science as well. Anthropometrists are now in the possession of a large amount of data derived from measuring and weighing many school children and youth ; but data obtained by the individualizing method, *i.e.*, by subjecting the same individuals to repeated observations during a series of years, are rare and greatly needed.

THE INTRODUCTION OF ADJUSTABLE DESKS AND CHAIRS.

Since my last report the new buildings of the Cudworth Primary School, in East Boston, and the Choate Burnham Primary School, in South Boston, have been occupied. They are furnished with adjustable desks and chairs. During the last summer vacation the first class of the Bennett Grammar School, in Brighton, was supplied with adjustable furniture,*

* That is to say the desk boxes and chairs already in use were placed upon adjustable standards.

and a considerable number of the same sort of desks and chairs have been placed in various rooms of the Robert G. Shaw Grammar School by the order of the School Committee, to obviate the inadequate supply of properly assorted sizes of seats in that school. Counting in the Charles C. Perkins Primary School, in the Prince District, there are nearly 1,400 sets of adjustable furniture now in use in our schools. Rather more than half of that number are of the so-called Perry style; not quite one-half of the remainder were furnished by the Globe Desk Company; while of the residue one-half, enough to fill three rooms, were furnished by the Chandler and Bobrick Companies respectively. If the School Committee holds to its present policy of furnishing new buildings with adjustable furniture, it is probable that between 2,600 and 3,000 adjustable desks and chairs will be required during the next twelve months towards fitting up school buildings now in process of erection or under contract.

In accordance with the order passed by the School Committee, Oct. 25, 1892 (see page 108 of my last report), it has devolved upon me to render advice and assistance to the principals for the purpose of securing the proper use of these new and improved styles of desks and chairs. Besides which I have been called upon to study the seating of the pupils in rooms recently fitted up for the use of primary pupils in the Agassiz, Dudley, Hancock, and Wells districts; to inspect the redistributed furniture in the Brimmer Grammar School; to report upon the misfitting of pupils in the Robert G. Shaw Grammar School, and to suggest a remedy for the same; and to furnish plans for seating the pupils in the Cudworth School mentioned above, and in the Oak-square Primary School, in Brighton. Necessarily, therefore, much of my time and attention have been occupied during the current year with various phases of the "seating problem."

THE PROBLEM OF SCHOOL SEATING.

Having had occasion to study somewhat closely the peculiarities, as regards construction, working, and effects, of the desks and chairs now in use, both fixed and adjustable, and being more than ever convinced that the present amount of unhygienic seating in our schools is so large as to constitute a serious obstacle to the legitimate success of the department of physical training; I feel called upon to devote the remainder of this report to questions connected with the seating of school children.

School seating is primarily a question in animal mechanics, and the rules which govern it must be based upon the laws of human anatomy and physiology. But the development of a strictly scientific and hygienically sound system of school seating has been halting and incomplete, particularly in this country, because scientists and educationists have been slow to perceive the full significance of the fact that the school population is made up of growing animals, whose growth-rates, in respect to length of legs and length of arms, as well as in respect to total height, differ in the two sexes and vary in each sex during school life. Moreover, the problem of school seating is complicated and rendered difficult by the predilection of teachers for certain conventional forms of procedure in the management and discipline of their pupils, and by the commercial exigencies which regulate the manufacture and sale of school furniture.

THE MECHANICS OF THE SITTING POSTURE.

The most searching and convincing researches in this connection are those of Prof. Hermann Meyer, of Zürich, whose paper, "Die Mechanik des Sitzens mit Rücksicht auf die Schulbankfrage" (Virchow's Archiv, Bd. XXXVIII., Heft. I., 1867), should be studied by all who undertake to pass critical judgment on the claims of alleged improvements in school chairs. As a succinct summary of Meyer's views is

found in Cohn's "Hygiene of the Eye in Schools," London, 1886, I have taken what follows from that work.

At the lower part of the pelvis are the two seat-bones (*tubera ischii*), or lowest parts of the great hip-bones. They are curved like a bow and rock easily. A line drawn through these two seat-bones may be called the "seat-bones' line." The centre of gravity of the human body is situated in front of the tenth chest vertebra; a line drawn perpendicularly from that place to the ground is the *line of gravity*. Now, it is only when the line of gravity falls exactly upon the seat-bones' line that the body can remain at rest in a sitting posture. The slightest movement of the trunk that displaces the centre of gravity, and therefore also the line of gravity, must bring the line of gravity either before or behind the seat-bones' line, and then a third point must be sought for which will secure equilibrium in a sitting posture in spite of the instability of the seat-bones. This third point may be situated either before or behind the seat-bones' line. We must therefore distinguish between a forward and a backward sitting posture. In the *forward* sitting posture the third point of support is furnished by the *front edge of the seat*. The line of gravity may now fall on any part of that surface which is determined by the seat-bones and the front edge of the seat; the nearer, however, it approaches to the latter, the more easily is the equilibrium disturbed. A quiet sitting posture, therefore, will only be possible when the surface of the seat on which the thighs rest is very *large;* things are best when this surface extends forward as far as the knees. If, moreover, the knees being bent at a right angle, the feet are planted firm and flat on the floor, their resting-places form auxiliary surfaces of support.

No one, however, can remain in the forward sitting posture for any length of time, because the trunk is not immovably fixed in the hip-joint, but is joined movably to the thigh. The attitude, therefore, is only maintained by very complicated work of the pelvic muscles. These muscles grow fatigued and the trunk, obeying the law of gravity, would *fall forward* if the chest or arms did not support it by leaning against the desk. When we prop ourselves up with our arms, we in a manner catch the body as it falls forward.

In the *backward* sitting posture, in which the line of gravity falls *behind* the seat-bones' line, the third point of support, firmly connected with the seat-bones, is found in the end of the coccyx. The pelvis being now inclined backward, this point does not need to be determined, but is an immovable datum. But as the body, with this backward inclination of the pelvis, would have to fall backward its fall must be arrested by the back-rest. The lower down the back-rest is applied, the more

upright is the position of the pelvis and the trunk. Applied at the height of the last vertebra the back-rest allows the best upright sitting posture.

In writing the head is slightly bent forward on its horizontal axis, the arms are stretched forward and somewhat upward, and the body curved slightly forward; and thereby the centre of gravity is brought forward in front of the seat-bones' line. Any arrangement, therefore, which brings the centre of gravity further back will help the child to sit upright.

TYPICAL SITTING POSTURES.

There are, then, three typical sitting postures, in each of which the following general conditions obtain, viz.: the thighs are more or less fixed at a right angle to the trunk, the leg makes a right angle to the thigh at the knee, and the feet are placed flat upon the floor or a foot-rest. These are: (1) *the erect posture*, in which the line of gravity falls between the *tubera ischii*, when the muscles of the legs are relaxed and the rigid trunk is maintained in a position of mobile equilibrium, by a minimal amount of action on the part of the muscles of the neck, trunk, and pelvis; (2) *the forward posture*, in which the line of gravity passes in front of the seat-bones' line and the body is kept from falling forward on its rockers either by "the complicated work of the pelvic muscles," or by an anteriorly placed prop of some sort; (3) *the backward posture*, in which the line of gravity falls behind the *tubera ischii*, and the body is prevented from falling backward, either by the fixation of the trunk upon the thigh, the legs being kept extended, through the action of the flexor muscles of the hip and the extensors of the leg, or by means of a prop supporting the pelvis and the back.

THE CHAIR-MAKER'S PROBLEM.

Expressed in general terms the problems which confront the designers and makers of chairs are: (1) to provide a base of support or seat having a sufficient and intelligently proportioned area, *i.e.*, a bottom whose length and breadth are proportional to the under surface of the thighs and buttocks of the person to be seated; (2) to place the seat

at such a height from the floor, or foot-rest, that the sitter's feet may rest flat upon the floor or foot-rest when his legs make a right angle at the knee with his thighs; and (3) to provide the seat with a back that shall support the sitter's back whether he be quiescent or be actively engaged, *e.g.*, in writing or drawing. But a properly constructed chair may be rendered nugatory or even positively harmful, if its occupant is forced to work at a desk whose upper surface is too high or too low, or insufficiently sloped, or whose under surface exercises a cramping influence upon his knees or thighs, or if he is given a desk which, though correct in its proportions, is so placed with relation to his chair that the backward sitting posture is beyond his reach, and the forward sitting posture can only be maintained at the expense of prolonged and wearisome muscular exertion.

Again, the occupant of a correctly designed and properly constructed chair may be prevented from reaping its benefits through the stupid or injudicious requirements of his teachers as to the manner of using his chair and desk during recitation, when studying, or when engaged in the act of writing or drawing.

NORMAL DIMENSIONS OF DESK AND SEAT.

Figure 1, adapted from a similar cut in Eulenberg and Bach's "Schulgesundheitslehre," Berlin, 1891, p. 217, will be of assistance to us in further discussing the normal dimensions of desks and seats. It represents the dimensions recommended by Eulenberg and Bach, for a seat and desk adapted to a pupil 175 centimeters (68.89 inches) in height. R, the total depth of desk and seat, equals 78 centimeters. A, the outer height of the desk, equals 84 centimeters. The inner "*height of the desk*," equals the sum of the lines C and M D, *i.e.*, 78 centimeters, — C, "*the height of the seat*," being 48 centimeters ($\frac{3}{11}$ of the total bodily height), and M D, technically termed "*the difference*," being 30 centimeters, or about 17 per cent. of the total height. The width of the

horizontal part of the desk L equals 10 centimeters and that of the sloping part K equals 35 centimeters. The book-shelf N is placed 25 centimeters ($\frac{1}{7}$ of the body-height) below the surface of L, and is 22 centimeters ($\frac{1}{8}$ of the body-height) in width. C, the "*height of the seat*," equals 48 centimeters ($\frac{3}{11}$ of the body-height). The length of the seat equals 58 centimeters ($\frac{1}{3}$ the body-height). E, "*depth or breadth of seat*," equals 35 centimeters ($\frac{1}{5}$ the body-height). The total height of the back-support equals 44 centimeters ($\frac{1}{4}$ the body-height); G, the total "*height of cross-rest*" (S) for the small

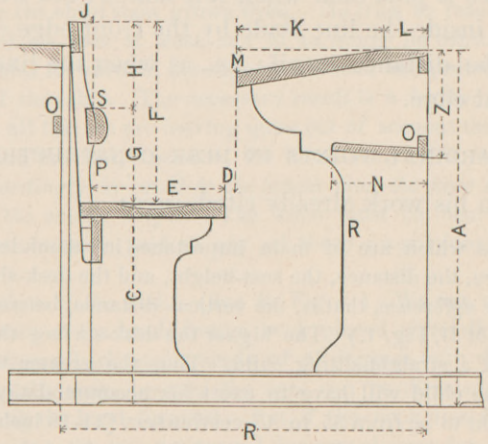


FIGURE 1.

of the back, being 22 centimeters ($\frac{1}{8}$ the body-height). The back-support slopes backward, it will be noted, some 3 centimeters, so that J, the shoulder-rest, cannot come into contact with the pupil's back unless the upper part of the pupil's trunk is slightly inclined beyond the perpendicular line J S. This is to enable the pupil to assume the so-called "back-sitting" or "reclined position" which is strongly advocated by Prof. A. Lorenz, of Vienna. Eulenberg and Bach recommend hollowing out the seat to a depth of $1\frac{1}{2}$ centimeters as shown at E, instead of inclining the surface of the seat from front to rear. It will be observed that the line M D, techni-

cally called "*the difference*," does not strike the edge or surface of the seat. The result is that "*the distance*," *i.e.*, the distance between the rear edge of the desk and the forward edge of the seat, is a plus or positive distance, which was usually found in school-seating twenty-five years ago, but which is almost universally condemned by modern authorities, since it involves the necessity of leaning forward in writing, which is sedulously to be avoided. In the present case the plus distance noted is a concession to convenience, since it is easier for a pupil to get in and out of his seat when the distance is plus than when it is minus; *i.e.*, when the line M D falls inside the line made by the front edge of the seat, or when the distance is nil; *i.e.*, as when the line M D just strikes that edge.

CARDINAL POINTS IN DESK CONSTRUCTION.

Cohn, in his work already cited, says:

The points which are of main importance in school-desks are four: the difference, the distance, the seat-height, and the desk-slope.

(1.) *The difference*, that is, the vertical distance, between desk and seat. (See M D, Fig. 1.) The higher the desk-surface the nearer it is to the eye of a straight-sitting child. Thus the greater the difference the more the child will have to exert his accommodation. Now, the writing ought to be from 35 to 45 centimeters [14–18 inches] from the eye, for that is about the distance of a child's eye from the elbow when hanging straight down, and the text of the school-books should be easily legible at that distance. If, however, the difference is great, so that the elbows have to be considerably raised in writing [*as is generally the case in our Boston schools*] the shoulders will not hang from the body, but the body from the shoulders, and the writing hand will be too near the eye.

(2.) An exceedingly important correlative of the difference is the horizontal *distance* between desk and form. (See D, Fig. 1.) In the right arrangement of distance lies the kernel of the school-desk reform. The greater the distance the more the body will have to fall forward of the seat in order that the arms may reach the paper; and the more will the head be obliged to drop and to get near the writing. Thus, whenever we intend to sit upright at a table for a considerable time, we instinctively push the chair so far under the table that the table's

edge is vertically over the chair's edge, or, if possible, overhangs it by an inch. *For the upright position of the head, therefore, the distance must be nil or, still better, negative.* . . . I once proposed a minus distance of one inch; but after further observations I think that the upright position is sustained still longer when the thigh is supported still further towards the knee, and therefore I agree with Buchner, who requires a minus distance of two inches.

Here every inch is of consequence. No physician has ever opposed the requirement of nil or minus distance . . . the opposition has come solely from *individual teachers.*

(3.) *The height of the seat.* (See C, Fig. 1.) If the legs are not bent at a right angle at the knee and the feet resting with the entire sole flat upon the foot-board (or floor), the feet must be left dangling in the air. Then the child soon grows tired. He tries to reach the floor with the tips of his toes at least, and in so doing he bends his thigh downward, slides forward on the edge of his seat, and presses his chest on the edge of the table. The necessary result is a further collapse of attitude. (In all this we are leaving quite out of account the hindrance to breathing and the compression of the intestines.) *The height of the seat must accordingly be equal to the length from the knee to the sole; that is, $\frac{2}{7}$ of the child's height.* The knee must be bent at a right angle. No attention is paid to any of these proportions in the old school-desks.

(4.) *The slope of the desk.* (See K, Fig. 1.) We can read easily, without any stoop of the head, from a book placed *vertically* before us. If the book slopes back at an angle of 45 degrees with the horizon, reading is equally easy, because the eyes can be directed downward without bending the head forward. But if the book lies flat and the reader sits upright, the eyes are turned downward very far. This continued for any considerable time is very tiring, and so we prefer to bend the head forward. It follows that the desk must not be horizontal, but sloped. A slope of 45 degrees, however, is not to be recommended, because it would make writing difficult, and the writing materials would fall down. A slope of 1 in 6 is the best. The old school-desks are all flat and therefore wrong.

The breadth of seat usually termed "*seat-depth*" (see E, Fig. 1) and the "*seat-back*" (see J P, Fig. 1) are of scarcely less importance than Cohn's "cardinal points" noted above. The seat-depth is determined by the length of the sitter's thigh, whose mean value, according to most observers equals $\frac{1}{5}$ the total height. Provided the soles of the feet can rest

flat upon the floor, a seat may be theoretically too narrow without entailing prejudicial effects; whereas, too deep a seat is to be scrupulously avoided as it prevents the sitter from availing himself of the support offered by the seat-back. That no one, not even a child, can maintain the erect sitting or the backward sitting posture for any considerable length of time without the aid of some sort of back-rest or prop, no longer admits of argument. This matter of back-rest or seat-back is of so much importance that Professor Lorenz, in his admirable "Die Heutige Schulbankfrage," Wien, 1888, declares that the present school-seat question is "first of all a question of seat-back."

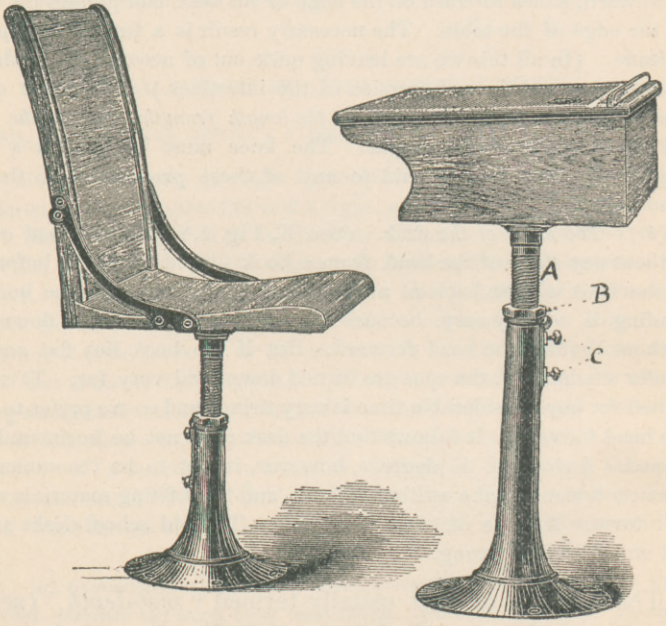


FIGURE 2.

