A STUDY OF THE NATURAL LIGHTING OF CLASSROOMS OF THE
ELEMENTARY SCHOOLS OF KANSAS CITY, MISSOURI 1880-1927

by

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<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Chapter I</td>
<td>A Brief History of Investigations of Natural Lighting for Classrooms in Schools</td>
<td>3</td>
</tr>
<tr>
<td>Chapter II</td>
<td>Hygienic and Physiological Aspects Relative to Proper Lighting</td>
<td>7</td>
</tr>
<tr>
<td>Chapter III</td>
<td>Standards of Classroom Lighting</td>
<td>17</td>
</tr>
<tr>
<td>Chapter IV</td>
<td>Method of Procedure</td>
<td>29</td>
</tr>
<tr>
<td>Chapter V</td>
<td>Presentation of Data</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Comparative Chart Showing the Composites</td>
<td>73</td>
</tr>
<tr>
<td>Chapter VI</td>
<td>Summary</td>
<td>74</td>
</tr>
<tr>
<td>Bibliography</td>
<td></td>
<td>76</td>
</tr>
</tbody>
</table>
INTRODUCTION

The sense of vision is the most valued of all the senses of mankind. Such a valuable heritance should not be abused, but properly cared for in order that we may enjoy life. Conservation of vision is well worth while since at least one-fourth of the inhabitants of Europe and America, as authors tell us, are handicapped in some manner by defective eye-sight. This great amount in eye deficiency cannot be reduced unless the children receive the proper treatment of their eyes during their school years.

Irving Fisher believes that by proper treatment of preventable diseases, fifteen years may be added to the average human life. Hygienists have discovered that many bodily disorders have their origin in weak eyes and through the proper treatment of the eyes many of these disorders have been removed. Eye-strain causes headache, exhaustion, nervousness, indigestion, sleeplessness, lack of interest in study, and many other disturbances any of which, if permitted to continue, will develop into permanent ill-health.

Many cases of myopia (nearsightedness) develop in the early years of children’s lives. The improper lighting of classrooms makes it necessary for them to bring their work too close to their eyes. Most of the factors which cause eye trouble in the classroom are: insufficient light, shadows
caused by crosslighting, glare from windows, improper artificial lighting and improper seating. We seldom find a classroom which has too much light for all times of the day.

In the following study the number and location of windows from floor and ceiling, ratio of glass area to floor area, and kinds of glass in windows are some of the factors considered. The findings from period to period are compared with the standards of school lighting.
CHAPTER I

A BRIEF HISTORY OF INVESTIGATIONS OF NATURAL LIGHTING FOR CLASSROOMS IN SCHOOLS

Perhaps the most prominent of all pioneer investigators of classroom lighting was Herman Cohn, who was among the first to suggest the size of classroom windows. He gave tests in reading various types and made examinations of actual performance of the eyes to determine the ratio of glass area to floor area. After many examinations, about 1866, he made his conclusion and stated that the ratio of window area to floor space should be 1 to 5.

Later Javal, a French ophthalmologist, in 1881, suggested that no school building should be situated closer to another building than twice the height of that building to insure proper light. He further stated that a portion of the sky should be visible from any seat in the classroom. In 1882, as a result of Javal's investigations, the French department of education ruled that a "portion of the sky vault must be seen from each desk extending 30 centimeters from the top of the window."

Forster, from his studies in 1884, made the statement that the angle from the top of any desk formed by a line drawn to the top of the window and another to the top of the nearest building should not be less than 4 degrees.

1. Kerr, James, Illuminating Engineer, July, 1914.
Weber's photometer, in 1883, and later the solid angle gage, opened new lines of investigation. Cohn made his conclusion on desk lighting, from observations made from Weber's instrument. This conclusion was: "The minimum requirement for lighting a school desk is 50 reduced square degrees of visible sky vault."

Gilbert modified Cohn's estimate, in 1890, after daily measurements in a Berlin school for a year. He concluded that, "when the mean elevation of a light beam is 5 degrees, 574 square degrees are necessary to satisfy the lighting requirement, but when the elevation is 90 degrees, only 50 degrees are necessary."

A commission in Berlin made this recommendation in 1899: "As a test of illumination efficiency, ordinary type should be easily read at 80 centimeters." In 1902, Wingen introduced a new form of light tester, and in 1904, Max Gruber recommended roof lighting.

Porcy Waldram, in 1913, stated that no rules existed which determine what width, height and arrangement of glass will give proper light for any given size room. He is the only writer observed who takes such a position.

The object of this brief history is to give the reader an idea of some of the suggestions of the early writers. Concise as it is, it shows that there was an early tendency to improve the situation of classroom lighting.

1. Waldram, Porcy J. Illuminating Engineer, Jan., 1914.
THE SPECIFIC FIELD OF THIS STUDY

The preparation of this study is intended to give the reader a complete and accurate conclusion of the status of a classroom window lighting from 1880 to 1927 inclusive in the elementary public schools of Kansas City, Missouri. The work involves the investigation of one hundred and three building projects or periods from 1880, the oldest buildings now in use, to those completed in 1927. There are more than eight hundred rooms in the study and each was measured individually and data recorded according to standards. Each school was studied separately and the data so arranged that it may be easily verified. The author has not used opinions or facts without evidence, but has stated them actually as they were found. Since there are a great many schools studied over such a long period of time, the author is assured that the findings will lead us to a satisfied conclusion.

There are many writers on school standards of lighting and many surveys of similar school systems have been made. But these studies are mostly made for rating or scoring purposes for remedial measures and do not show the trend of the system, or the rating of one period compared with another.

Out of the many public supported institutions of the great American commonwealth, the school system is the most expensive. This fact is ascertained by the amount of school tax levied in ratio to other taxes. Large sums of money are spent annually and each year the amount exceeds that of the preceding one. This steady increase in expense of housing and educating children is indicative of progress in the adventure. New standards in building, methods of teaching, classifying children, preparing teachers and revising curricula replace the old with added efficiency.

School buildings, like any other human creation, have certain characteristics by which they are known. Because students require a certain amount of heat for their health and comfort, sufficient fresh air while housed, adequate light for study, etc., certain standards are set and one of the most important of these standards is that of the proper amount and distribution of light.

The author having become interested in certain developments in the elementary schools of Kansas City, Missouri, especially natural lighting, after some meditation, concluded to make a study of natural lighting of these elementary schools. For reasons above mentioned, the writer's intention was to compare these schools with the standards, to find whether or not the trend was approached the ideal, and to show such a trend in comparative periods. It is further hoped that this work will be of value to future students of lighting as well as to those interested in school hygiene, building and administration.
CHAPTER II

HYGIENIC AND PHYSIOLOGICAL ASPECTS RELATIVE TO PROPER LIGHTING

One of the greatest contributions of all the human senses to our pleasures in life is light conducted by our sense of sight or vision. We begin to use the eye from early life and continue its use constantly while awake throughout life. It is because of the constant use of the eye that we readily notice any weakness which might temporarily or permanently impair our vision at its earliest onset.

Since light plays such an important part in our lives; since our sense of sight must be alive to enjoy light, the greatest of care should be taken in our adjustment of light to the eyes at all times. We cannot profitably "learn to do by seeing" if we injure our eyes in the process. Inadequate light in the classroom is bound to cause eye-strain. Eye-strain soon causes fatigue and tiredness which in turn is sure to cause lack of interest in study. The child, under such abstractions, becomes nervous and restless and is unable to remain quiet in his seat. He may be thrown into such a disturbed state of being that his health becomes bad, his interests diverted toward evil sources and finally he makes a great failure as a student and as a citizen. It is impossible for intellectual processes to develop to their best under such influences which cause distraction and uneasiness.

Clark and Beal quote the following in regard to defective

lighting:

"Faulty illumination causes the assumption of injurious postures and the acquirement of a 'postural habit' that may aid indirectly in the production of postural defects which may act injuriously on the health in later life. In fact, the faulty posture frequently assumed by the child under conditions of poor illumination has been assigned by a number of medical authorities as a causative factor in the production of nearsightedness."

In a health study made by Frances and Jesse Burks, directors of Municipal Research, Philadelphia, revealed 30.7 percent of defective eyesight of the 468 children studied. Eyes were second in number of defective organs found, the teeth rating first.

The four most commonly known defects in vision found in this study were: myopia (short-sightedness), hypermetropia (far-sightedness), astigmatism (blurred vision) and eye weakness. All of these might be caused by over use of the eyes or poor lighting in study. Any or all of these cause nervous strain which shows itself in stomach ailments, headache, irritable temper, lassitude, restlessness, and a general nervous condition.

Joshua E. Hammon states the following concerning eye care and hygiene:

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"There is a general misconception that eyestrain results only when some eye defect exists. In the attempt to see clearly an abnormal strain is placed upon the eyes. Eye strain will inevitably result when normal eyes are abused, misused or subjected to faulty illumination.