THE SEAT–BACK.

Seat-backs may be continuous from top to bottom and as wide as the seat is long (see Fig. 2); or they may consist of one or more transverse rests, as in Fig. 1, with free spaces

below or between them ; or they may consist in their essential features of a transverse shoulder-rests borne by or connected with an upright back-prop (see Fig. 3) as is the

FIGURE 3.

case in most of the chairs used in our schools. Considered chiefly with regard to the height of the prop to support the trunk in the backward-sitting posture, the various kinds of seat-back present three principal types, viz.: (1) the low-hip or pelvic rest, when the support (see S, Fig. 1) extends no higher than the upper edge of the pelvis ; (2) the high-hip or loins-rest, when the prop is so placed as to support the back in the region of the lower loin-vertebræ; and (3) the so-called "high back-support" which reaches at least as far as the most prominent point of the curve made by the chest-vertebræ. The seat-back J P, shown in Fig. 1, belongs to the *third* type. Were its upper part, designated by the line J S, omitted, it would belong to the *second* type. As a rule, seat-backs of the first and second types are placed perpendicularly to the seat-surface, while those of the third type, as a rule, are more or less inclined backwards from the seat-surface, at least in their upper portion.

It is chiefly to the researches and inventions of the eminent orthopædic surgeons, Dr. Felix Schenk, of Bern, and Dr. Adolf Lorenz, of Vienna, that the school-seat constructed to give support to the back of the child in the "reclined sitting position" has come into vogue in Europe. The special purpose of this form of seat-back, whose essential characteristics are fairly well illustrated in Fig. 1, is to afford adequate and comfortable support to the back of the child whether he be writing, studying, or simply engaged in "sitting still." By reason of the backward inclination of the support, above the loins-rest S, it is claimed that the upper portion of the back of the sitter is pressed by its own weight against the support and not simply brought into contact with the upper rest. In other forms of the same type of seat-back, the back-support is continuous and is curved so as to conform to the S-form of the backbone, in the chest and loins regions.

Fig. 1 represents the seat as being placed at a slight plus distance, both seat and desk being immovable. This is a compromise between the demands of hygiene and the requirements of convenience. To enable the child to maintain the reclined sitting position when engaged in writing, the seat should be at a considerable minus distance from the desk. This is usually effected by rendering the desk-top movable so that the distance may be made plus or minus at the pleasure of the sitter. It should be said that the Schenk seat is somewhat sharply sloped from front to rear.

MALPOSITION IN WRITING.

Cohn (op. cit., p. 95) quotes from "Das Kind und der Schultisch," Zürich, 1865, by Dr. Fahrner, the following description of the mechanism of the collapse of the child's posture in writing, consequent upon the use of an unsuitable desk and seat:

> Before the writing begins the children sit perfectly upright with both shoulder-blades thrown back equally (that is, so that the shoulders are parallel to the edge of the desk), and the slate or copy-book is so placed

before the child that its left margin lies a little to the left of the middle of the body. *But as soon as the writing begins all the children move their heads slightly forward and towards the left*, without perceptibly altering their attitude in any other way. *Soon, however, head after head drops down with a rapid jerk*, so that the neck now forms a considerable angle with the rest of the spinal column. In a short time *the upper part of the back also collapses*, so as to hang from the shoulder-blades, which in their turn are supported by the upper arm. *From this moment the scholars are divided into two groups, according to the part of the slate at which they happen to be writing.* Those who are writing on the upper half of the slate or at the beginning of the line are able to support themselves on *both elbows*, and they let their chests sink straight forward against the table. The back in this way becomes curved simply; it becomes what I call a *round back*. The eyes are three or four inches distant from the desk and look straight down upon the writing. For the points of support the child uses the front of the chest, the left elbow (which is constantly moved outward till it is a long way from the body,) and the right fore-arm anywhere between the elbow and the wrist. But those scholars who at the critical moment are writing at the end of the line or near the bottom of the slate cannot any longer support themselves on the right elbow, because it too much overhangs the table and is too far from the body; they are therefore forced to lean on the left elbow alone, and in so doing not only to bend the spinal column, but to twist it on its axis towards the right. The position is that of the *skewed back*. The points of support are the left side of the chest and the left elbow, which lies very much to the left of the body and forward from the body; the head is bent towards the left shoulder; the right arm, with its shoulder-blade standing out like a wing, rests anywhere between the elbow and the wrist; the eyes, now frequently only from two to three inches distant from the writing are rolled considerably towards the right and almost squint over the paper. . . . In the normal position the head has its centre of gravity resting upon the bony framework of the spine and is supported by it, so that the muscles of the neck have nothing to do but to balance the head. *That slight stoop forward, however, is enough to push this centre of gravity over the front edge of the spinal column.* The *muscles of the neck* must now hold up the head if it is not to drop downward. The work thus laid upon them is considerable; the muscles of the neck are accordingly soon tired out, their tension is relaxed, and the work now falls upon the *muscles of the back*; these in their turn are soon tired out and the child is then forced to lean on other points of support. He tries first one or both elbows. The elbows support the upper arm, the upper arm supports the shoulder-blades, and

the body hangs upon the shoulder-blades until they also give way and the chest must needs find a stay and support at the edge of the desk.

VIEWS OF LORENZ AND SCHENK.

It is now generally held by competent authorities, *e.g.*, Schenk and Lorenz, that collapse of the writing position due to bad seating tends to produce the *round-backed* or *fatigue posture* or the *skew-backed* or *scoliotic position*, or both; and that each of these undesirable postures is bad for the eyes as well as the back. The main objects of the movement for school-desk reform and the introduction of vertical writing — which movement having spread from Switzerland and Germany has at last begun to be felt in this country and city — are the prevention of impaired vision and of scoliosis (lateral curvature of the spine). It is noteworthy that both Lorenz and Schenk distinctly prefer furniture that is more or less adjustable to fixed seats and desks, for the purpose of protecting the eyes and backs of school children from the untoward effects of their occupation. In this connection the following may serve as a condensed statement of Lorenz's views:

In general, fixed furniture cannot be recommended, though it may be tolerated under certain restrictions. It is needful above all not to prolong the period devoted to writing, since it is impossible for the seat-back to support the writer's back in a chair fixed, for the sake of convenience, at a positive distance 1–2 centimeters (.4–.8 inch) from the desk. During the intervals between writing periods, it should be possible for the child to rest his back comfortably against a properly curved high-back-support, having an inclination of 10°–15°.

The posture of the child in writing is to be judged differently from that of the adult. The forward sitting position, in which the trunk is somewhat bent forward and supported on the desk by the elbows, which we adults prefer, almost without exception, is a dangerous one for the child, since it tends to injure his eyesight through the sinking forward of the head when the neck and trunk muscles become fatigued, and also leads to the production of "round-back." The upright (military) sitting position, in seats with perpendicularly placed low-hip or hip and loin supports is too rigorous, calls for an excessive amount of muscular

exertion, and does not afford sufficient support to the back of the child either in the writing-periods or in the intervals between them. The reclined-sitting position, in which the back is supported at all times by a properly curved back-support inclined backwards from the inclined seat-surface at an angle of 10°–15° is to be recommended as the best and simplest means of preventing impaired eyesight and of combating the dangers of *rounded back* and *skewed back*. For one who writes in the reclined position, a relatively very large minus distance of 7–12 centimeters (2¾–4¾ inches) is demanded, together with an increased desk-slope, to correspond to the inclination of the seat-back. Through devices for changing from plus to minus distance and *vice versa*, freedom of movement is assured to the trunk. For purposes of adjustment a movable desk or desk-top is preferable to a movable seat, since if the latter is used the negative distance must be maintained in the intervals between writing-periods, which may prove an inconvenience. The adjustability of the desk-plate is preferably to be secured through contrivances which produce a to and fro sliding motion.

It is evident from Schenk's latest paper "Zur Schulbankfrage" (see "Zeitschift für Schulgesundheitspflege," No. 10, 1894) that he does not altogether agree with these views of Lorenz, which were published in 1888, as to the superiority of the reclined-backward-sitting position in writing as a means of preventing the skew-backed malposition; though he still holds that the reclined seat and seat-back, which he himself introduced some years since, afford an efficient means of preventing the collapsed attitude of fatigue, *i.e.*, is the rounded back. Schenk's original desk and chair were fixed, it may be remarked. His so-called "Simplex" school-seat, which is described at length in the article cited above, is movable in respect to seat, desk-top, and foot-rest. It approximates more nearly to an automatically adjustable seat and desk *suitable for occupants of various sizes* than any adjustable school-seat hitherto offered the public on either side of the ocean, so far as I can learn. Schenk's "Simplex" desk and chair embody the results of his elaborate experimental study of the mechanism of writing with copy-books in different positions. His claim that they afford an effectual means of preventing the skew-backed malposition in writing is plausible

and deserving of careful study. His arguments in favor of placing the paper or copy-book so that its edges shall be parallel with the corresponding borders of the desk-top, in the so-called straight position, appear to be quite conclusive. He favors vertical writing as a powerful influence towards habituating the pupil to maintain the correct position in writing; *i.e.*, squarely facing the desk without any deviation of the spine to right or left or any rotation of the shoulders or the pelvis on the long axis of the body. Schenk's rules for the position of the paper are as follows: *The straight position is necessary both in sloped and vertical writing. In vertical script the middle, in oblique script the beginning of the line of script should lie in front of the median line of the body.*

Schenk holds, on the strength of his ingenious and searching measurements of the amount of distortion in shoulders, spine, and pelvis conditioned by various positions of the paper with relation to arm and forearm, that *the greater the abduction of the upper arm from the trunk, the more crooked, bent, and twisted is the carriage of the body.* "The best writing posture, then, is that in which the abduction of the arm used in writing equals zero; *i.e.*, when the upper arm lies lightly against the body."

Schenk's views may be condensed as follows:

The school-seat is adjusted to this best position of the body, when it brings the paper in front of the body in such wise as to necessitate rotation only, without abduction of the upper arm in the shoulder-joint, during the act of writing a line of script. This is possible only when *the horizontal distance between the desk and the back of the seat*, which I would call "distance," — even though it be contrary to the usage followed with regard to this term hitherto, — equals the length of the forearm (elbow to wrist) of the person writing, and when the so-called "difference" is equal to the height of the elbow, when hanging straight downwards at the side, from the seat. Since by chance this last-mentioned distance corresponds to the length of the forearm, we have the following very simple and valid formula for the construction of the school-seat, viz.: *Distance = Difference = Length of Forearm of the person writing*, when as I have said the term "Distance" denotes the distance between desk and seat-back. To the usual pedagogical and technical requirements

of a school seat, such as convenience in stowing the pupils' utensils; adaptation to the various uses and needs of the individual pupil, so as to avoid all interference with his neighbor; noiseless play of its movable parts, which must be so constructed so as to prevent pinching of the pupil's clothing or fingers; that it shall present no obstacles to the easy, daily cleaning of the floor; economy of floor-space, solidity, and cheapness — I would add a new one which seems to me of the very highest hygienic and pedagogical importance, viz.: *that every seat, with its desk, should be adjustable for any and all sizes of children.* The height of children of school-age varies between 90 and 175 centimeters (35.43 and 68.89 inches). Accordingly most current systems of school-seating provide 5–8 sizes of seats and desks, which gives under the most favorable conditions a new size for an increase of 10 centimeters (3.9 inches) in height. Inasmuch as children in a given class vary from 20–30 centimeters (7.8–11.7 inches) in height, three sizes of furniture are placed, as a rule, in each class-room. This is usually deemed sufficient.

But in truth it is quite otherwise. The smallest children are frequently found occupying the largest seats. Of careful fitting there is very little. Where are the children measured every six months in order to seat them in accordance with their growth in height? Where are the seats redistributed, if tall, middle-sized, and short pupils happen to be allotted to a class in numbers that are disproportionate to the quota of variously sized seats? Above all, where do we find hygienic insight and good will among the teachers, combined in the same school with facilities for fitting the furniture to the pupils? Certainly such instances are very rare. Here as elsewhere theory is agreed to and there it rests. The carrying out of the theory in practice is too troublesome and encounters too many obstacles of all sorts. This will continue until we have a school-seat which shall render the ranking of the pupil completely independent of the position of his seat; which shall permit the teacher to arrange his pupils so as to meet the demands of instruction, as he must do, for instance, in the case of short-sighted, deaf, or merely inattentive pupils, if they are to profit from his instruction. In short, we need a school-seat adjustable in a wholly automatic way to children of all heights. This is the principle on which my "Simplex" seat has been constructed, for whose use only one direction need be given by the teacher to the pupil in order to rectify the vicious writing posture. It is this: *take hold of the desk-plate in front of you and draw it towards you till your elbows touch the seat-back!* By this easy and simple means of adjusting the school-seat to its occupant we shall be able to combat the ill-conditioned writing posture (skewed-back) with the same success that has crowned our efforts to prevent the evil fatigue-position (rounded-back), through the "reclining" of the seat and seat-back.

GROWTH AND ITS BEARING ON SCHOOL SEATING.

The fact of capital and inexpugnable importance with regard to our school population is that it is made up of the growing young of the human species. Dr. Bowditch showed twenty years ago that the average yearly increase in height of Boston school children of five to fifteen years inclusive ranges between *one* and *three inches* per year. The importance, nay, the necessity, of providing children of all ages with easy-fitting head-gear, collars, overcoats, and shoes is tacitly admitted and generally acted upon. It is fully as important, to say the least, that they should be equally as well fitted in respect to their seats and desks, since under our compulsory education acts, neglect of school-seating practically amounts to condemning large numbers of pupils to deleterious "confinement with hard labor" without due process of law. The actual amount of misfitting in our schools, taking them as a whole, has not been fully determined, but Dr. Scudder's investigations and my own (see School Document No. 8, 1894, p. 112–115) leave no room for doubt that it is excessive and largely preventible.

An examination of our course of study in respect to the time devoted to sedentary and non-sedentary pursuits yields some interesting results, which I have brought together in the following table:

TABLE II.

SHOWING (1) THE RELATIVE AMOUNT OF TIME ALLOTTED TO SEDENTARY AND NON-SEDENTARY EXERCISES BY THE COURSE OF STUDY AND (2) THE ACTUAL TIME IN HOURS CALLED FOR BY THE SAME IN THE SCHOOL YEAR 1893-94.

		Sedentary Occupation.	Non-Sedentary Occupation.	Recesses.	Physical Training.	Manual Training.	Total.
Primary schools, Class III.	1.	86%	14%	10%	4%	.....	100%
	2.	825.6	134.4	96.0	38.4	.....	960.0
Primary schools, Classes II. and I.	1.	84%	16%	10%	6%	.....	100%
	2.	806.4	153.6	96.0	57.6	....	960.0
Grammar schools	1.	88%	12%	7%	5%	(8%)	100%
	2.	844.8	115.2	67.2	48.0	(76.8)	960.0
Girls' Latin	1.	86%	14%	10%	4%	.....	100%
	2.	825.6	134.4	96.0	38.4	.....	960.0
High Schools	1.	82%	18%	10%	8%	.....	100%
	2.	787.2	172.8	96.0	76.8	.....	960.0

In the above table no account is taken of the Mechanic Arts High School or of the Normal School. Manual training in the grammar schools, excepting that given in the second class, *i.e.* 2 hours a week, or 8 per cent. of the school period per week, is practically a sedentary pursuit. That so much as 86 per cent. of the school period in the first year of the primary grade, and 84 per cent. in the second and third years of the same grade should be allotted to sedentary occupations, especially as the rudiments of penmanship are taught in the primary school, emphasizes the need of special attention in regard to the seating of primary school children.

TABLE III.

SHOWING (1) INCREASE IN HEIGHT OF BOSTON GIRLS AND BOYS, OF 5-15 YEARS, AND CORRESPONDING CHANGES IN DIMENSIONS CALLED FOR IN CHAIRS AND DESKS; AND (2) INCREASE IN CERTAIN MEASUREMENTS OF GIRLS AND BOYS OF 10-15 YEARS WHICH ARE USED AS STANDARDS IN "SIZING" CLOTHING, ETC.

1.	Total Height. 1.		Height of Chair. 2.		Difference. 3.		Height of Desk. 4.		Depth of Seat. 5.		Height of Back-Rest. 6.	
	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.
At 5 years .	41.29	41.57	11.25	11.34	7.01	7.06	18.25	18.40	8.25	8.31	5.16	5.19
At 15 years,	61.10	62.30	16.65	16.98	10.38	10.59	27.05	27.57	12.22	12.46	7.63	7.80
Increase 5–15 years..	**19.81**	**20.73**	**5.40**	**5.64**	**3.37**	**3.52**	**8.88**	**9.17**	**3.97**	**4.15**	**2.47**	**2.61**
Average yearly increase....	**1.98**	**2.07**	**0.54**	**0.56**	**0.33**	**0.35**	**0.87**	**0.91**	**0.39**	**0.41**	**0.24**	**0.26**

2.	Girth of Head. (Hats.) 7.		Girth of Neck. (Collars.) 8.		Girth of Chest. (Coats.) 9.		Length of Foot (Shoes.) 10.	
	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.
At 10 years.....	20.7	21.1	10.4	10.9	24.4	25.6	8.3	8.3
At 15 years.....	21.7	21.8	11.9	12.6	29.1	31.4	9.3	10.0
Increase 10–15 years ..	**1.0**	**0.7**	**1.5**	**1.7**	**4.7**	**5.8**	**1.0**	**1.7**
Average yearly increase.....	**0.20**	**0.14**	**0.30**	**0.34**	**0.94**	**1.16**	**0.20**	**0.34**

The above figures are in inches.

The above table shows the extent of change in certain bodily measurements due to growth during the age period 5–15. The figures in column 1 are taken from Dr. H. P. Bowditch's tables; those in columns 2–6 are computed according to Eulenberg and Bach's scale (see page 172), in which height of chair equals $\frac{3}{8}$ body height; difference equals 17 per cent. of body-height; height of desk equals sum of differ-

ence and height of chair; depth of seat equals $\frac{1}{5}$, and height of back-rest (see Fig. 1) equals $\frac{1}{8}$ of body-height. The figures in columns 7–10 I have compiled from anthropometric charts compiled and published by Dr. D. A. Sargent, of Harvard University.

I have compiled and introduced this table for the sake of emphasizing the indubitable fact that it is quite as needful to have the desks and chairs of variously sized children fitted to their trunks and limbs as to fit their shoes to their feet or their collars to their necks. The table also suggests that desks and chairs, as well as collars and shoes, require to be made in girls' sizes and boys' sizes if an accurate and easy fit is to be secured, a suggestion which I shall take occasion to refer to further on.

To my mind the table suggests considerations in favor of adjustable over fixed systems of school furniture, but it also suggests the difficulty of constructing an automatically adjustable school-seat that shall precisely and surely fulfil all the requirements of children whose height of knee ranges between 11.25 and 16.98 inches, and whose length of thigh ranges between 8.25 and 12.46 inches.

REQUIREMENTS OF ADJUSTABLE FURNITURE.

The purpose of the foregoing discussion is to bring out the main factors which enter into the seating problem; to suggest their relation to each other; and to call attention to the best considered and most successful of the attempts thus far made towards solving the problem. It may be said with perfect fairness that the best European opinion is opposed to the use of school desks and chairs having no movable parts, which is tantamount to saying that the most competent authorities on school-seating have pronounced in favor of adjustable school furniture. Before proceeding to a comparative study of European and American systems of adjustable school furniture, it will be well to summarize the leading principles of seating in relation to the individual and class

needs of children. The child's height is a better criterion than his age in determining the dimensions of his seat and desk, which, to merit the designation "hygienic," must be so constructed as to obviate the strained and exhausting actions of the muscles of the eye, head, and trunk which are dangerous, as they tend to produce impaired vision, rounded backs, and skewed backs. To this end the seat must be provided with loin and shoulder rests that shall afford appropriate support to the child's back when he is engaged in drawing, writing, or ciphering, as well as in the intervals between those operations.

The *height* of the seat must correspond to the height of the child's knee; its *depth* to the length of his thigh; the *points of support* offered by the seat-back must be proportioned to the height of pelvis, loins, and shoulders, and conform to the natural curves of the spine; the *desk-height* should equal the *seat-height* plus the *difference* between the height of the sitting bones and the height of the elbow; the *desk-top* must so slope, and at such a distance from the child's eye, as to obviate any necessity of bending the head forward for the sake of securing distinct vision in reading or writing; and there must be a *minus distance* between seat and desk, lest the seat-back be rendered useless or harmful.

The child requires such a seat and desk at every stage of his school-life. Theoretically this requirement may be met by providing each class-room with a large and varied assortment of fixed seats. Practically, owing to the constant growth of the individual child's trunk and limbs, and owing to the wide range in the mean and extreme lengths of his body and its parts, — a range that fluctuates from year to year, — it is well-nigh impossible, except at the expense of an excessive outlay of time and money, to furnish a series of class-rooms with the right number of fixed seats of different sizes. At the best we can look for only approximate success in seating classes when fixed furniture is exclusively used, even when it is carefully graded as to sizes.

The ideal end of school-seating is that every child shall be provided, during each stage of his growth, with a separate desk and chair whose several parts shall be so proportioned and put together as to meet the individual needs of the child. Strictly speaking, no school-seat is worthy to be called perfect unless it affords automatic adjustability in respect to height of seat, difference, distance, depth, and length of seat, height of back-rest, and slope of desk, and in such wise that the movable parts can be worked easily, noiselessly, and safely by a primary pupil. For such a seat to be available for children throughout their period of growth, the range of motion in its adjustable parts must correspond to their range of variation in length of trunk, legs, and arms. It is possible, of course, that such a seat can be devised, but it is highly probable that ideal hygienic needs would be sacrificed in practice to pecuniary considerations, or to purely technical and pedagogical requirements. I am free to say that no single-sized seat that I have seen, or seen described, fulfils the requirements of an ideal seat. Economy of floor-space, not to speak of other considerations that readily suggest themselves, would seem to necessitate the making of certainly two and perhaps three distinct sizes of seats and desks, be they never so perfectly adjustable.

EUROPEAN ADJUSTABLE DESKS AND CHAIRS.

Lorenz (op. cit., p. 30) and Janke (see "Zeitschrift für Schulgesundheitspflege," Vol. III., 1890, p. 461) describe a school desk and chair made by Pedersen, of Copenhagen, which more nearly fulfils the requirements of complete adjustability than any I know of. It is automatically adjustable as regards distance, difference, seat-depth, and height of back-rest. However, it seems to be rather complicated for the use of young children.

Dr. Schenk's "Simplex desk" well deserves its name. It is as ingenious as it is simple in its contrivances for effecting automatic adjustment in respect to distance, difference, and

desk-slope. But, though a movable foot-rest is provided, the seat is not adjustable either for height or depth, and the seat-back is immovable in all its parts. Its shortcomings as a compromise seat might be largely obviated, if it were made in three sizes instead of one.

Holscher and Neudörfer, both Germans, and Kryloff, a Russian, have each devised completely adjustable seats for home use that suggest ingenious expedients for improving school furniture. Dr. Brandt, of the University of Charkow, and Dr. Sandberg, of Stockholm, have invented school-seats that are adjustable for difference, distance, and depth, while that of Dr. M. Roth, of London, is adjustable for difference and distance, but not for depth.

The great majority of European inventors of adjustable furniture have directed their attention to contrivances for effecting a change from plus to minus distance and *vice versa;* and a somewhat long list of desks and chairs might be drawn up to show that their efforts in this direction have been fairly successful. For instance, at the competitive exhibition of school-seats, held at the City Hall, in Vienna, in January, 1894, of the forty-nine placed on exhibition no less than thirty-nine were adjustable for distance. In five cases the seat was made movable; and in thirty-four the desk or the desk-top was movable, — of which twenty were provided with hinged flaps and nine with devices for swinging the desk or the desk-plate forward and backward, while four had sliding tops, and one a roller top.

Of American adjustable school furniture as a whole it must be said that it does not adequately represent "the present state of the art." Our inventors and manufacturers have been slow or timid in profiting by foreign example and experiment. Inventive genius on this side of the Atlantic has been chiefly devoted to the one matter of devising mechanical contrivances for raising and lowering desks and chairs, *i.e.*, for effecting adjustment for difference. None of our so-called adjustable furniture, so far as I know, is adjustable in respect

to the very important points of distance, depth of seat, desk-slope, and height of back-supports, and most of it is not adjustable in respect to any one of the four points I have mentioned. It is but fair to say, however, that American inventors and manufacturers as a class have shown more enterprise and interest in the problem of school-seating than have either American educationists or scientists. The fact that our much lauded technical and manual training schools have done next to nothing hitherto towards the improvement of school furniture suggests an interesting and fruitful line of inquiry and criticism.

EARLY EFFORTS IN SCHOOL-DESK REFORM IN NEW ENGLAND.

It is now nearly sixty-five years since school-seating began to be discussed in New England.* At the first meeting of the American Institute of Instruction, which was held in August, 1830, in this city, Dr. John C. Warren, the foremost surgeon of Boston, gave a lecture on "Physical Education." The following extracts from his lecture which stands as "Lecture I." in the annals of the institute are of interest:

> I feel warranted in the assertion that of the well-educated females within my sphere of experience, about *one-half are affected with some degree of distortion of the spine*. . . The immediate cause of the lateral curve of the spine to the right is the elevation and action of the right arm in writing. . . . Young persons, however well disposed, cannot support a restriction to one place and posture. . . . The postures they assume while seated at their studies are not indifferent. They should be frequently warned against the practice of maintaining the head and neck long in a stooping position; *and the disposition to it should be lessened by giving a proper elevation and slope to the desk; and the seat should have a support or back of a few inches at its edge.*

The last lecture before the American Institute of Instruction in 1830 was on "The Construction and Furnishing of

*It is more than fifty years since the first American adjustable desk and chair was introduced by Amos Chase, of No. Weare, N.H., to an unappreciative public.

School-Rooms," by Mr. Wm. J. Adams, of New York, who in his remarks on seats and desks speaks with disapproval of

That ancient form, in which the seat occupied by a row of pupils is attached to a desk of the same length immediately behind, which supports the back. The most modern construction, he goes on to say, appears to be that of detaching the seat occupied by each pupil from the desk behind, and from the other seats, — the desks themselves remaining continuous, as before. The seats are made without backs and behind them is a passage for walking. In this way each child is *insulated*. . . . The seat itself is either a piece of plank, nine inches by twelve, with the corners rounded off, nailed upon a firm pedestal; or it may be simply a *box* without a cover, made to stand upon one end, and fastened to the floor.

To the plan just described there is still one objection; viz., the want of some support to the back. This want may be supplied by the upward continuation of the board which forms the rear of the box, — perpendicularly, so as not to encroach upon the passage behind, and so low as to reach only the hollow of the back of the child, without touching the shoulder-blade. A convenient rule for regulating the height of seats and desks is to suppose the former of such a height that the knee shall be bent at a right angle, the foot resting firmly on the floor. If, then, the pupil sit perfectly upright, the place of the elbow will indicate the true level for the *edge* of the desk. Each desk should have a slope, but so slight that books and slates may not slide off.

In 1831 the American Institute of Instruction's prize for an essay "On the Construction of School-houses" was awarded to Dr. William A. Alcott, of Hartford, Conn., afterwards of Boston. Appended to the essay is a plan of a school-room to accommodate fifty-six pupils (*which is the regulation number in our schools to-day*), each pupil to be provided with a desk 2 feet by $1\frac{3}{4}$, and a seat "in effect a square box closed on all sides," support for the pupil's back being afforded by front of the desk behind him.

The height of the desks and seats, says Dr. Alcott, is proportioned to the height of the pupils who occupy them [*but no scale of heights is given*]. . . . The particular arrangement of each seat and desk is such as almost to compel the person occupying it to sit in an erect

position. The edge of the desk will be directly over the edge of the seat [*i.e., distance equals zero*]. In writing, the arms will hang naturally by the side, while the flexure at the elbow will be such that the lower position of the arm with the hand will form a right angle with the upper portion and rest lightly upon the desks. The desks will thus be much lower than is usual, but all parts of the body, as well as every limb, will be at the same time free and unconstrained. This is a point of vast importance. The most common position at the school desk is extremely unfavorable to the healthful action of the lungs, stomach, liver, etc., as well as liable to produce distortion of the spine, and consequent disease.

Yet even to this day the majority of desks in the Boston schools are too high, so much so that in writing the forearm is forced to make a more or less acute angle with the upper arm, while the upper arm is unduly abducted from the body and the right shoulder is unduly raised. This is especially the case in the vicious but still too common writing position in which the pupil is required to sit with his side towards the desk, so that his back must be totally unsupported.

Dr. Alcott may be said to have set the tone among educational reformers in regard to school-seating, since we find his plans adopted and adapted and his recommendations approved and advocated in Horace Mann's "Report on the Subject of School-houses," supplementary to his first annual report as Secretary of the Massachusetts Board of Education, in 1838, and by George B. Emerson in "the School and Schoolmaster," published by Harper & Brothers, in 1842, at the expense of Mr. James Wadsworth, of Geneseo, N.Y. As 11,000 copies of "The School and Schoolmaster" were distributed gratuitously in the school districts of that State, and Mr. Martin Brimmer, of Boston, when mayor of Boston, "caused to be printed, at his expense, such a number of copies as would supply one copy each to all school districts, and one copy each to all boards of school committee men in Massachusetts," Dr. Alcott's views became widely diffused. At the same time Dr. Alcott was ahead of his time in recommending separate desks and chairs, *set at a zero*[1] *distance* for each pupil, for we

[1] As late as 1839 influential writers in England recommended *a plus distance of three inches between desk and form.*

read in Superintendent Philbrick's fortieth report, 1874, that when the Quincy Grammar School was erected in 1848, being a radical innovation, "it contained a separate desk and chair for each pupil, this being probably the first grammar school-house here or elsewhere, so far as I know, into which this feature was introduced." During the decade prior to 1848, the most usual way of seating was to provide grammar and high school pupils with a separate seat, but to seat two pupils at a desk. Primary children in Boston had separate chairs as early as 1842, but it was not till 1856 or later that the Common Council could be induced to provide them with desks as well.

INTRODUCTION OF SEPARATE DESKS AND CHAIRS INTO THE LATIN SCHOOL.

Rev. Edward Everett Hale has kindly furnished me with the following notes on the seats used in the Public Latin School when he was a boy:

Until 1831 the desks at the Latin School were long fixed forms, with seats attached in front of the next row. Generally there were but two rows, I think in some cases three. Always there were three rows of seats; the front row having no desk. For recitations the boys, until 1831, went out and sat on benches without backs. The height was uniform for the form seats, and of course for each bench. The desks of the forms were fixed, not on hinges. It was in 1831 that Mr. Dillaway introduced some separate desks, in some rooms. He had bought them or had them bought at some other school. They had been used before. The seat was attached solidly — I never knew one broken — and was like a small wooden chair-seat. All the seats were of the same height, for boys six feet high or for boys four feet high. Oddly enough I do not remember ever complaining of this or thinking there was any hardship about it. These newer desks, which were not forms and were never called so, — were in fact tables with desks on top. The desk opened with a hinge so that the boy supported the cover on his head when he looked for anything. These desks had had locks; but they had none in our day. They did have inkstands set in the top. They were painted green. They were much more popular than the forms, and where the forms and desks were used together, little boys had the forms and big boys the desks. Mr. Dillaway also introduced the ordinary *settees*, just such as

are now in general use, for recitations, in place of benches. I am quite clear that these desks (which could be moved and were not generally screwed to the floor) were introduced in September, 1831. Observe that the *forms* had backs; namely, the wall or the form behind. The desks had the same, if a desk were behind you, or the wall were behind you. If not — not.

The fact noted by Dr. Hale with regard to lack of back support for boys seated in the rear rows is of interest in considering the evolution of the Boston school chair, for it was evidently to make good this lack that the seats in the back row were the first to be provided with chair-backs, as were later all seats. The transition is shown by a cut in Mr. Mann's report, cited above, which shows the arrangement of seats and desks in the Wells School, Boston, in 1838: "The seats in the back row are chairs. The others are without support to the back. The scholars are tempted to lean backward against the next tier of seats, which not only throws them into an unnatural and unhealthful posture, but is also a source of annoyance to others."

ACTION OF SCHOOL COMMITTEE REGARDING SCHOOL-SEATING.

The records of the School Committee are not rich in respect to school-seating. The following extracts from reports and minutes may, however, serve to indicate the main course of events.

Feb. 12, 1833, Mr. Samuel A. Eliot, as chairman of a special sub-committee, recommended certain needful changes in the interest of better ventilation, heating, and arrangement of seats. Mr. Eliot's advocacy of his recommendations is couched in very vigorous terms.

It may sound strangely, he says, to ears accustomed to hear the praise which is often bestowed upon our system of public schools, and to those who see what appears the great sum annually spent upon them, to hear it asserted that the children have not room enough and that more care is taken of the health of the convicts in our penitentiary than than is bestowed upon the health of the children we send to our schools,

or upon the rooms in which they are assembled. But it is nevertheless strictly true.

It is the duty of parents and those who act for them to take care that the school-room shall be a place where the children may acquire the use of their intellectual faculties without having their physical organization disturbed or their vital powers debilitated by a constrained position or an impure atmosphere.

Aug. 8, 1837, when Mr. Eliot was mayor, in the report of a special committee appointed "to consider the expediency of applying to the City Council for a new school-house for the accommodation of the northern wards of the city," the Eliot School-house was pronounced "inconvenient in almost every respect. . . . The forms, besides being too narrow, are crowded too closely together; and the seats, which are merely oval stools without backs, are quite too contracted." Finally the Eliot School-house was rebuilt, and furnished in 1838–39 with separate seats for each pupil, the seats being provided with a back-support "resembling the back of a chair."