The direct causes of eyestrain from lighting have been summarized in the following manner:
(a) Bad lighting which compels bringing the eyes too near the work and thus involves an effort of accommodation and convergence.
(b) Bending over the work which causes fatigue and is likely to induce myopia (near-sightedness).
(c) The effect of working with insufficient light and the consequent rapid exhaustion of the eye.
(d) The use of direct lighting not properly shaded and the consequent ill effect from the brilliant source.
(e) The rapidity with which the work is done in proportion to its delicacy and fineness, the brightness of the work, the distance at which the work is placed and the length of time during which it is done.
(f) Lack of constancy in the light source."

After examining thousands of children in Philadelphia, Newmeyer concluded that about ten percent of the eye cases found are diseases of the eyes and the remaining ninety percent are defects in vision caused by poor lighting, eyestrain or some other external factor.

Fletcher B. Dressler, specialist in school hygiene of the United States Bureau of Education has the following to say about the danger of facing windows:

2. Dressler, Fletcher B.--School Hygiene p. 55-75.
"There is no excuse in this day and age for anyone to construct a school building with windows facing the children, though this was not uncommon a few years ago. If strong direct light from the windows strikes the retinae, automatic adjustment of the eyes takes place to suit this and hence of necessity maladjustment for the weaker, light reflected from the page must follow. If, therefore, the eyes are subjected to the stimulations of two or more sources of light of unequal intensity there will be a conflict between the demands of these stimuli, varying with the conscious attempts of the person to adjust to one or the other. The pupil at work will attempt to shade his eyes from the windows, or else he will be subjected to the strain of unhygienic vision and fatigue of the ciliary muscles.

Eye Defect and School Conditions. There can be no doubt of the fact that there is danger of our children injuring their eyes under the pressure of modern school demands. In fact, the results of careful examinations made in all progressive countries prove conclusively that school conditions are responsible for a large part of the myopia (near-sightedness) prevalent among the children of the higher grades. Myopia usually develops during the early years of school age as a result of school requirements or other work which makes it necessary for the children to bring the objects with which they work too close to their eyes."

There must be the necessary amount and proper kind of light in the school room. If this demand be disregarded, the eyes of the children will suffer, for lack of light will, of necessity, compel the child to bring the objects that he has been directed to observe closer to his eyes in order to see them with sufficient clearness and if this forced accommodation is continued too long, fatigue, eye-strain and finally, myopia will result."

Reading from Berkowitz we get the following:


"Competent authorities seem to agree as to the causes of eye strain in children other than congenital defects. Standard works on diseases of the eye are practically unanimous in declaring that myopia results from the protracted and unhygienic use of the eyes in near work.

Most of the factors tending to cause eye strain exist in the schools; glare from windows, from glazed paper, and from improperly arranged artificial illumination; improper seating; poor printing and improper type.

The report of Hemer, medical officer of London follows:

"The great majority of children enter the schools with normal vision, but owing in large measure to the defective conditions under which instruction is given, that number is seriously diminished in the course of a few years. School medical officers frequently refer to two of the causes, that of imperfect lighting of the school room and the near distance work of children in reading, sewing and handwork."

The following was taken from "Sight Saving and Brain Building" by F. Park Lewis:

"It is an accepted fact recognized by ophthalmologists everywhere that changes occur in eyes of children during the period of their school life of which the most prominent symptoms is a steadily progressive development of nearsight. As definitely formulated by the late Professor Dufour:

1. In all schools the number of shortsighted pupils in increases from class to class.

2. The average degree of short-sightedness increased from class to class.

3. The number of short-sighted pupils increases with the increase in the school demand.


2. Lewis, F. Park -- Fourth International Congress on School Hygiene No. 5 (1913).
The following is from Terman on the hygiene of vision:

"Excepting touch alone, the eye is the most valued of our special senses. The conservation of vision has been called "more important than all the work of our universities." At least one-fourth of the inhabitants of Europe and America are more or less handicapped by defective vision. Since most of the instruction given in the schools is based upon the visual impression, it is well to examine the efficiency of the visual functions to ascertain the effects of school work upon them.

What kind of an eye did primitive man require? Plainly, one which would be effective chiefly for distant seeing, able to make as many as forty to fifty movements per minute, and one which could focus for a few minutes on near objects, if occasion demanded. For the bulk of the human race, little more than this was required of the eye until the last few hundred years. The eye was permitted, for the most part, to roam in freedom; it made only large movements and made them slowly. Fixation was rarely for more than a few seconds. When it tired of one kind of work it was usually free to change its activity.