In the Mayor's address to the School Committee, Jan. 8, 1839, Mr. Eliot notes the improvements with respect to ventilation and seating embodied in several school-houses recently built or remodelled, and recommends "that a committee be appointed to devise and recommend a plan of a school-house to this board, to be by them recommended to the other branches of the city government, embracing such a system of ventilation and such arrangement of the seats as shall appear best calculated to promote the health and reasonable comfort of the children." Messrs. Eliot, Ezra Palmer, Jr., and S. G. Howe were appointed to serve as such a committee. Mention of the committee's report is made in the minutes of the Board, but the report is missing from the files of 1839. In response to a petition of S. G. Shipley and others deploring "the increasing prevalence of diseases of the spine among young females educated in the public schools" owing to backless seats, Mr. Eliot was empowered to "provide such seats as may be deemed suitable."

Either the seats were not furnished, or Mr. George S. Hilliard was hard to please, for as chairman of the Annual Committee on the Grammar Department we find him saying, in 1841:

> The schools are too crowded and the seats are not properly constructed. There is not a single school which has come under the observation of your committee in which the seats are adapted, as they ought to be, to the young and growing frame. Especially do the girls suffer from this cause, from their greater delicacy of organization and less hardy habits of exercise. Such seats cannot be viewed without pain by any one acquainted with the principles of physiology.

The policy of furnishing the pupils in the Grammar Schools with separate desks and chairs seem to have been steadily followed after its inauguration in the Quincy School in 1848. But difficulties were encountered in reforming the method of seating primary pupils, as appears from Superintendent Philbrick's mention of the matter in his fortieth report. "In 1856 the primary pupils were seated in movable arm-chairs without any desks before them, and without any suitable place to keep their books and slates. Without desks the use of slates was out of the question. As the use of slates was deemed essential, an attempt was made to supply the primary schools with single desks and chairs. On the part of the City Council there was determined and persevering opposition to this requirement, and it was only after four or five years of persistent efforts that this desirable object was fully accomplished."

In 1892, at its meeting on January 26th, the School Committee voted to constitute a Special Committee on the Seating of Pupils, and Messrs. Green, McDonald, and Mecuen, all physicians, were appointed to serve in that capacity. This committee was instrumental in securing the introduction of adjustable furniture into the new Charles C. Perkins Primary School, in the Prince District, in 1892, and in securing the publication of Dr. C. L. Scudder's valuable "*Investigation into one of the Etiological Factors in the Production of Lateral*

Curvature of the Spine — Reasons why the Seating of School-Children should receive very Careful Supervision," which constitutes School Document No. 9, 1892.

The following extracts from the minutes of the School Committee relate to orders offered by the Committee on the Seating of Pupils:

Oct. 25, 1892, Mr. Green, for the Special Committee on the Seating of Pupils, offered the following:

Whereas, a carefully prepared report to the School Committee, by a competent expert, on the seating of pupils in the public schools (School Document No. 9, 1892), has deen printed and distributed to all teachers in charge of rooms, it is hereby

Ordered, That the Supervisors and the Director of Physical Training be and hereby are directed to ascertain, in their visits to their respective schools, whether or not the said report has been received and studied by the teachers, and whether intelligent effort is made on the part of the teachers to seat their pupils in accordance with the teachings of the report, as far as the present provision of school furniture will allow.

Ordered, That the Supervisors and the Director of Physical Training be directed to render to teachers any needed advice and assistance in the seating of pupils, and to include in their next reports to this Board the general results of their observations, and any suggestions pertaining to the proper seating of pupils which they may think desirable to bring to the notice of the School Committee.

Accepted, and the orders passed.

Feb. 14, 1893, Mr. Green offered the following:

Ordered, That the Superintendent of Public Buildings be directed to gradually rearrange the desks and seats in the older school buildings, providing new furniture where needed, so that there shall be three sizes of desks and seats in each room. Referred to the Committee on School Houses.

March 14, 1893, Mr. Pettigrove, for the Committee on School Houses, to whom was referred, February 14, an order that the Superintendent of Public Buildings be directed to gradually rearrange the desks and seats in the older school buildings, so that there shall be three sizes of desks and seats in each room, reported that in the opinion of this committee the matter of providing suitable school furniture is one of great importance, and needs careful consideration, and may require certain experiments before any formal recommendation as that contained in the order can be wisely endorsed and carried out. It is the purpose of this committee to give the subject the attention it deserves, and by experi-

ment and investigation to secure some wise and beneficial improvements in this particular. The committee therefore recommend that no further action of the Board in the matter is necessary at present.

Accepted.

RECENT REPORTS ON SCHOOL-SEATING IN BOSTON.

Dr. Scudder's investigations were confined to girls' schools chiefly of the grammar grade. Out of 37 rooms examined, only 13 were found to be provided with as many as two sizes of desks and chairs. "In every instance," says Dr. Scudder. "where these two sizes are found there are only a few of the second, and the difference in sizes is often scarcely noticeable. With very few exceptions it is true that girls of the grammar schools in any one room sit in the same-sized seats, and at desks of uniform height."

His report contains tabulated statements showing the range of age and the range of height exhibited by the pupils of 6 girls' schools; the data concerning 34 rooms are complete. We may divide these rooms into two classes, viz.: (1) those with desks of *one size* only, and (2) those with *two sizes* of desks. Of the former there were 21, of the latter 13 rooms. In 21 rooms, in which the desks were of one size only, the average difference between the height of the tallest and shortest girls amounted to 31.3 centimeters, or 12.26 inches; and the average difference between the ages of the oldest and youngest girls was 5 years and 4 months. In 13 rooms, which contained desks of two sizes, the average difference in height between the tallest and shortest girls was 41.14 centimeters, or 16.26 inches; and the average difference in age between the oldest and youngest pupils was 6 years and 2 months.

The report contains twelve plates which serve "to illustrate a few of the faulty positions taken because of the disproportion between child, seat, and desk."

Dr. Scudder states his conclusions as follows:

1. The present method of seating the school-houses of Boston is at fault, in that children are compelled to sit in desks unsuited to them.

2. This method of seating tends to the production of permanent deformity of the spine.

3. The poor seating in our schools has not been hitherto sufficiently emphasized by orthopædic surgeons as a cause of spinal deformities.

4. A larger number of different-sized desks and seats, or adjustable desks and seats, should be provided for each school-room.

5. The teachers of the public schools should be impressed with the fact of the importance of maintaining erect positions, both in sitting and standing.

6. Having greater variety in sizes of seats and desks, and recognizing the danger of malpositions in sitting, great care should be used to seat each child before a desk and in a chair as nearly as possible her proper size.

7. The desk should be low enough to just allow the bent elbow to touch it when the hand is raised to write without raising the shoulder or tilting the trunk.

8. The chair should permit easy contact of the whole sole of the shoe with the floor when the child sits well back in the seat.

9. The foot-rests should be used more than at present, not only to support the foot and leg, but to give a feeling of support to the whole trunk, and to prevent the slipping forward of the buttocks upon the chair, causing one of the commonest of bad postures.

10. The present system of gymnastics in use in the public schools will help to overcome slight tendencies to deformity which might go unchecked and lead to disastrous results.

Acting under the committee's order of Oct. 25, 1892, I investigated the conditions of seating found in 100 class-rooms taken at random, in primary, grammar, and high schools; in old, middle-aged, and new buildings; in boys' schools, in girls' schools, and in mixed schools In my last report to the School Committee an account is given of the results of that investigation, together with an account of the measures taken in coöperation with Mr. Gibson, the master of the Agassiz School, to secure a suitable assortment and allotment of fixed desks and chairs in the new Agassiz building. Since the completion and occupancy of that building the question of the introduction of adjustable furniture

into new school-houses has become prominent, and thanks to the activity of rival manufacturers is still acute. It seems proper to introduce some extracts from my report, published in September, 1894, at this point.

In studying the conditions found in 100 sample class-rooms, no effort was made either to avoid or seek the rooms investigated by Dr. Scudder. In general, I found a relatively larger number of rooms provided with more than one size of desks and chairs than did Dr. Scudder. But it should be noted that the mere provision of three sizes of desks is no guarantee against misfitting, as I found misfits in rooms containing three sizes of desks. In one such room, in a grammar school, I found that more than one-half of all the pupils were misfitted. It was a room which had been assigned to third-class boys for very many years, though it was fitted with desks and chairs intended for fourth-class boys.

The following figures relate to two kinds of misfit only, which for convenience are characterized as "minus-misfits"; *i.e.*, when the pupil is unable to assume an erect sitting position, with both feet flat on the floor, owing to contact between his knees and the under surface of his desk, and "plus-misfits," *i.e.*, when the pupil, in the erect sitting position, is unable to put both feet flat on the floor — the seat being too high.

Of the 100 rooms alluded to above, there were only 18 in which no case of misfitting was found, while 733 cases of misfitting were found in the remaining 82 rooms, which contained upwards of 3,600 pupils in actual attendance. In other words, misfits were found in 82 per cent. of the classes examined, and 20.27 per cent. of the pupils in those rooms were misfitted; 8.76 per cent. of the pupils presented "minus-misfits," and 11.51 per cent. of them presented "plus-misfits." Of the whole number of misfits noted, 317 or 43.24 per cent. were minus-misfits, and 416 or 56.76 per cent. were plus-misfits, which goes to show that the number of children forced to sit in chairs that are too high is considerably greater than the number of those obliged to use chairs and desks that are too low. In one of the high schools for boys, about one-third of the members of the first class were found occupying desks which cramped their knees, though the desks in question were of the largest size.

In 16 night-school classes, with 627 pupils in attendance, misfits were found in all but 2 rooms; 144 minus-misfits, but

no plus-misfits, being found in 14 rooms containing 554 pupils. In other words, 23 per cent. of all the pupils examined were placed at desks which were too small for them. The ill effects of misfitted desks and chairs upon night-school pupils are trifling in comparison with such effects upon the rapidly growing children who make up the population of the day schools.

While it would be unjustifiable to assume from the data given above in regard to 100 rooms that 20 per cent. of the pupils in 82 per cent. of all the school-rooms belonging to the city are misfitted in respect to their desks and chairs, it does seem to be tolerably clear that there is an undue amount of such misfitting, and that Dr. Scudder was right in saying, "A larger number of different-sized desks and seats, or adjustable desks and seats, should be provided."

The general conclusions which I have reached in this matter may be stated as follows:

1. Little if any improvement has been made in the methods of seating pupils in the Boston schools since Superintendent Philbrick's efforts, some twenty-five years ago, to secure desks and chairs of improved construction.

2. The method of seating which now prevails is so arbitrary, antiquated, and inadequate that it needs amendment.

3. The desks and chairs which are customarily furnished, although they are durable and well made when considered simply as articles of manufacture, do not conform as regards their design and construction to the recognized principles of modern school-hygiene.

4. The present condition of things appears to be due to the fact that the designing, selection, and distribution of the school-furniture now in use have been left too largely in the hands of interested and inexpert persons, who were practically outside the jurisdiction of the School Committee. Our methods of seating, therefore, have not kept pace with the progress made in those parts of the world in which expert knowledge has been turned to pratical account in the attempt to solve the problems involved.

5. Certain manufacturers of school-furniture have recently shown an active disposition to improve the quality of their wares, especially in the direction of devising adjustable desks and chairs. This is a hopeful sign of the times. Still the present state of their art is so rude and undeveloped, and is so likely to undergo further change and improvement within the next few years, that the wisdom

and expediency of adopting any of the newer and so-called improved American systems of seating, except in a tentative and experimental way, may be doubted seriously.

6. The problem of providing our school-population with desks and seats which shall adequately meet the requirements of growing children is one of vital importance. It is also an intricate and difficult problem, since it involves questions of a medical nature, in addition to questions which pertain to mechanical engineering and to the practical management of schools. The best interests of pupils, teachers, school-managers, and of manufacturers as well, all demand the adoption of more comprehensive and active measures than have been taken as yet in this country. To enlighten the public mind with regard to the essential principles involved in the construction and use of school-furniture, it is eminently desirable, to say the least, that the whole problem of seating should be authoritatively pronounced upon by a commission of disinterested men, who are competent and willing to avail themselves of the best that has been attempted or accomplished by similar commissions in Europe during the past ten years. The conclusions and recommendations of such a commission, if it were appointed and supported by a representative organization such as the Massachusetts State Board of Health, the Massachusetts Medical Society, or the State Board of Education, or by the conjoint action of all three, could hardly fail to prove widely influential in promoting the public welfare. By hastening the settlement of vexed questions, and by obviating the necessity of costly and partial experiments, with all manner of "improved chairs and desks" on the part of the school boards of the Commonwealth, such a commission would save the cost of its investigations and publications many times over to the taxpayers of the State.

METHOD OF SEATING IN THE NEW AGASSIZ SCHOOL.

The Committee on School Houses not being favorably impressed with any of the adjustable desks and chairs then in the market, wisely determined on providing the new Agassiz Grammar School-house with fixed furniture of the Whitcomb pattern, so called, such as is found in the majority of all the newer school buildings. The problem was to secure a sufficiently varied assortment of desks and chairs in each class-

room. It is but fair to say that the seating of the pupils in the old building was less objectionable than in many other districts, as it had an unusual number of rooms containing two or even three sizes of desks, and exceptional care had been taken by Mr. Gibson to make the best distribution of the seats furnished. Still 6.2 per cent. of the pupils in the grammar school were found to be misfitted (using the term as in the sense defined above) in January, 1893. In February, 1894, I found the proportion of misfits in the new building reduced to 1.2 per cent.

Mr. Gibson kindly undertook to determine the height of the pupils in his district, 668 in all, in January, 1893, and twice repeated his measurement of all grammar-school pupils (boys), between that date and February, 1894; and placed all his measurements at my disposal. The age of each pupil was noted in addition to his height. These series of measurements were used in determining how many of each size of Whitcomb desks and chairs should be placed in the new school-rooms. Eight sizes are included in the Whitcomb scale, which purports to "embrace all the heights and sizes for pupils of the age of 5 years to 18 and upwards." The Whitcomb scale is set forth in the following tabular view:

Scale-number.	VII.	VI.	V.	IV.	III.	II.	I.	I. Extra.
Corresponding age, year	5–6	6–7	7–8	8–10	10–12	12–14	14–16	16–18
Height of chair, inches	10.5	11.25	12.25	13.5	14.5	15.50	16.75	16.75
Height of desk, inches	20.5	21.50	23.0	24.5	25.5	27.0	28.5	29.0
"Difference," inches	10.	10.25	10.75	11.0	11.0	11.50	11.75	12.25

It will be noticed that the gradation of sizes is based on the age of the pupil for whom the furniture is intended. Experience and reason show that height is a more accurate and serviceable criterion than age in this field, and that height of knee is a better criterion than total height. But as we do not know the knee-heights of Boston children at each year of school age, I availed myself of the average

TABLE IV., SHOWING PER CENT. OF DESKS AND CHAIRS OF EACH SIZE (No. I. EXTRA–No. VI.) CALLED FOR (1) BY AGE-SCALE, (2) HEIGHT-SCALE, AND (3) THE PER CENT. OF EACH SIZE ACTUALLY FURNISHED: A. IN OLD AGASSIZ GRAMMAR SCHOOL; B. IN NEW AGASSIZ SCHOOL-HOUSE.

Whitcomb-scale Number.		No. I. Extra.		No. I.		No. II.		No. III.		No. IV.		No. V.		No. VI.		Misfits.		No. of sizes furnished.	
	Per cent. of each size.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.
Class I.	Called for by age-scale	14.6	2.6	73.1	7.6	12.1	21.0	1.8											
	Called for by height-scale	41.5	28.9	39.0	39.4	19.5	31.5	3.7											
	Actually furnished	0.0	13.1	50.0	47.3	50.0	39.4	13.7	.....	.....	.....	.....	.....	.....	.....	9.7	0.0	2	3
Class II.	Called for by age-scale	7.4	7.6	51.8	51.9	38.8	40.3	1.8	0.0										
	Called for by height-scale	16.7	17.3	33.3	30.7	46.3	44.2	3.7	7.6										
	Actually furnished	0.0	5.7	41.3	38.4	44.8	50.0	13.7	5.7	.....	.....	.....	.....	.....	.....	7.4	0.0	3	3
Class III.	Called for by age-scale	0.0	8.9	27.2	26.7	63.6	57.1	9.0	7.1	0.0									
	Called for by height-scale	3.6	7.1	29.1	32.1	54.6	48.2	10.9	12.5	1.8									
	Actually furnished	0.0	0.0	40.6	25.0	30.5	50.0	28.8	25.0	0.0	.....	.....	.....	.....	.....	1.8	1.7	3	3
Class IV.	Called for by age-scale	0.0	5.3	19.7	19.6	44.3	51.7	36.0	23.2	.....	0.00								
	Called for by height-scale	4.9	12.5	16.4	19.6	44.3	50.0	34.4	16.0	.....	1.7								
	Actually furnished	0.0	0.0	1.6	12.5	51.3	39.2	40.9	37.5	.....	10.7	.....	.....	.....	.....	6.5	7	2	4
Class IV.^{2}	Called for by age-scale	1.6	7.1	25.0	8.9	35.0	50.0	36.7	32.1	1.6	1.7								
	Called for by height-scale	3.3	3.5	16.7	19.6	40.0	51.7	35.0	25.0	5.0	0.0								
	Actually furnished	0.0	0.0	1.5	14.2	17.6	46.4	52.3	28.5	28.0	10.7	.....	.....	.....	.....	6.6	0.0	4	4
Class IV.^{3}	Called for by age-scale	.....	0.0	.....	19.6	.....	48.2	.....	32.1	.....	0.0								
	Called for by height-scale	.....	1.7	.....	12.5	.....	53.3	.....	32.1	.....	0.0								
	Actually furnished	.....	0.0	.....	0.0	.....	44.6	.....	42.8	.....	12.5	.....	.....	.....	.....	.....	5.3	....	3
Class V.	Called for by age-scale	0.0	.....	14.7	1.7	37.7	23.2	44.3	60.7	3.3	14.2	0.0	0.0						
	Called for by height-scale	1.6	.....	8.2	3.5	49.2	33.9	32.8	39.2	6.6	19.6	1.6	3.5						
	Actually furnished	0.0	.....	0.0	0.0	20.6	26.7	38.0	46.4	41.2	19.6	0.0	7.1	.....	.....	3.2	1.7	3	4
Class VI.	Called for by age-scale	.....	.....	5.4	3.5	10.7	8.9	71.4	60.7	12.5	26.7	.....	0.0						
	Called for by height-scale	.....	.....	1.8	1.7	28.6	21.4	55.3	39.2	14.3	33.9	.....	3.5						
	Actually furnished	.....	.....	25.4	1.7	27.1	14.2	16.9	26.7	30.5	50.0	.....	7.1	.....	.....	14.2	0.0	4	5
Class VI.^{2}	Called for by age-scale	.....	.....	1.3	0.0	10.8	5.4	55.4	69.0	32.4	25.4	0.0	0.0	0.0					
	Called for by height-scale	.....	.....	0.0	0.0	21.6	27.2	37.8	40.0	57.8	30.9	1.4	1.8	1.4					
	Actually furnished	.....	.....	1.2	0.0	13.7	18.1	35.0	32.7	50	41.8	0.0	7.2	0.0	.....	2.7	0.0	4	5

N.B. — The per cents. in the columns marked A refer to analysis of investigation made in January, 1893; those in columns marked B, to the investigation made in February, 1894. The seats "actually furnished" in the first case purported to correspond to Whitcomb's age-scale. The distribution of the seats occupied in February, 1894, was based on measurement of the height of the occupants of the seats, *and observation of their sitting-height besides.*

heights of Boston school-children as determined by Dr. H. P. Bowditch, in 1875, in changing the Whitcomb age-scale to a height-scale, which is given below:

Scale-number.	VII.	VI.	V.	IV.	III.	II.	I.	I. Extra.
Range of height in inches.....	41–43	44–45	46–47	48–51	52–54	55–59	60–64	65+
Corresponding age, in years.....	5–6	6–7	7–8	8–10	10–12	12–14	14–16	16–18

It was strikingly brought out by the three series of measurements made by Mr. Gibson on his pupils, that the average height in the same class varies considerably from year to year, and even from one six months to another. This variation which is inevitable, greatly enhances the difficulty of providing a sufficient number of accurately assorted seats and desks, *unless they are adjustable.*

The appended tables serve to show how the demands for assorted sizes may vary at short intervals in the same classroom, owing to the changing stature of the pupils.

Table IV. is constructed to show the per cent. of seats of each size called for, in each class, by the age and height-scales already cited, at periods a year apart. It also affords a comparison between the distribution of seats actually furnished the pupils of the Agassiz Grammar School, and between the percentage of misfits in the old building and the new building. The figures in the column marked "A" relate to conditions found in January, 1893, while those in the column marked "B" relate to conditions found in February, 1894, after the new building had come into use. The seats actually furnished in fitting up the new building were assorted in accordance with the results of the measurements made in January and September, 1893. Still the scale based on total height was found to be approximative only, and when the assignment of seats came to be made it was found necessary to adopt the *sitting-height* as the criterion in many instances. This suggests that *absolute accuracy* in the seating of growing children cannot be

secured, unless their individual peculiarities in regard to stature, length of trunk, length of leg, etc., are taken into account periodically. Even where adjustable furniture is used, it is doubtful if average heights can be implicitly relied upon as criteria.

TABLE V.

SHOWING DIFFERENCE BETWEEN PER CENT. OF DESKS CALLED FOR BY WHITCOMB AGE-SCALE, THE SAME EXPRESSED IN TERMS OF HEIGHT, AND THE PER CENT. OF EACH SIZE OF DESKS FURNISHED TO AGASSIZ GRAMMAR SCHOOL, JANUARY, 1893, AND FEBRUARY, 1894.

Scale Number of Desk-size.	Scale.	Per Cent. of Desks. At first measurement, January, 1893.			Per Cent. of Desks. At third mensurement, February, 1894.		
		Called for by scale.	Furnished.	Difference.	Called for by scale.	Furnished.	Difference.
No. I. Extra . .	Scale of age	2.3	0.0	−0.3	3.5	0.0	−3.5
	Scale of height	7.3	0.0	−7.3	7.0	17.7	−7.0
No. I.	Scale of age	24.4	17.7	−6.7	20.9	17.7	−3.2
	Scale of height	16.4	17.7	+1.3	16.8	17.7	+0.9
No. II.	Scale of age	31.6	31.1	−0.5	34.3	31.1	−3.2
	Scale of height	38.0	31.1	−8.9	40.5	31.1	−9.4
No. III.	Scale of age	34.1	29.8	−4.3	33.0	29.8	−3.2
	Scale of height	27.9	29.8	+1.9	34.5	29.8	−4.7
No. IV.	Scale of age	7.3	21.0	+13.7	8.1	21.0	+12.9
	Scale of height	9.5	21.0	+11.5	9.9	21.0	+11.1
No. V.	Scale of age	0.0	0.0	0.0	0.0	0.0	0.0
	Scale of height	0.4	0.0	−0.4	1.0	0.0	−1.0
No. VI.	Scale of age	0.0	0.0	0.0	0.0	0.0	0.0
	Scale of height	0.2	0.0	−0.2	0.0	0.0	0.0

N.B. — In January, 1893, there were 29 misfits among 462 boys, or 6.2 per cent.
In February, 1894, there were 6 misfits among 481 boys, or 1.2 per cent.

The above table shows that the requirements as regards the number of seats of a given size will vary in a given school according as the pupils vary in height from time to time; and favors the contention that when fixed desks and chairs (graded according to an average-age or an average-height standard) are used, the necessity for re-sorting and rearranging them is likely to recur frequently.

While this table suggests the superiority on general principles of adjustable over fixed desks and chairs, very much remains to be done before American adjustable furniture will be equal to the task of abolishing all or even most of the patent evils of the traditional and haphazard methods of school-seating now in vogue. I doubt the expediency of adopting adjustable furniture in a wholesale way so long as the inventors and makers of such furniture change their adjustment-devices from year to year, and fail to turn out desks and chairs that are hygienic in all respects, instead of in one or two only.

It is extremely desirable, in my opinion, that the present needless misfitting in the Boston schools should be reduced without further delay. The most feasible way to reduce it at the present time, as is shown by our experience in fitting up the class-rooms of the new Agassiz Grammar School, is to redistribute the desks and chairs now in use, so that each room shall have at least three sizes of desks and chairs. In several of the Agassiz School-rooms odd-sized desks were placed in the front row, in order to meet the needs of deaf and short-sighted children. Had one or two rows of adjustable desks been placed in each of the Agassiz School-rooms, I believe that misfitting, in the sense in which that term is used in these pages, would have been reduced to nothing, or at least to a fraction of one per cent.

OBSTACLES TO REFORM.

The teachers can do something towards mitigating the ill effects of the present unsystematic fashion of assorting and

setting up school-seats, by exercising more care than is common in assigning seats to the children under their charge; and by ceasing to assign the seats of their pupils according to their proficiency in their lessons but without regard to the length of their legs and arms. There is too much of this unhygienic course of procedure at present. But in many of our schools the teachers, with the best will in the world, are prevented from seating their pupils according to the plain teachings of hygiene and of common sense, by the haphazard and ill regulated way of fitting up the school-room.

The most striking example of our present lack of method was brought to my notice by the master of the Dudley School. At his request I investigated the seating in a third primary class in the Vernon-street School, Roxbury. I found that 39 old seats and desks, of the Ross pattern mostly, had been placed in the room *during the long vacation of* 1894. Of these, 18 were "No. Fours" and 21 were "No. Fives." If the seats had been selected with malice aforethought, instead of thoughtlessly as was probably the case, the result could have hardly been worse than it was. According to the Whitcomb scale, changed to a height-scale (see p. 205), there should have been 29 "No. Sevens," 8 "No. Sixes," 1 "No. Five," and 1 "No. Four;" the result was, that of the 33 children present (ranging in age from 4 to 8 years, and in height between 37 and 49 inches) 29, or 87.9 per cent. of the whole, were misfitted, being placed in seats too high for them. Of these 13, or 39 per cent., could barely reach the floor with their toes, and 16, or 48 per cent., had their feet in the air. This is by no means the only case that has been brought to my notice in which the principal has been obliged to put up with antique furniture so ill-assorted as to insure misfitting.

THE SEATING OF THE CUDWORTH PRIMARY SCHOOL.

This school in the Lyman District has a new building, occupied for the first time in December last. The Division Committee having secured the adoption of Perry's adjustable

TABLE VI., SHOWING DISTRIBUTION BY HEIGHT AND CLASS OF 465 PUPILS IN THE CUDWORTH PRIMARY SCHOOL, EAST BOSTON. THE NUMBERS IN COLUMNS A, B, AND C RESPECTIVELY INDICATE (1) THE NUMBER OF PUPILS AT EACH INCH OF HEIGHT, (2) THE NUMBER OF MISFITS AT EACH HEIGHT, AND (3) NUMBER OF SEATS REQUIRED ACCORDING TO THE BOBRICK SCALE.

Height in inches.	1. Class I.			2. Class I.[2]			3. Class II.			4. Class II.[2]			5. Class II.[3]			6. Class III.			7. Class III.[2]			8. Class III.[3]			9. Class III.[4]			10. Totals.			11. Bobrick Scale Number.	12. Per cent. of each Size needed.	13. No. Seats required in New House.	14. Per cent. of Misfits at Each Height.	Height in inches.
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.					
58										1	1	1 X.																1	1		X. 1	0.21	1	100.0	58
57																												0	0	0	IX.			—	57
56							2	2	2 IX.																			2	2	2	2	0.43	2	100.0	56
55																												0	0	0	VIII.			—	55
54	2	2	2 VIII.	1		1 VIII.																2	1	2 VIII.				5	3	5	5	1.29	6	60.0	54
53	6	1		4																		1	1					11	2		VII.			18.1	53
52	2	1	8 VII.	2		6 VII.	1	1	1 VII.	2	2	2 VII.												1 VII.				7	4	18	18	4.73	21	57.1	52
51	6	3		5			5	3		2	2		5	2											1			24	10	24	VI.			41.6	51
50	8	1	14 VI.	8	3	13 VI.	8	1	13 VI.	3	3	5 VI.	3	1	8 VI.				1		1 VI.						1 VI.	31	9	31	55	12.68	59	29.0	50
49	6	2		3			3	1		6	5		3						1			1						23	8	23	V.			34.3	49
48	5	0	11 V.	3	2	6 V.	4		7 V.	9	3	15 V.	11	3	14 V.	2		2 V.			1 V.	1		2 V.	1		1 V.	36	8	36	59	12.90	60	22.2	48
47	6	1		9	6		7	1		13	1		10			1			4	1		2			2	1		54	11	54	IV.			20.3	47
46	6	2	12 IV.	4	4	13 IV.	6	2	13 IV.	8	1	21 IV.	11	4	21 IV.	4	3	5 IV.	3		7 IV.	10	2	12 IV.	6	3	8 IV.	58	21	58	112	24.94	116	36.8	46
45				5	2		9			2			9	4		8	3		8			4	1		9	6		54	16	54	III.			29.6	45
44				2	1	7 III.	9	1	18 III.	7	4	9 III.	3	2	12 III.	6	6	14 III.	3		11 III.	8	4	12 III.	7	5	16 III.	45	23	45	99	23.01	107	51.7	44
43				1	1		2	1		4			1			6	4		4	2		6	4		4	4		28	16	28	II.			57.1	43
42						1 II.	3	2	5 II.	1		5 II.	2	2	3 II.	9	6	15 II.	3	2	7 II.	7	4	13 II.	10	10	14 II.	35	26	35	63	15.05	70	76.4	42
41																6	5		10	9		2	1		6	6		24	21	24	I.			87.5	41
40																1	1	7 I.	6	6	16 I.	1	1	3 I.	3	3	9 I.	11	11	11	35	9.03	42	100.0	40
39																3	3	3 O.	2	2		3	3		1	1		9	9	9				100.0	39
38																						1	1		1	1		2	2	2	O.			100.0	38
37																			2	2	4 O.			4 O.	2	2	4 O.	4	4	4	15	4.30	20	100.0	37
?										1																		1		1	1				?
Total pupils	47		47	47		47	59		59	59		59	58		58	46		46	47		47	49		49	53			465		465	465		504		
Total misfits		13			19			15			22			18			32			24		23			42			208							
Per cent. misfits		27.6			40.4			25.4			37.2			31.0			69.5			51.0		46.9			79.2			44.7						

desk and chair, which is made in three sizes, I was requested by the principal, Mr. Kelley, to furnish plans for the seating of the nine rooms to be occupied. Being furnished by Mr. Kelley with schedules and diagrams showing the height, age, and seating of 465 children who made up the nine classes in question, I noted the misfits among the children when seated in the fixed furniture in the old buildings; and having determined the required number of seats for each class observed, according to the Bobrick height-scale (which I adopted for convenience and in order to test its value), I was enabled to calculate the number of seats and chairs of each size required to seat nine new rooms with 56 seats in each room, and to furnish diagrams showing the calculated height of desk and chair for each individual pupil, in each and every room. These diagrams were used by the contractor in setting up the seats. After the seats were occupied they served effectively as a guide to rectifying chance errors. By these means the misfitting, which amounted to 44.7 per cent. in the old rooms, was reduced to zero in the new.

Table VI. was constructed to serve as the basis of the schedules and diagrams just alluded to. The A, B, and C columns respectively (cols. 1–9) show: (1) the number of pupils at each inch of height, (2) the number of misfits at each height, and (3) the number of desks and chairs called for in *each class* to correspond with the calculated heights of the Bobrick scale, the totals being given in column 10. The percentage of seats of each size for the 465 observed pupils in the old rooms is found in column 12; and the number of seats of each "scale number" required for 504 pupils in the new rooms is shown by the figures in column 13. To determine the proper proportion of differently sized seats required in each room, it is first necessary to compute the ratio, in terms of percentage, between the several numbers found in the C column and the total number of seats found in the room or required to be placed there.

Given a room with adjustable furniture of accurately

assorted sizes, still the children must be remeasured at intervals or they are liable to out-grow the adjustments which have been prescribed. It is generally agreed, I believe, that adjustable furniture should be readjusted at least twice a year. The readjustment must be based on remeasurement and cannot safely or advantageously be relegated to the janitor or the average class teacher, unless an extremely clear and simple set of directions be provided and enforced by the School Committee. I venture to express the hope that the Committee on Rules and Regulations will be impelled or induced to frame a set of rules which shall serve as the basis for a responsible and intelligent control of the seating of Boston school children, whether they occupy fixed or adjustable seats. Such blunders as that perpetrated on the first year primarians of the Vernon Street School might thereby be rendered impossible.

THREE KINDS OF ADJUSTABLE DESKS IN CHOATE BURNHAM SCHOOL.

The present phase of the school-seating question is exemplified by the tripartite division of the new Choate Burnham Primary School, where three kinds of adjustable desks and chairs have been put on trial. In the new Eustis-street Primary School, the trial is to be continued between but two of the three styles found in the South Boston school, I believe. As each of the three companies which is represented in the seating of the Choate Burnham School has its own system of grading its furniture in respect to size of castings, range of adjustability, etc.; its own rules for prescribing the height of chair and desk; and its own patent mechanical device for effecting adjustment, the conditions are favorable for making a comparative study, in the Lincoln District, of the leading styles of American adjustable school furniture. The seats and chairs, in this case, were assorted, set up, and adjusted to their occupants without any suggestion or intervention on my part. Since then I have meas-

ured all the children, and have noted the heights of their desks and chairs, and the amount and character of such misfitting as was found. A certain though not very considerable number of misfitted children were found in each of the three kinds of seats. In most cases it appeared to be due to carelessness; but in some cases I should attribute it to faulty construction of the desks, whose bottoms being placed lower than is necessary for primary school purposes pressed more or less heavily against the knees of their occupants. Unless the height or thickness of the desk box is carefully worked out, the knees may be cramped even when the difference between seat and desk-surface is theoretically correct. I have brought this matter to the attention of the manufacturers concerned, and, the remedy being obvious and simple, it is likely that the desks for primary pupils will henceforth be better proportioned.