Quite recently, however, the eye has been subjected by the tyranny of print and sentenced to a treadmill form of action for which it was never originally designed. In five minutes of reading the eye makes, ordinarily over one thousand separated movements and as many fixations, each with "rifle-aim precision." This is probably as much work as it was earlier required to do in one hour. The ciliary muscle, in accommodating the eye for near work, such as reading probably expends as much energy in five minutes as formerly it was necessary to expend in a whole day of distant seeing. Moreover, the accommodation must shift in the reading of each line as the eyes move across the page from left to right, since only in the middle of the line are the two eyes equally near to the point of fixation. Add to these burdens the difficulties of too fine print, insufficient light, an unsuitable form of type, improperly colored paper, unhygienic spacing of letters, lines, or words, and the abuse to which the eye is now universally subjected at once becomes apparent.

1. Terman, Louis H. The Hygiene of the Child - Chap. XIV.
Among the essential facts are the following:

Myopia is by no means unknown among primitive races, though its exact frequency has not been sufficiently established for many tribes. Investigations of eye conditions among army recruits in Germany and Denmark have revealed the presence of all degrees of myopia in recruits who had never attended school or engaged in near work of any kind. Although most of these studies agree in finding a larger proportion of myopia among recruits who had attended school longest, one investigation, at least, finds exactly the reverse.

The fact that myopia becomes much more frequent in the upper grades is admitted by all, but that the school is the chief culprit remains to be proved. The evolution of the eye from a condition of hyperopia to one of myopia has been frequently observed among those who have attended school little or none at all. The presence of more myopes in the upper classes is also partly accounted for on the theory that inasmuch as extreme near-sight unfitst the child of ordinary distant seeing but leaves the ability to read little impaired, children with myopia are for this reason more likely to be retained in school and to crowd the upper grades.

The reflex, or general, symptoms of eyestrain are legion. Among the most important are:

- Headache (often with nausea)
- Feelings of exhaustion and weakness
- Indigestion (sometimes constipation)
- Dizziness
- Sleeplessness
- Neurasthenia (fatigue of the nervous system)
- Motor disturbances, such as twitchings, automatism, stuttering, etc.
- Irritability, lack of emotional control, outbursts of temper, etc.

We are told by authors of hygiene that from 15 to 30 percent of school children are in some manner afflicted with sufficient defective vision to incapacitate them in their studies. While the school is not the only cause of refractive
errors in vision, its responsibility in relation to eye trouble is very great. This responsibility lies chiefly in the avoidance of eye-strain. The chief cause of eye-strain comes primarily from improper light in some manner. It may come from insufficient amount of light, dazzling light, cross-shadows, improperly distributed light, or some other form.

Eye-strain almost invariably causes faulty bodily posture which in time leads to such permanent anatomical defects as stoop shoulders and spinal curvatures. Such defects are no more than fore-runners of future bodily weakness and ill health.

The author in this study found many poor lighting arrangements in various well planned rooms for lighting throughout the schools of Kansas City. Desks in many places were improperly placed with reference to good lighting, or were crowded and thus causing shadows. Empty seats were found in best lighted portions of the room while those in the darker parts were occupied. It seemed that no effort had been made to seat children with reference to their best visual needs. Charts, pictures, maps and other equipment were wrongly placed to receive the best light and in a few rooms curtains did not operate. About some buildings stood large trees with their boughs extending almost against classroom windows greatly
Reducing the amount of light needed within. Windows of many rooms were nearly half filled with plants which greatly decreased the light, while in others the windows were partly obscured by lace curtains, posters, and announcements, or slogans. It is needless to say that these conditions should be removed at once.

There are many small hazards to good lighting that a careful teacher will guard against:
(a) Use artificial light any time that it becomes difficult for the pupils to see.
(b) See that walls, windows, and reflectors are kept clean.
(c) Dark colored pictures should not be placed upon the walls or dark charts about the room as these diminish the light in the room.
(d) Keep decorative curtains, flowers, and other obstructions out of the windows.
(e) Fill the best lighted seats first—if any vacant seats let them be the poorer lighted ones.
(f) Window shades should always be adjusted for best light.
(g) Seat children with defective vision nearest front of the room.
(h) Arrange the work so that there will be no two consecutive periods of close eye work.

Children afflicted with myopia have a narrow field of mental concepts because most of the "light of the world" is cut off from them. They live a sedentary life because the
whole world, except within a few feet of them, seems hazy and gives an uninviting atmosphere. Trees and houses are mere blurs and forest and fields are shadowy ghosts. Games with other children cannot be indulged in with pleasure and hence the victim is isolated from pleasures and learning which should be his.