In the Agassiz Primary School the shortest child found was 41 inches in height. Both in East and South Boston a considerable number of children ranging between 37 and 40 inches in height were found. The pupils of the Choate Burnham School were not measured prior to the occupancy of the new building. But it is a significant fact that all the children under 41 inches in height examined in the Lyman District, before the Cudworth building was occupied, were found in chairs so much too high for them that they could not place their feet flat on the floor. This fact led Mr. Perry to construct a chair and desk with lower supports than it had been customary to make in the case of fixed furniture. In fact it led to the reintroduction of a No. VIII. size which had been dropped from the Whitcomb scale. Both the Bobrick and Chandler companies have found it necessary to take somewhat similar steps. While it is possible that the average height of our youngest primarians is less than formerly, it is perfectly clear to me that our primary pupils have legs that are relatively as well as absolutely shorter than those of their older brothers and sisters. This fact should be taken

into account in attempting to determine the proper dimensions of desks and chairs for the use of our younger children.

Since the designers and makers of adjustable furniture propose to furnish "hygienic desks and chairs," they will do well to develop better methods than those yet adopted for rendering the new furniture an improvement on the old, in respect to such matters as seat-area, slope of desk, adjustability for distance, slope, and height of chair-back. All of the adjustable furniture which is on trial in our schools presents so many features that are novel to the teachers, children, and janitors, that a considerable period of time must elapse before thoroughly decisive and correct conclusions can be reached touching the distinctive merits as regards ease and accuracy of practical working of the several sorts.

CONCERNING SOME TESTS MADE IN THE CHOATE BURNHAM SCHOOL.

With the approval of Mr. Eaton, chairman of the Committee on School Houses and chairman of the Sixth Division Committee, certain tests were made under my direction to determine the ease and accuracy with which (1) an expert and (2) a janitor can adjust a given number of the three different kinds of desks and chairs used in the school above mentioned. Several members of the School Committee witnessed the first test. The second test was conducted by Mr. White, principal of the Lincoln District, and myself, at a later date. The results of the tests are set forth below in Tables VII. and VIII.

TABLE VII., SHOWING RELATIVE ACCURACY OF ADJUSTMENT OF ADJUSTABLE FURNITURE, STYLED A, B, AND C, IN USE IN CHOATE BURNHAM PRIMARY SCHOOL, SOUTH BOSTON.

	1. Number of Pupil using Seat.	2. Total Height in Inches.	3. Observed Height of Desk.	4. Calculated Height of Desk.	5. Difference between 3 and 4.	6. Observed Height of Chair.	7. Calculated Height of Chair.	8. Difference between 6 and 7.	9. Distance.	10. Remarks.
	No. 1	53.50	24.50	23.31	+1.29	12.87	15.06	−2.19	Minus.	
	" 2	48.00	21.75	21.11	+0.64	12.37	13.64	−1.27	Zero.	Desk touched knees.
	" 3	46.00	20.37	20.23	+0.14	11.12	13.07	−1.95	Plus.	" " "
	" 4	42.50	20.12	18.47	+1.65	11.12	11.93	−0.81	Zero.	
	" 5	51.87	24.25	22.43	+1.82	13.50	14.49	−0.99	Plus.	
Style A	" 6	43.37	20.00	18.91	+1.09	11.00	12.22	−1.22	"	
	" 7	50.50	23.12	21.99	+1.13	12.37	14.21	−1.84	"	
	" 8	50.25	22.50	21.99	+0.51	11.25	14.21	−2.96	"	Desk touched knees.
	" 9	47.25	21.87	20.67	+1.20	11.37	13.35	−1.98	Zero.	" " "
	" 10	47.62	21.50	20.67	+0.83	11.75	13.35	−1.60	Minus.	
					Av. +1.03			Av. −1.78		
	No. 1	41.00	19.25	18.03	+1.22	10.50	11.65	−1.15	Plus.	
	" 2	41.62	19.37	18.03	+1.34	9.62	11.65	−2.03	Minus.	
	" 3	41.00	19.50	18.03	+1.47	10.00	11.65	−1.65	Plus.	
	" 4	40.37	19.50	17.59	+1.91	10.00	11.36	−1.36	Zero.	
	" 5	41.75	19.37	18.03	+1.34	10.25	11.65	−1.40	Minus.	
Style B	" 6	40.00	19.50	17.59	+1.91	10.37	11.36	−0.99	Zero.	
	" 7	42.87	19.50	18.47	+1.03	10.87	11.93	−1.06	Minus.	
	" 8	43.62	20.87	18.91	+1.96	11.75	12.22	−0.47	Zero.	
	" 9	42.62	22.75	18.47	+4.28	12.25	11.93	+0.32	Minus.	Desk uneven.
	" 10	45.37	22.75	19.79	+2.96	11.00	12.78	−1.78	Plus.	" " chair loose.
					Av. +1.94			Av. −1.15		
	No. 1	41.12	19.25	18.03	+1.22	11.00	11.65	−0.65	Minus.	
	" 2	41.37	19.25	18.03	+1.22	11.00	11.65	−0.65	"	
	" 3	41.50	19.25	18.03	+1.22	11.00	11.65	−0.65	"	
	" 4	41.37	19.25	18.03	+1.22	11.00	11.65	−0.65	"	
	" 5	42.00	20.06	18.47	+1.59	11.54	11.93	−0.39	"	
Style C	" 6	41.25	19.25	18.03	+1.22	11.00	11.65	−0.65	"	
	" 7	40.75	19.25	17.59	+1.66	11.00	11.36	−0.36	"	
	" 8	41.00	19.25	18.03	+1.22	11.00	11.65	−0.65	"	
	" 9	42.12	20.87	18.47	+2.40	12.12	11.93	+0.19	"	
	" 10	45.25	21.66	19.79	+1.97	12.66	12.78	−0.12	"	
					Av. +1.49			Av. −0.45		

TABLE VIII., SHOWING TIME TAKEN (1) BY EXPERT (2) BY JANITOR IN ADJUSTING STYLES A, B, AND C OF SCHOOL FURNITURE IN USE IN CHOATE BURNHAM SCHOOL, SOUTH BOSTON.

Style.	Time Taken.						
	(1) by expert.				(2) by janitor.		
	To adjust Ten Desks and Chairs for Ten Designated Children.	To adjust Ten Desks and Chairs at Prescribed Heights.	Total Time. (Minutes.)	Average Time. (Minutes.)	To adjust Ten Desks and Chairs for Ten Designated Children.	Average Time. (Minutes.)	Time required for One Hundred Desks and Chairs.
A	17 minutes.	10.5 minutes.	27.5	2.75	32.5 minutes.	3.25	5 hours 25 minutes.
B	13.5 minutes.	12.75 minutes.	36.25	3.62	33.5 minutes.	3.35	5 hours 35 minutes.
C	12.5 minutes.	[1]14.5 minutes.	27.0	2.70	23.0 minutes.	2.30	3 hours 50 minutes.

[1] The same expert took 9.5 minutes to adjust ten desks and chairs according to prescription in "scale numbers" instead of specified heights.

CHARACTERISTICS OF ADJUSTABLE FURNITURE NOW IN USE.

The salient characteristics of the four kinds of adjustable desks and chairs now in use, viz., Chandler or "Roulstone," "Globe," "Peerless" or Bobrick, and Perry styles are set forth below with the aid of cuts which were politely furnished

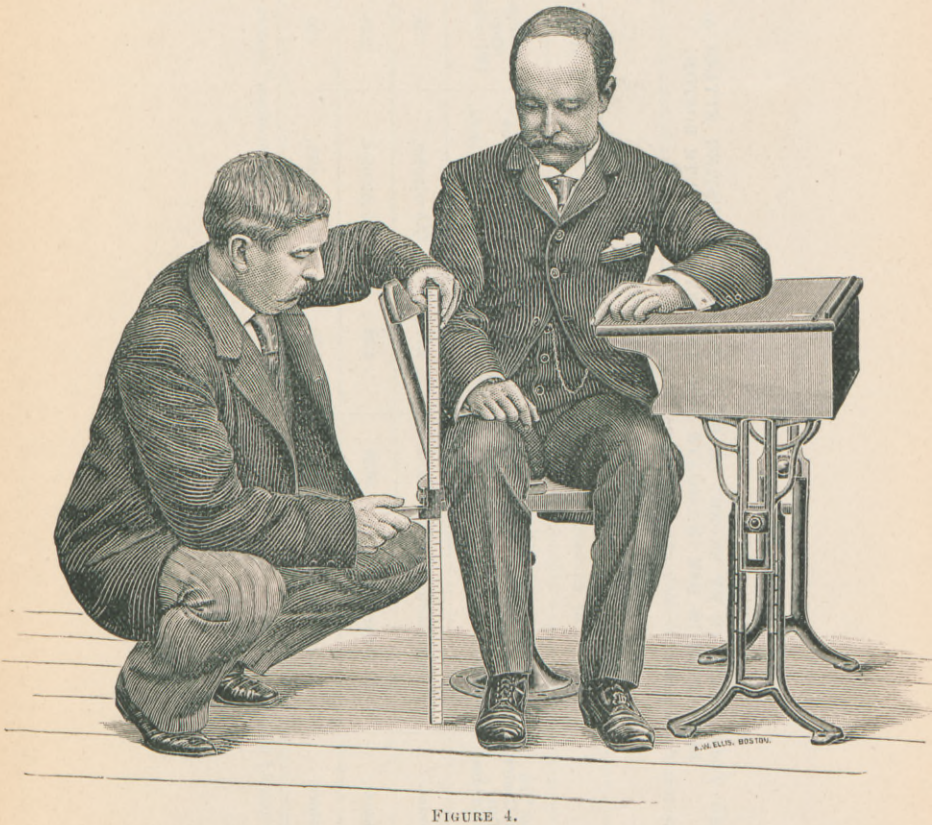


FIGURE 4.

by Messrs. Hill, Hockaday, Bobrick, and Perry, for use in this report.

Fig. 4 represents the Chandler seat and the method of using the measuring-rod to determine the height at which chair and desk should be set. By bringing the sliding arm of

the rod against the under surface of the thigh in the hollow of the sitter's knee, the knee-height which equals chair-height, is found and read off. The chair-height being determined, it is only necessary to turn the rod to read off from the condensed scale of elbow-heights, which is inscribed on another side of the rod, the corresponding height of desk. The directions for adjusting are thus given in the Chandler Company's catalogue: "Adjust the chair first; then the desk.

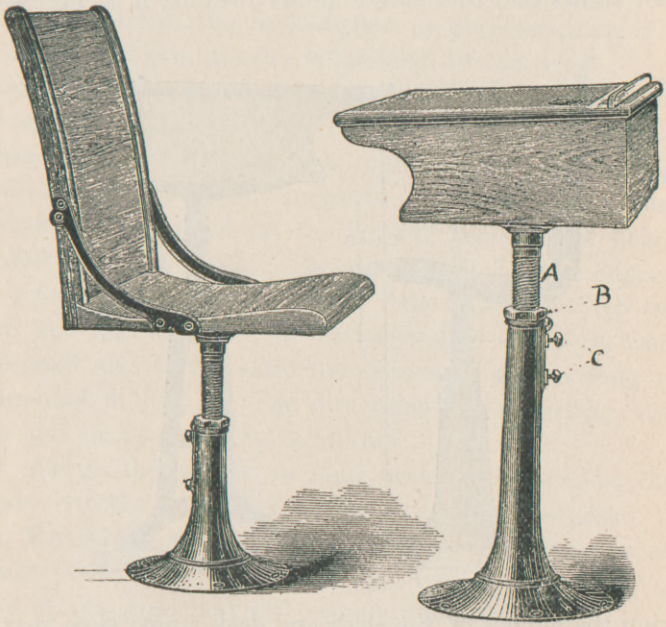


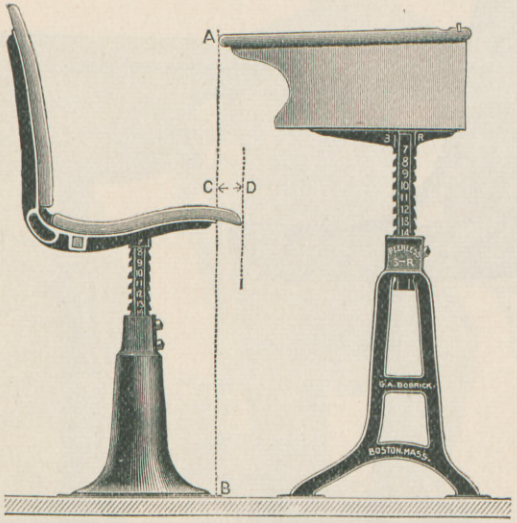
FIGURE 5.

With wrench which we supply loosen the nut on the bolt, place chair or desk at desired height, then turn nut tight."

The rod and scale alluded to above have been adopted by the Chandler Company since their catalogue was published. The use of any scale is scouted in the catalogue. Aside from the sliding frame attached to bottom of chair and desk, which is fastened by an adjustment bolt, the only novelties requiring mention in this style of seat are the flat

shoulder support, and the curve of the middle piece of the chair-back, which is intended to support the pupil's back in the lumbar region.

Fig. 5 represents the "Globe" chair and seat. Its single-pillared pedestal which supports the desk seems to me objectionable, as the pedestal is in the way of the pupil's feet, so that his position is not a natural one if he is careful to put them flat upon the floor. Experience in the Perkins Primary School shows that to secure a minus distance it is necessary



to bring the flanges of the chair and desk supports so near to one another as to prevent the children from placing their feet flat upon the floor. It will be noticed that the chair-backs shown in Fig. 5 and in Fig. 6 differ from the usual type of chair-back in being continuous instead of open, as in Fig. 3. In my opinion the continuous back is superior to the open back, with vertical lumbar-rest and transverse shoulder-rest, since it affords a broader surface to fit the hollow of the back. As between continuous chair-backs, such as are represented in Figs. 5 and 6, and the open style of chair-

back shown in Fig. 1, with transverse props at S and J, I prefer the latter, since it affords a free space between the rear edge of the seat and the lower edge of the loins-support. This is certainly a convenience when we consider the more voluminous clothing worn by school-girls. The Globe Company has adopted no particular scale, so far as I know.

The Bobrick or "Peerless" desk and chair are shown in Fig. 6. Attention has just been called to the general character of its chair-back, but it may be noted further that the lower third of the back-support is perpendicular, while the upper part (two-thirds) is inclined 10 degrees.

Aside from the mechanical devices for securing desk and chair-supports at the requisite heights, the most characteristic feature of the "Peerless" is found in the notched and bevelled desk- and chair supports. The position of these notches is determined on the basis of the scale of heights adopted by Mr. Bobrick. The notches in the two supports bear a fixed relation, viz., that of "the difference" to each other, and are indicated by corresponding numbers, which correspond also to the scale numbers on the measuring rod represented in Fig. 7. The directions for adjusting these desks and chairs are given as follows:

1. Assign the pupils to their desks and measure their heights with the scale furnished by us for that purpose.
2. Record the heights of the pupils on slips of paper, and place on each desk a slip with the number indicating the height of the pupil that will occupy the desk.
3. Loosen the set-screws of all the desks and seats.
4. Adjust all the desks and seats to the corresponding numbers, as indicated on the slips.
5. Refasten all the set-screws.

For measuring the heights of the pupils, we furnish a scale. (See Fig. 7.) It gives the heights of the pupils in numbers. *Bobrick's newest scale is also graded for knee-heights.*

The heights of the desks and seats are indicated by cor-

responding numbers cast on both sides of the desk- and chair-supports.

Each number of the desk-support, when set so as to be seen

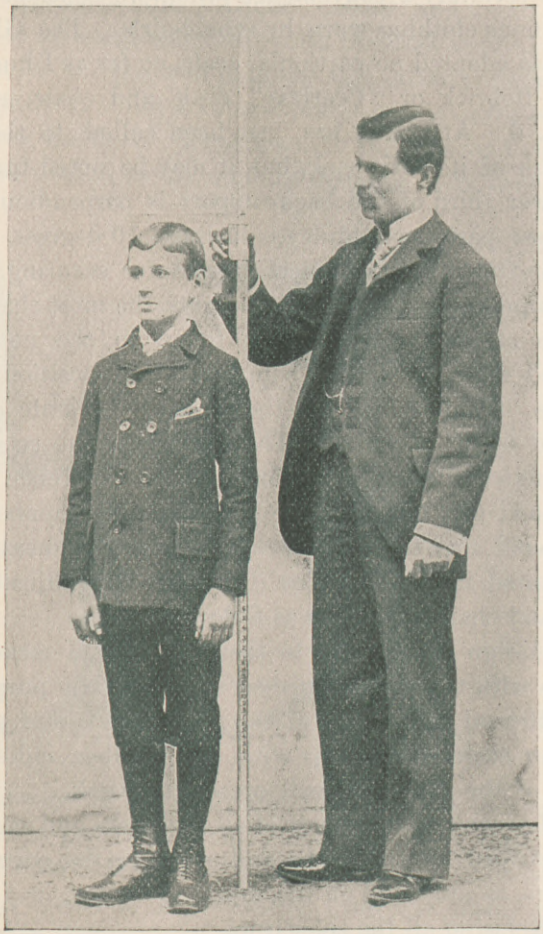


FIGURE 7.

above the head of the desk-bracket, indicates a certain height of the desk on line A–B, and each number of the chair-support, when set so as to be seen above the head of the chair-pedestal, indicates a certain height of the seat on line C–B.

For instance, a pupil between 40–42 inches in height is a No. 1, requiring a No. 1 desk and seat, a pupil between 42 and 44 inches in height is a No. 2, requiring a No. 2 desk and seat, etc.

FIGURE 8.

The Perry adjustable desk and chair are shown in Fig. 8. The numbers cast in the desk- and chair-supports correspond to the sizes of the graduated Whitcomb scale. No particular form of measuring-rod or height-scale is used in determining the heights of desk and chair for the adjustment of this style of furniture. But I am informed that Mr. Perry intends to adopt such a scale, and to change his adjustment devices in certain important respects. The curved lumbar back-rests is an improvement upon the old Whitcomb chair-back. It is noteworthy that all of the desks figured here have tops that are insufficiently sloped.

SCALE FOR GRADING SEAT–SIZES.

The fixed furniture customarily furnished in fitting up new schools in Boston, prior to the recent advent of adjustable

furniture, is made in various sizes according to the so-called Whitcomb scale, which is as follows:

Scale number	VII.	VI.	V.	IV.	III.	II.	I.	II. extra.	I. extra.
Age of pupil	5–6	6–7	7–8	8–10	10–12	12–14	14–18	14–16	16–18
Height of chair....	10.50	11.25	12.25	13.50	14.50	15.50	16.75	15.50	16.75
Height of desk	20.50	21.50	23.00	24.50	25.50	27.00	28.50	27.50	29.00
Difference	10.00	10.25	10.75	11.00	11.00	11.50	11.75	12.00	12.25

Numbers VII.–V., inclusive, are for primary schools; numbers IV.–I., for grammar schools, and Numbers II.–I., extra, for high schools, academies, etc. On its face this is an age-scale and nothing else.

Dr. Scudder has called attention (op. cit.) to the traditional nature of this scale and to the manner in which it is used. His remarks on these points are as follows:

The method of providing seats and desks for the various school-houses of Boston is somewhat as follows:

A school-house is built and ready for seats. The Commissioner of Public Buildings, or his assistant, having ascertained the grade of the school and the number of pupils to be accommodated in each room, sends an order to the manufacturer of school furniture who is fortunate enough to hold the contract for the current year, to seat and desk the building. The manufacturer, knowing approximately the ages of the children who will attend a school of the given grade, provides desks and seats as he sees fit, furnishing one, two, or three sizes to a single room, as he is inclined, or as may have been suggested by the head-master of the school.

How does the manufacturer determine the sizes that shall be sent to meet the requirements of certain ages? After corresponding and talking with those who have supplied for many years large cities and Boston with school furniture, I find it impossible to learn how the standard of the height of desk and chair has been determined. *The standard for the gradation of the modern school-desks has evidently been handed down, from one generation to the next, until it can no longer be traced to its originator.*

As I have shown below (see Table X.), the Whitcomb scale is probably derived from a height-scale originated by Dr. Henry Barnard, in 1838.

TABLE IX., SHOWING DISTRIBUTION OF HEIGHT IN INCHES, BY AGE AND SEX, OF 1,528 BOSTON PRIMARY SCHOOL CHILDREN.

Inches.	14 years.	13 years.	12 years.	11 years.	10 years.	9 years.	8 years.	7 years.	6 years.	5 years.	4 years.	3 years.	Boys.	Girls.	Total.
59		1				1							2	0	2
58				1									1	1	2
				1											
57													0	1	1
					1										
56		1			1								2	2	4
	1		1												
55			2	2	3	1							8	4	12
			2		1	1									
54				4	7	3	1						15	5	20
		2		1	1	1									
53	2				7	2	1	2					14	23	37
		1		3	6	7	4	2							
52				3	9	9	11						32	12	44
				3	3	4	2								
51				5	7	29	16						57	28	85
			1	1	8	9	5	4							
50		1	1	1	4	23	25	7	1				63	47	110
				3	5	17	15	7							
49				1		10	29	16	1				57	31	88
					2	9	14	6							
48					1	10	47	24	6	2			90	41	131
				1	1	3	20	16							
47						7	30	45	15	5			102	62	164
						5	25	23	9						
46					1	5	25	40	23	2			96	77	173
					1	4	20	33	18	1					
45				1		2	7	22	40	18			90	73	163
						3	9	25	28	8					
44						1	6	19	24	11			61	57	118
							6	17	18	16					
43							1	5	28	26			60	51	111
								11	30	10					
42								9	24	26	1		60	55	115
								5	24	22	4				
41							1	1	13	20	2		37	35	72
								1	9	22	3				
40									8	13	1		22	21	43
						1		1	6	12	1				
39										6	1		7	14	21
							1	1	1	8	3				
38													0	7	7
									2	5					
37										1	1		2	3	5
										2		1			
Boys	2	3	3	18	40	103	200	190	183	130	6	0	878	650	
Girls	1	3	4	13	29	64	121	152	145	106	11	1	650		1,528
Total	3	6	7	31	69	167	321	342	328	236	17	1	1,528		1,528

I have compiled the Table IX. to show the distribution by sex, age, and height, of 1,528 primary school children in certain districts of the city, whose seating I have had particular occasion to investigate. Inspection of the table shows that the range of height in children of the same age is so great that no dependence whatever can be put upon a mere age-scale as a guide in grading the sizes of school-seats and desks. For instance, according to the Whitcomb age-scale, 254 No. VII. chairs and desks would suffice to seat the 254 children *five years old or under* whose heights are found in the last three age-columns of Table IX. If, however, we make use of the Whitcomb scale, after changing it to a height-scale (see p. 205), we find that 191 No. VII., 53 No. VI., 8 No. V., and 2 No. IV. chairs would be needed to seat the children in question. According to the Bobrick height-scale (see Table XI.) the number of each size of chair and desk would be: 28 No. O., 74 No. I., 89 No. II., 53 No. III., 8 No. IV., and 2 No. 2.

I have prepared a table, given on p. 68, which affords a comparison between height of chairs, height of desk, and difference corresponding to the scale numbers of several systems of school-seating formerly used in Boston and elsewhere in New England. The figures given, excepting those of the Whitcomb scale which is the most modern, are taken from Barnard's "School Architecture," New York, 1854. As the first edition of that work was published in 1848, it is probable that most of the scales in question were in use before 1848. *The Barnard scale, as I shall show later on, was based on measurements of children made as early as* 1838.

TABLE X., SHOWING HEIGHT OF DESK, HEIGHT OF CHAIR, AND DIFFERENCE, ACCORDING TO CERTAIN SYSTEMS OF GRADING FIXED FURNITURE.

System.	Whitcomb.	Ross.	Wales.	Mott.	Barnard.	Fahrner.
	1.	2.	3.	4.	5.	6.
Scale number	VII.	VII.	I.	I.	I.	I.
Height of desk	20.50	20.50	20.00	17.00	19.50-20	18.30
" " chair	10.50	10.00	10.00	10.00	9.50-10	11.22
Difference	10.00	10.50	10.00	7.00	10.00	7.08
Scale number	VI.	VI.	II.	II.	II.	II.
Height of desk	21.50	21.25	21.00	19.00	20.50-21	20.07
" " chair	11.25	11.00	11.00	12.00	10.50-11	12.40
Difference	10.25	10.25	10.00	7.00	10.00	7.67
Scale number	V.	V.	III.	III.	III.	III.
Height of desk	23.00	22.00	22.00	22.00	22.00	21.85
" " chair	12.25	12.00	12.00	14.00	12.00	13.58
Difference	10.75	10.00	10.00	8.00	10.00	8.27
Scale number	IV.	IV.	IV.	IV.	IV.	IV.
Height of desk	24.50	23.00	23.00	24.00	23.00	23.62
" " chair	13.50	13.00	13.00	16.00	13.00	14.76
Difference	11.00	10.00	10.00	8.00	10.00	8.86
Scale number	III.	III.	V.	.....	V.	V.
Height of desk	25.50	24.50	24.00	.....	24.00	25.39
" " chair	14.50	14.00	14.00	.....	14.00	15.94
Difference	11.00	10.50	10.00	.....	10.00	9.45
Scale number	II.	II.	VI.	.....	VI.	VI.
Height of desk	27.00	26.00	25.50	.....	25.00	27.16
" " chair	15.50	15.00	15.00	.....	15.00	17.12
Difference	11.50	11.00	10.50	.....	10.00	10.04
Scale number	I.	I.	VII.	.....	VII.	VII.
Height of desk	28.50	27.50	27.00	.....	26.50	27.75
" " chair	16.75	16.00	16.00	.....	16.50	17.12
Difference	11.75	11.50	11.00	.....	10.00	10.63

TABLE X.— *Concluded.*

System.	Whitcomb.	Ross.	Wales.	Mott.	Barnard.	Fahrner.
	1.	2.	3.	4.	5.	6.
Scale number.....	II. extra.	.....	VIII.	.....	VIII.	
Height of desk	27.50	.....	28.50	.....	27.50–28.00	
" " chair	15.50	.....	17.00	.....	17.00–17.50	
Difference	12.00	.....	11.50	.....	10.50	
Scale number	I. extra.	I. extra.				
Height of desk	29.00	29.00				
" " chair	16.75	17.00				
Difference	12.25	12.00				

EARLIEST AMERICAN AND EUROPEAN SCALES.

The Barnard scale appears to be the first original American scale for school-seating, and it is probably fair to say that the other American scales given in Table X. were more or less directly derived from it. In column 6, I have placed the earliest European scale known to me, viz.: that of Dr. Fahrner, of Zürich, which is based on his measurements in respect to height of 1,789 Zürich school-children. It was published at least as early as 1865, possibly in 1863. Like most European scales it was intended to be a guide in seating children between 6 and 14 years of age. Most American scales relate to a wider range of age, *e.g.*, the Whitcomb scale for pupils of 5–18, the Barnard scale 4–20.

I quote from a recent letter received by me from Dr. Henry Barnard, of Hartford, Conn., the author of "School Architecture," and of the scale given in column 5, of the above table: "Yes, the scale of dimensions and respective heights of desk and seat for at least eight groups from the 'tots' up to young men and young women, printed on page 343 of my 'School Architecture,' Cincinnati, 1854, [I think identically the same as that printed in New York in 1854,] is the final results of hundreds of measurements of *groups* of two to eight

children of about the same age, begun as early as 1838, on a challenge that I could not make a scale which would meet the varying heights of pupils from four years of age up to twenty. The most successful effort was in seating the school-rooms described on pages 113, 115 [in Windsor and Bloomfield, Conn., respectively]. It was said at the time, 1841–42, that every pupil in the school in Windsor when seated for study or writing was perfectly comfortable, — feet resting on floor, and no conscious strain on muscles below or above the knee, or in arms or shoulders." So much cannot be said of the majority of Boston school-children to-day.

Barnard, like Alcott and Horace Mann, approved of a zero distance. According to Barnard the desk-slope should be one inch in a foot and the back of the seat "should rise above the shoulder-blades, and should in all cases incline back as it rises, one inch in every foot." As to height of seat for little children, he notes a point which seems to have been too much neglected by his successors. "In a primary school," he says, "composed of children from four and even three years of age to eight or ten, the height [of seats] should *vary from* 8–12 *inches*, and the width (depth) *from* 6–10 *inches*, and for a school for pupils ranging from ten to sixteen years of age, the height of the seats should vary from 10–17 *inches*, and the width (depth) from 8–13 *inches*." Though Fahrner does not quote Barnard, it is clear from citations made by Cohn, Lorenz, and others, that Barnard is recognized in Europe as a pioneer in school-seating.

COMPARISON OF AMERICAN AND EUROPEAN SCALES.

This table is reprinted from my last report. It shows the number of pupils at each inch of height, from 41 to 71 inches, in the Agassiz District, January, 1893, and affords a comparative view of the number of seats of each size required, according to the Whitcomb scale, reduced to terms of height, and the standards adopted at Frankfort-on-the-Main, in 1885; by the Prague Commission in Bohemia, in 1892–93; by the Vienna

TABLE XI., SHOWING NUMBER OF EACH SIZE OF CHAIRS AND DESKS REQUIRED TO SEAT THE 668 PUPILS RANGING IN HEIGHT FROM 41–71 INCHES IN AGASSIZ DISTRICT, 1893, ACCORDING TO VARIOUS SCALES BASED ON BODILY HEIGHT.

Number of pupils at each height		0	7	11	17	14	17	17	21	23	24	36	37	48	44	61	44	40	38	34	24	22	23	16	9	7	18	8	2	0	4	1	1	
Height-Scale.	Inches	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	
	Centimeters	101.6	104.1	106.6	109.2	111.7	114.3	116.8	119.3	121.9	124.4	127.0	129.5	132.0	134.6	137.1	139.7	142.2	144.7	147.3	149.8	152.4	154.9	157.4	160.2	162.5	165.1	167.6	170.1	172.7	175.2	177.8	180.3	
Whitcomb, Boston, Scale Nos.		No. VII.				No. VI.		No. V.		No. IV.				No. III.			No. II.					No. I.					No. I., extra large.							
No. needed of each size		35				31		38		120				153			180					77					34							668
Frankfort Scale Nos. 1885		No. O.				No. I.				No. II.				No. III.			No. IV.					No. V.		No. VI.		No. VII.						No. VIII.	
No. needed of each size		35				69				120				197			136					61		34		15						1	668
Prague Commission's Scale Nos. 1892–93		No. I.	No. II.		No. III.		No. IV.		No. V.		No. VI.			No. VII.		No. VIII.		No. IX.				No. X.		No. XI.		No. XII.							
No. needed of each size		0	35		31		38		47		121			105		84		96				45		32		34							668
Vienna Commission of Expert's Scale. 1892		No. I.					No. II.			No. III.				No. IV.				No. V.				No. VI.				No. VII.		No. VIII.					
No. needed of each size		66					85			121				189				118				55				28		6					668
Bobrick's Scale. Adjustable seats. 1892		No. I.	No. II.		No. III.		No. IV.		No. V.		No. VI.			No. VII.		No. VIII.		No. IX.				No. X.		No. XI.		No. XII.		No. XIII.		No. XIV.		No. XV.	No. ?
No. at each position		7	28		31		38		47		73			92		105		78				58		45		25		25		10		4	2	668
Seats actually furnished, Whitcomb's sizes, including 34 unoccupied		No. VII.				No. VI.		No. V.		No. IV.				No. III.			No. II.					No. I.					No. I., extra large.							
		28				**81**		**60**		**156**				**141**			**148**					**88**					**0**							702
Difference		−7				+50		+22		+36				−12			−32					+11					−34							

Commission of Experts; and by G. A. Bobrick, C.E., of Boston, the inventor of a system of adjustable desks and chairs. All of the scales, but the last mentioned, relate to furniture fixed as to difference, and all of them are based on average bodily height as a modulus. The scale-numbers of the Bobrick scale stand for positions in which his *three sizes* of desks and seats may be adjusted. It is evident from inspection that adjustable furniture is capable of being much more accurately adapted to pupils differing in height. The Frankfort, Prague, and Vienna scales are based on careful measurements of large numbers of school-children for whose use the variously sized desks were intended.

The height of children of different races and social classes varies so widely that the adoption for American children of any European height-scale for the purpose of grading school seats would almost certainly prove illusory and disappointing.

TABLE XII., SHOWING DESK HEIGHT, A; SEAT HEIGHT, B; AND DIFFERENCE, C, CALCULATED FOR EACH INCH OF HEIGHT (70-36 INCHES) ACCORDING TO (1) EULENBERG AND BACH, (2) "COMPOSITE," AND (3) BOBRICK SCALES OF HEIGHT.