With this knowledge, it is easy to understand why children afflicted with eye trouble do not learn readily, are usually backward and often truants from school. There is a mental starvation within them which they cannot feed or satisfy as nervousness, melancholy, and lack of interest result.

Tests show that the average schoolroom in the central part of the United States may receive only about 16 per cent as much light in December as in June, and only 27 per cent as much at 4:30 P.M. as at noon. This justifies the fact that a schoolroom should have more light than is needed at certain times of the day and certain seasons to assure ample amount of light in winter, evening and on cloudy days.
CHAPTER III
STANDARDS OF CLASS ROOM LIGHTING

"The Revised Code of Lighting School Buildings" which was prepared jointly by the American Illuminating Engineering Society and the American Institute of Architects gives as requirements that the daylight illumination of classrooms in use during daylight hours shall not be less than five foot-candles on desk tops and three foot-candles on charts and blackboards.

A word of explanation is needed here. There is a tendency to confuse light with illumination. They are closely related but are not one and the same thing. Illumination is the amount of light received on a surface and is measured in foot-candles. A foot-candle is the amount of light from a standard candle falling on a surface at a distance of one foot. Originally the standard candle was of sperm wax, of one-sixth pound in weight, and burned 120 grains an hour.

Quantity of light admitted by a light source is measured in lumens. A lumen is the quantity of light required to illuminate one square foot of a surface to an intensity of one foot candle. Throughout this study we will speak in terms of

2. Ibid., p. 3.
3. Ibid., p. 3-4.
lighting and lighting ratio rather than illumination for the
sake of simplicity as most standards speak in terms of amount
or ratio of light.

Standards set forth by Walsh are the following:

1. No place is fit for use in a school room
   where diamond type cannot be read easily
   by a normal observer at a distance of half
   a meter.

2. The darkest desk in any schoolroom should
   receive not less than 0.5 percent of the
   unrestricted light from the complete sky
   hemisphere.

3. The windows should be located in the wall
   to the left of the pupils and the glass
   should be carried to the ceiling and not
   interrupted by cornices, pillars, or deco-
   rations.

4. No desk in a school room should be farther
   from the window wall than twice the height
   of the top of the glass above the desk
   surface.

5. The area of the window glass should not be
   less than one-fifth of the floor space in
   rooms up to 20 feet across and one-fourth
   the floor area in wider rooms.

6. Right-hand lighting is depreciated; bilateral
   lighting is less satisfactory than left-
   lighting; lighting from behind the teacher
   is usually a source of glare to the children
   who face the window. Lighting from behind
   the children is apt to cause glare and dis-
   comfort to the teacher.

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1. J.W. Walsh, Elementary Principles of Lighting
Chapter IX, 1923.
Roof lighting generally provides an abundance of light but gives a comfortless imprisoned impression.

Taliaferro Clark, a member of the National Bureau of Public Health and an accepted authority on school lighting, states the following:

"In general, the amount of light falling on any desk in a classroom is proportionate to the illumination which it would obtain from the whole luminous sky above the horizon if the walls, ceilings and other obstructions were removed. It is obvious, therefore, that all other things being equal, the adequacy of the illumination falling on a school desk at any hour of the day is determined, in a large measure by the size of the window opening. Certain numerical standards have been adopted to express the relationship, but owing to the varying intensities of daylight illumination from minute to minute these standards in light of present knowledge of illumination, must yet be considered as approximations."

Herman Cohn, a German writer and student of lighting, as early as 1866 suggested a ratio of one of clear glass to five of floor for rooms up to twenty feet in depth and one to four for rooms which are wider.

Strayer and Englehardt have the following to say on classroom lighting:

"The glass area should be one-fifth to one-fourth of the floor area - determined by latitude and the presence or absence of light obstructions."

1. Strayer and Englehardt - Standards for Elementary School Buildings, P. 34.
"For regular classrooms, windows should be located only on the long side of the room for left hand lighting. The head of all windows should be square and close to the ceilings. Windows should be about three to three and one-half feet from the floor and grouped symmetrically. Plain glasses should be used in all sash. Distance between windows should not exceed twelve (12) inches. At front and of window side of classrooms, five to seven feet of dead wall space should be provided. Clear wire glass should be provided where the windows adjoin fire escapes. The width of classrooms should be governed by the height of the windows. Where windows are twelve (12) feet high and reach approximately to the ceiling, the maximum width of classrooms should be twenty-four feet. Similar proportions should govern other instances."