Height in Inches.	A. Height of Desk in Inches.			B. Height of Chair in Inches.			C. Difference in Inches.			Height in Inches.
	1	2	3	1	2	3	1	2	3	
70	30.990	30.797	30.800	19.090	19.894	20.020	11.900	10.902	10.780	.. 70
69	30.547	30.357	30.360	18.817	19.610	19.734	11.730	10.746	10.626	.. 69
68	30.104	30.917	29.920	18.544	19.326	19.448	11.560	10.590	10.472	.. 68
67	29.662	29.477	29.480	18.272	19.042	19.162	11.390	10.434	10.318	.. 67
66	29.219	29.037	29.040	17.999	18.757	18.876	11.220	10.278	10.164	.. 66
65	28.776	28.597	28.600	17.726	18.473	18.590	11.050	10.122	10.010	. 65
64	28.334	28.157	28.160	17.454	18.189	18.304	10.880	9.966	9.856	.. 64
63	27.891	27.717	27.720	17.181	17.905	18.018	10.710	9.810	9.702	.. 63
62	27.448	27.277	27.280	16.908	17.621	17.732	10.540	9.654	9.548	.. 62
61	27.005	26.837	26.840	16.636	17.336	17.446	10.370	9.498	9.394	.. 61
60	26.563	26.397	26.400	16.363	17.052	17.160	10.200	9.342	9.240	.. 60

TABLE XII. — *Concluded.*

Height in Inches.	A. Height of Desk in Inches.			B. Height of Chair in Inches.			C. Difference in Inches.			Height in Inches.
	1	2	3	1	2	3	1	2	3	
59	26.120	26.957	25.960	16.090	16.768	16.874	10.030	9.186	9.086	.. 59
58	25.677	25.517	25.520	15.817	16.483	16.588	9.860	9.030	8.932	.. 58
57	25.235	25.077	25.080	15.545	16.199	16.302	9.690	8.874	8.778	.. 57
56	24.792	24.637	24.640	15.272	15.915	16.016	9.520	8.718	8.624	.. 56
55	24.349	24.197	24.200	14.999	15.631	15.730	9.350	8.562	8.470	.. 55
54	23.906	23.757	23.760	14.726	15.347	15.444	9.180	8.406	8.316	.. 54
53	23.464	23.317	23.320	14.454	15.063	15.158	9.010	8.250	8.162	.. 53
52	23.021	22.877	22.880	14.181	14.778	14.872	8.840	8.094	8.008	.. 52
51	22.578	22.437	22.440	13.908	14.494	14.586	8.670	7.838	7.854	.. 51
50	22.136	21.998	22.000	13.636	14.210	14.300	8.500	7.782	7.700	.. 50
49	21.693	21.558	21.560	13.363	13.926	14.014	8.330	7.626	7.546	.. 49
48	21.250	21.118	21.120	13.090	13.641	13.728	8.160	7.470	7.392	.. 48
47	20.807	20.678	20.680	12.817	13.357	13.442	7.990	7.314	7.238	.. 47
46	20.365	20.238	20.240	12.545	13.073	13.156	7.820	7.158	7.084	.. 46
45	19.922	19.798	19.800	12.272	12.789	12.870	7.650	7.002	6.930	.. 45
44	19.479	19.358	19.360	11.999	12.505	12.584	7.480	6.846	6.776	.. 44
43	19.036	18.918	18.920	11.726	12.220	12.298	7.310	6.690	6.622	.. 43
42	18.594	18.478	18.480	11.454	11.936	12.012	7.140	6.534	6.468	.. 42
41	18.151	18.038	18.040	11.181	11.652	11.726	6.970	6.378	6.314	.. 41
40	17.708	17.598	17.600	10.908	11.368	11.440	6.800	6.222	6.160	.. 40
39	17.266	17.158	17.160	10.636	11.084	11.154	6.630	6.066	6.006	.. 39
38	16.823	16.718	16.720	10.363	10.799	10.868	6.460	5.910	5.852	.. 38
37	16.380	16.278	16.280	10.090	10.515	10.582	6.290	5.754	5.698	.. 37
36	15.937	15.838	15.840	9.817	10.231	10.296	6.120	5.598	5.544	.. 36

The above table is constructed to show the variation in height of desk, height of chair, and difference presented by three different modern scales based on total height of the body. I have calculated the heights and differences set forth in this table, according to three distinct but similar formulæ, viz., (1) that of Eulenberg and Bach (see p. 172); (2) that which I have termed "Composite," which is compounded from

the rules set down by several careful writers; and (3) the formula adopted by Bobrick. The figures in this table purporting to correspond to the Bobrick scale are not identical with those found in his published scale, in which he has made use of a coefficient of correction, thereby following certain European scales, *e.g.*, Erismann's, Fahrner's, and Uffelmann's.

The figures set down in the columns marked 1, 2, and 3 were obtained by using the formulæ above designated as (1) (2) and (3) respectively. Those formulæ may be expressed as follows:

(1)	Height of desk	= 44.272	per cent.	of	total height.
(2)	" "	= 43.996	"	"	"
(3)	" "	= 44.000	"	"	"
(1)	" of seat	= 27.272	"	"	"
(2)	" "	= 28.421	"	"	"
(3)	" "	= 28.600	"	"	"
(1)	Difference	= 17.000	"	"	"
(2)	"	= 15.575	"	"	"
(3)	"	= 15.400	"	"	"

The table serves, to my mind, to show the difficulty of using average heights as an accurate criterion in determining the dimensions of desk and chair for either fixed or semi-adjustable furniture. With fixed furniture, however, we must be content with scales of this nature in grading the sizes of desks and chairs; but, as I have already remarked, only approximately accurate seating can be obtained with fixed furniture.

The ratio of height of knee and the ratio of height of elbow (in the sitting posture) to total height varies markedly in the two sexes, and at different ages in the same sex. So much do these ratios vary that I am convinced that scientific accuracy of seating (which is what the designers of adjustable and semi-adjustable furniture profess to offer us) is not attainable unless the height of knee, elbow, etc., are taken, as well as the total height, in each individual case as the data for prescribing the height of seat and desk.

SCALE ADOPTED BY THE PRAGUE COMMISSION.

The table of normal dimensions of desks and seats for pupils ranging between 95–165 centimeters in height and 6–14 years in age adopted by the Prague commission of experts in 1892–93, is introduced below as it is the latest, and in some respects the fullest and most suggestive that has come under my notice.

TABLE XIII., SHOWING NORMAL DIMENSIONS[1] OF DESKS AND SEATS I.-XII., GRADED ACCORDING TO RECOMMENDATIONS OF PRAGUE EXPERT COMMISSION ON SCHOOL-SEATING, 1892-93.

Desk Number.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1. Age of pupil	**6.**	**7.**	**7.**	**8.**	**8.**	**9.**	**9.**	**11.**	**11.**	**13.**	**13.**	**14.**
2. Height of pupil	95–104	105–110	111–116	117–122	123–128	129–134	135–140	141–146	147–152	153–158	159–164	165+
3. Height of desk, corresponding to M D plus C in Fig. 1	52	53	56	59	61	63	66	68	70	72	75	78
4. Height of seat, corresponding to C in Fig. 1	29	30	32	34	35	36	38	40	41	42	44	46
5. Negative distance	10	10	10	10	10	10	10	10	10	10	10	10
6. Positive distance, corresponding to space D in Fig. 1	8	8	8	8	8	8	8	8	8	8	8	8
7. Difference between desk and book-shelf, corresponding to Z in Fig. 1	10	10	10	10	10	12	12	12	12	12	13	13
8. Difference, corresponding to M D in Fig. 1	23	23	24	25	26	27	28	29	29	30	31	32
9. Inclination of desk, M to L in Fig. 1	18°	18°	18°	18°	18°	18°	18°	18°	18°	18°	18°	18°
10. Inclination of back of seat, J P in Fig. 1	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°	10°
11. Inclination of seat, E in Fig. 1	8°	8°	8°	8°	8°	8°	8°	8°	8°	8°	8°	8°
12. Depth of seat, E in Fig. 1	23	23	24	24	25	25	26	27	28	29	30	31
13. Width of open space between seat and lower edge of back support	12	12	13	13	14	14	14	14	15	15	15	16

[1] The dimensions given in this table are given in centimeters.

SEXUAL DIFFERENCES IN RESPECT TO HEIGHT.

Fahrner recommended a "difference" of one-eighth of the total height for boys, and one-seventh for girls, on account of the "bunchiness" of the girls' clothing. But I feel convinced from my own observations and from my study of heights and lengths of various parts of the bony framework of the body as set forth by other observers (Dr. D. A. Sargent's anthropometrical charts have been of especial service to me in this connection) that there is a deeper reason for thinking that different height-scales should be used in seating boys and girls respectively.

Females have relatively longer trunks and shorter lower limbs than males; hence girls can sit in lower chairs and write comfortably at somewhat higher desks than can boys of the same total height. Furthermore both the arms and forearms of females are relatively as well as absolutely shorter than those of males; hence a seat placed at a plus, zero, or insufficient minus distance from its desk is calculated to produce weariness, distortion, and deformity more readily in the case of girls than of boys. In the inevitable and unequal contest between the force of gravity and muscular exertion which results from unhygienic seating (when average height without discrimination as to sex is used as the modulus) the ill-seated girl is placed at a greater disadvantage than the ill-seated boy of the same height. Hence I am led to think that one reason for the occurrence of a larger percentage of cases of curvature of the spine among schoolgirls than among schoolboys (and scoliosis is now generally recognized as a school-disease) is to be found in the fact that the legs and arms of girls are shorter than those of boys of corresponding height. So far as I can learn no writer has called attention to this fact, hitherto, as a reason for the greater liability of girls to scoliosis, but the fact, if it shall be established by wider investigations, is none the less worthy of consideration on that account, I should say.

INDIVIDUAL MEASUREMENTS VERSUS AVERAGE HEIGHT-SCALES.

Furthermore, in determining the difference between desk-height and seat-height for children of different heights and ages, it must not be forgotten that the legs, *i.e.*, knee-heights of young children of both sexes, are relatively less in proportion to their total height than is the case in adolescents or adults. This fact also seems to me to militate against the value of scales based simply on average heights, as is the usual custom when scales are employed. Therefore I have given some thought to devising a measuring-chair by means of which we can secure the data requisite for prescribing accurately the height of desk, height of seat, and depth of seat for every child to whom an adjustable desk and chair are assigned. Such a chair, which I propose to call the Boston School Measuring-chair, is now in course of construction at our Mechanic Arts High School. If this chair shall prove a convenient means of securing a more accurate adjustment of our adjustable desks and chairs to their occupants it will be placed at the disposal of the public; but first of all at the disposal of the Boston School Committee for use in our own schools. In any event I desire to express my obligation to Dr. H. P. Bowditch, Professor of Physiology in the Harvard Medical School; to Mr. Charles W. Parmenter, head-master; and Mr. Benjamin F. Eddy, instructor in the Mechanic Arts High School, for valuable aid and suggestions in perfecting the design and construction of the chair, which is figured and described below. I may add that, though I have found mention of chairs used for a similar purpose in Frankfort-on-the-Marn, and in Prague, I have not been able to find any serviceable description of them. It is quite possible that by means of the Boston School Measuring-chair, should its use become general, we shall be enabled to secure sufficient data for constructing a more satisfactory system of scales than any which are in use at present. in connection with either fixed or adjustable furniture.

BOSTON SCHOOL MEASURING-CHAIR.

Figure 9 is a reproduction of the working drawing used in the construction of the Boston School Measuring-chair. The framework of the chair is not adjustable. The seat B, the foot-board A, the arm-rest C, and the cap-pieces D and F are adjustable. The seat B is placed 30 inches above the floor to enable the observer to read the metric scales (not shown in the figure), without his having to crouch. The steps G are for the use of the sitter in mounting the chair, A being a foot-rest and not a step. The seat B is made to slide forwards and backwards, so that its front edge can be brought into contact with the posterior surface of the leg, in the hollow of the knee, where the leg makes a right angle with the thigh in the knee-joint. The feet are to be placed flat upon the foot-board A, which can be raised and lowered by a rotary motion. The arm-rest C can also be raised and lowered to provide a firm support to the under surface of the forearm, when the latter makes a right angle in the elbow-joint with the arm of the sitter. The vertically

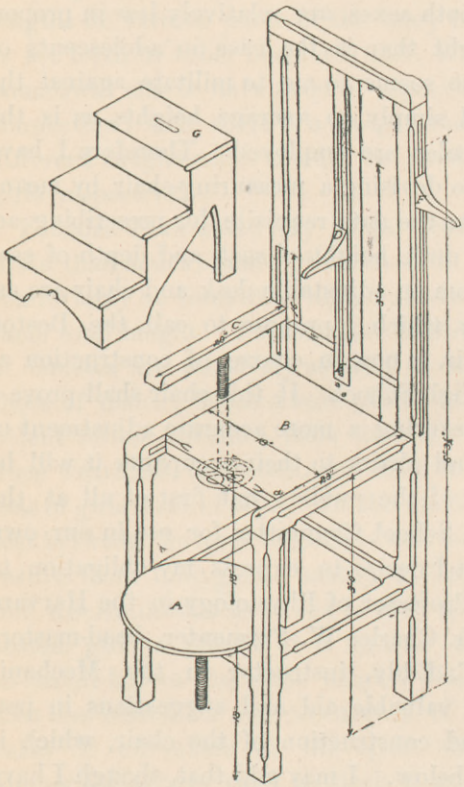


FIGURE 9.

sliding cap-pieces D and F are used in determining sitting and standing height respectively.

When the occupant of the chair sits erect, having his back against the back of the chair, his feet resting flat upon A, the posterior surface of his leg (which is flexed at a right angle to the thigh) being in contact with the front edge of the seat B, his forearm (which is bent upon the arm at a right angle in the elbow-joint) being supported by C, and the cap D resting lightly upon his head, — the observer has but to note the following distances to secure the data requisite for prescribing the dimensions of the seat best adapted to meet the individual needs of the sitter. Those distances are: (1) the distance of the under surface of D to the upper surface of B, which equals sitting height; (2) the distance between the upper surfaces of A and B, which equals height of knee; (3) the distance between the front edge of B and the back of the chair, which equals depth of seat; and (4) the distance between the upper surfaces of B and C, which equals the difference, which being added to A B, height of seat, gives the height of desk. The height of desk may be directly deduced from the height of C above the foot-rest. The height of lumbar back-rest is easily determined by noting (on a metric scale placed on the middle pillar of the chair-back) the height of the lower ribs and of the upper border of the pelvis.

The measurements of each child observed being recorded by the master, or other competent observer, on a specially printed card, which bears the name, class, and number of the child, that card will serve for the accurate guidance of the janitor in adjusting the seat and desk assigned to the child, until the growth of the child necessitates remeasurement and a new card. For adjusting the semi-adjustable furniture now in use in our schools, it is necessary to know only the distances A B and B C in each case. If we shall ever have completely adjustable chairs, the measuring-chair will enable us to secure all the data requisite for prescribing their proper use. It is conceiveable that

the janitors, through training and practice, may become competent to measure the children as well as to adjust their seats and desks.

Whatever course is pursued, whether we cling to the scales now in use, or determine the height of knee, and difference in the case of each individual; it will be found necessary, I believe, for the School Committee, through the appropriate sub-committees, to ordain certain rules and directions for the guidance of teachers and janitors in the seating of pupils.

NEED OF EXPERT COMMISSION.

American adjustable furniture is not automatically adjustable like the most highly developed forms of European school-desks, since the pupil has no control over their adjustment devices which relate almost entirely to adjustment for difference; and since adjustable furniture strictly speaking should be adjustable in other points no less important, our adjustable desks and chairs should be termed "semi-adjustable," it seems to me. The failure of American manufacturers of school furniture, hitherto, to keep pace with their European *confrères* seems to be largely due to the fact that they have received but little aid and stimulus from the studies and recommendations of American surgeons, oculists, mechanical engineers, and school officials, — all of whom have devoted comparatively little attention to the problem of school-seating. So far as I know we have never had a Committee of Experts on School Desks and Chairs in America. Our adjustable furniture is still in the stage of transition and tentative experiment. All of our leading inventors and manufacturers in this line have put forth and discarded some style or device within the last three years, and I am led to believe that all of them have valuable improvements under consideration or nearly ready for adoption.

This condition of things makes it seem not unlikely that an adjustable desk and seat which shall deserve the appellation of "hygienic" may be evolved in the United States within

the next ten years, especially if scientific experts can be induced to lend their aid in determining the dimensions and proportions of such furniture. But there is abundant evidence, it seems to me, that the time has not yet arrived for the general adoption of adjustable school-desks by the city of Boston or the cities of Massachusetts. Meanwhile let school authorities, medical and mechanical experts, and manufacturers take concerted action, in order that that time may be hastened!

No thoroughly accurate and adequate scale for determining the proper range of height in grading seats for Massachusetts children can be made until large numbers of city and country children in different parts of the State have been measured and remeasured in respect to total- and knee-height. The preparation and promulgation of such a scale might well be undertaken by a Massachusetts School Desk Commission, should such a commission be organized. It is hardly likely that the manufacturers and vendors of school-furniture will ever engage in an undertaking so purely scientific.

Meanwhile I believe that a thorough-going investigation into the present state of the seating of the pupils in all our schools is called for, so that the fixed furniture now in use may be used to the best advantage under the circumstances. To facilitate and guide the redistribution of fixed seats, and to serve as a basis for drawing up a clear and concise code of recommendations and regulations for the guidance of teachers and janitors in the assortment and adjustment of the adjustable furniture now in use, and likely to be purchased in the near future, I hold that such measurements as were made by Dr. H. P. Bowditch twenty years ago, in 1875, should be repeated on a larger scale.

On the main question of school-seating — the School Committee if it does not feel inclined to appoint a sub committee to decide so intricate a question, would find ample justification in the example of the cities of Frankfort, Prague, Vienna, and Zürich should it secure the coöperation of the

necessary experts by the appointment of a school-desk commission. There never has been such a commission in the United States, but there is need of one here and now. The city or State which moves first in the matter will deserve the thanks of school managers, school-children, and the taxpayers throughout the country.

EDWARD MUSSEY HARTWELL,
Director of Physical Training.