G.L. Lockhart, a celebrated school architect, gives the following treatise on classroom lighting:

"Lighting from two to three sides causes cross lights and shadows. Invariably the windows are small, wide apart, furnishing but a small percentage of the necessary light and that so poorly distributed that a majority of pupils are compelled to strain their eyes all the time while studying. We find many buildings with 10 to 15% of the total floor area in light, while 20% is the minimum amount.

The window openings should all be on one side of the room and adequate to admit light for the entire room.

In old buildings having class rooms with windows in more than one side, Lockhart maintains, should be changed. Of course this will be an expense but he believes it will be a profitable

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All windows should be closed except those on one side, if an oblong room, and to the left of the seated pupils. Old window openings on this side of the room should be enlarged or new windows built in.

The following is taken from an article by Cook in the U.S. Bureau of Education Bulletin:

Light ratio: Students of school lighting have, as a rule, decided on 1 to 5 as the proper ratio of window area to floor area, and legislative enactments and administrative rules have usually followed this minimum. The standards of different states, so far as established are exhibited below:

1 to 4  — Virginia.
1 to 5  — Indiana (if light is from the north)
        Minnesota, New Jersey, North Dakota, Ohio, Pennsylvania, Vermont (1 to 4 recommended)
1 to 6  — Indiana, Texas.
1 to 7  — Louisiana, Montana (all schools)
1 to 10 — Ohio (play, toilet, and recreation rooms)

It is not infrequent to find "actual glass area" mentioned instead of "window area." North Dakota permits the use of reflecting lenses to offset a deficiency in actual lighting area; New Jersey will allow a 10% deficiency to be corrected by the use of prism glass in the upper sash.

Direction of light: Children must not sit facing window (Delaware, Pennsylvania, South Dakota, and Texas). A strange provision is for light from the left, or left and rear only (New Jersey, North Dakota, Ohio, South Dakota, Vermont, Virginia). Montana's law for light is from left and rear. Indiana is the only state which requires light from the left only. Minnesota and Texas have also

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gone some distance toward unilateral lighting, but in Minnesota exception is made of those unusual class-rooms over 24 feet wide. Texas demands that the main light come from the left in all one-room schools and in larger as nearly as architectural demands and systems of ventilation will permit. A Minnesota regulation is: "Buildings shall be so placed that each room, except such as herein specified, shall receive sunlight during some part of the day. Laboratories, manual training rooms, rooms for mechanical and free hand drawing, and other rooms not continuously used for recitation and study, may be lighted from the north. Light from the east is most desirable. Light from the west holds second place. Light from the north as well as from the south should be avoided in study rooms."

Height of windows:—Minnesota, South Dakota, and Vermont require that the windows shall approach as nearly the ceiling as possible under the usual architectural limitations. Indiana and Montana make the permissible difference in height of ceiling and of windows not over one foot. Ohio makes it 8 inches. Texas reduces it to 6. It is apparent, nevertheless, that however close the windows may come to the ceiling, a low ceiling in a broad room will prevent proper lighting. Hence we find in Ohio that the height of the window head above the floor must always be 40 percent of the width of the room, if lighting is unilateral. And in Texas no part of a study hall or classroom is to be further from the window than twice the height of the window from the floor, except where adequate skylights are provided. No maximum distance of the window sill from the floor is given in any state, but the minimum is 4 feet in Indiana and Vermont, 3 1/2 in Texas.

In 1900 Morrison had this to say on classroom lighting:

In country school houses the light is commonly admitted on opposite sides but this is objectionable on account of the disagreeable and injurious effects of cross lighting. The necessity of lighting on one side only is recognized in common practice in Germany but it has been generally ignored in the United States of America. In a room lighted from two adjacent sides, either the teacher or pupils must face the light and the teacher by common consent has been made the victim.

The common practice of admitting light at the back of the pupils and into the face of the teacher cannot be too strongly condemned.

The objection to rectangular rooms lighted exclusively by numerous windows on one of the longer sides may be even though this side be on the south entirely removed by the proper use of curtains. The curtains for such a room should be of white muslin of light weight mounted on spring rollers. A room 24 x 32 ft. with four large full height windows in one of its longer sides facing south, will, with such curtains drawn, be fully lighted, when the sun is shining, with a soft, subdued, well-diffused and ample light.

A.D.F. Hamlin, William B. Ittner, and Frank Irving Cooper, along with several other noted architects in a series of authoritative articles on school planning, sanitation, heating, lighting, etc., give the following on lighting:

"To measure a section for adequate lighting, draw a right triangle having a base equal to twice its altitude and the desks should be placed that the farthest from the window should have its top at least partly within this triangle. Where the windows open upon a court of moderate size, upon a narrow street or upon a street lined with very high buildings, this is too large an allowance; the rooms should be reduced from 10 to 20 percent in width. Obstructions should be far enough away from school buildings so that the sun rays will touch the window sills of the lowest classroom in the school. In any building in which the inefficient lighting on the lower floor cannot be remedied, as few class rooms as possible or none at all should be placed on that floor.

Bilateral lighting is permissible only in wide study rooms or laboratories of 35 or more feet in width.

G. H. Snyder, Superintendent of Buildings for the Board of Education of New York sets these standards for classroom lighting:

"The German standard of school room dimensions, viz: 9 meters or 30 1/2 feet in length, 6 meters or 19 1/2 feet in width, 5 meters or 16 1/2 feet in height is practically followed in New York schools, a variation being made only because of limited ground area.

The source of natural light should be at right angles to the longer axis of the classroom in order to secure the best distribution of light. If the area of the window openings is fixed at not less than twenty-five percent of the floor surface, a new free illuminating surface of not less than twenty percent is obtained, due allowance having been made for frames and mullions.

Grouping of the windows at the left side of the pupil is to be favored, the vertical divisions between the sash being reduced to a minimum. Where at all possible the use of masonry piers between the windows is largely avoided even at the risk of a great similarity in the architectural design of the exterior."

The following is the problem of lighting as stated by Stuart H. Rowe:

"The key to the problem of lighting lies in adhering strictly to the demand for window space of at least a sixth of the floor space and more if the room is unusually deep."

1. A. F. D. Hamlin and others - Modern School Houses Part II, p. 9-11
2. Stuart H. Rowe -- The Lighting of School-Rooms, p. 27-45.
Switzerland one to four is the rule and one to five the minimum as prescribed by authorities. This ratio is practical. For while light is easily moderated the task of increasing it is difficult. It has been said that a schoolroom cannot have too much light. This is in general true except when some of the light comes from the wrong direction.

The full light must shine on the children's work and it must not be faced by the pupils or teacher.

The Reasons for Unilateral Lighting from the Left:— The reasons for this position of the light are chiefly freedom from shadows. Light from the rear casts shadows from the pupils' body and head upon his book or paper. Light from the right is obstructed by the pupil's hand in using pen or pencil. These are very serious objections to any dependence upon light from either the rear or the right. For reading, frontal light lights the binding of the book rather than the page to be read which is objectionable.

The light should come from the long side of the room rather than the short, though this is not essential, provided the requisite amount of light is secured. However, if the room is long and deep, the required amount of light could hardly be supplied from the shorter side, as in such cases there should be at least one-fourth as much window glass as floor surface to reach the farthest seats.

Bilateral Lighting——Light from two sides has some advantages however. On dark days it is easier to obtain ample light when there are windows on two sides. Outside obstructions in many cases cast shadows into the room from one side thus decreasing the amount of light. If the light comes from the left and rear it is best for reading as the rear light falls almost perpendicular upon the books and the children will learn to avoid shadows cast by their heads. The writing, however, could be seriously shadowed by this style of lighting.
Light from above -- No serious fault could be found with light from above, but it is only available in one-story buildings or in the top floor of larger ones. This method makes a warm room in summer, is expensive, and produces such a prison-cell effect as to make it undesirable unless it be for art rooms.

Conclusion on direction of light: -- In summarizing the direction of light it should be said that adequate unilaterial lighting from the pupil's left and the long side of the room is the best; that lighting from the rear and left and right and left may be advisable under some circumstances. Overhead illumination would seem to be thoroughly practical as an aid but not as a substitute for window lighting.

Location of windows: -- The best light for a classroom comes from the upper part of the windows. On this account the windows should extend as far toward the ceiling as possible. In old buildings it is not unusual to find two or three feet of side-wall above the window but modern architecture has reduced this to about six inches. On the other hand a very large percentage of the light coming through the window at or near the level of the pupils' heads goes directly to the floor and consequently is useless or worse than useless, as no light is gained and children's attention is drawn from their work by the distractions furnished outside. Moreover, they may get reflections from bright objects which intrude themselves upon children if their line of vision can reach the ground. Accordingly, windows should be from three to three and one-half feet from the floor. Four feet from the floor seems to be unnecessarily high for the bottom of the window, except where the conditions are extraordinary.

Width and Structure of window: -- The windows should be as wide as is compatible with the strength of the building. It is advisable to have the light enter the room as a unit. To secure this unity of lighting, the windows should be close together and therefore, the piers or mullions between the windows must be small, casting no noticeable shadows a few feet away. Piers have been reduced from six feet to as many inches to the great advantage of lighting.
Briggs, one of the authorities on school building construction, states that by using iron mullions and window boxes, six windows can be placed in the same space as five with the ordinary sixteen-inch brick piers at practically the same expense and the strength of the building just as great.

In summarizing the standards for classroom lighting set forth by the above authors we come to the following conclusions which will be used for comparison in this study:

1. The area of window glass should be not less than one-fifth of the total floor area in rooms up to twenty feet in width. In wider rooms it should be at least one-fourth of the total floor area. This is the minimum without exterior obstructions.

2. All glass should be clear.

3. The distance from the corner of room to first window should be not more than four feet; otherwise there will be dark corners.

4. The windows should be located in the wall to the left of the seated pupils, and the glass should reach as nearly as possible to the ceiling, from six inches to one foot. There should be no arched or curved tops to the windows.

5. The distance between the windows should be not more than two feet, but preferably one foot.

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6. The bottom of the lower pane should extend not lower than three feet from the floor and not higher than three and one-half feet.

7. Unilateral lighting is best, as before stated, and should come from the pupil's left. Bilateral lighting from the left and rear is next best. Light should never come from opposite sides except in very wide rooms and never from the front.

8. There should be no black board space between windows.

9. There should be no piers, either inside or outside, between windows, as these obstruct light and cause shadows.

10. Each child, when seated, should be able to see above the horizon from his seat.

11. Sunlight should penetrate the room sometime during the day.

12. There should be curtains to all windows to properly control the light.

13. Although roof lighting gives abundance of light it is not comfortable or practical and is much more expensive.

14. Frosted or flowered glass as far as good-lighting is concerned is faulty.

15. No unilateral room should be wider than twice the height of the windows from the floor.

16. No classroom should be more than thirty feet wide.

17. There should be no shadows caused by cross-lighting or dazzling surfaces caused by reflection.

There are many other factors set forth in the standards which we cannot consider in this study since we are confined to window lighting only.
CHAPTER IV

METHOD OF PROCEDURE

All materials for this study were obtained by personal visitation to the different schools in Kansas City, Missouri. The survey method was used to obtain the necessary data:

1. First, permission was obtained from the Board of Education to go into the schools, after school hours, for the needed measurements.

2. Then, with the assistance of the Manual Training teachers of the various schools, actual measurements were personally made by the writer in the following manner:

   a. Exact width of room.
   b. Exact length of room.
   c. Exact height of room.
   d. Number of windows were noted with reference to their position in the room.
   e. Distance from the floor to the bottom of the lower pane.
   f. Distance from the corners of room to first windows.
   g. Distance from the corners of room to first windows.
   h. Distance between windows.
   i. Number and size of clear panes in each window.
   j. Number and size of frosted panes in each window.
   k. Number and size of sky-lights, if any.
1. Rooms were listed as "between" and "corner" rooms.

m. Number of arched windows.

n. Dates of erection and repair of buildings were obtained from the records of the Board of Education.

For a comparative purpose, the period from 1860 to 1927 was divided into periods of five years each, with the exception of the last, which is seven years. By this division, the schools of each period may be more readily compared and one period may be compared with the other.

The data for each school studied are listed under the following headings:

I  Total floor area for the number of rooms.
II Total clear glass area for the number of rooms.
III Total frosted (or skylight) glass area for the number of rooms.
IV Ratio of total clear glass area to total floor area.
V Ratio of total clear and total frosted or mazed glass area to total floor area.
VI Average distance from the corners of the room to the first window on lighting side of room.
VII Average distance between windows.
VIII Average distance from the floor to the bottom of the lower pane.
IX Average distance from the top of the top pane to the ceiling.
X Average number of panes to the window.
XI Average distance from window side of room to opposite side.
XII Location of windows—whether in one, two, or three sides of corner rooms.
XIII Number of windows arched.
Tests show that the average schoolroom in the central part of the United States may receive only about 18 per cent as much light in December as in June, and only 27 per cent as much at 4:30 P.M. as at noon. This justifies the fact that a school room should have more light than is needed at certain times of the day and certain seasons to assure ample amount of light in winter, evening and on cloudy days.
Chapter V

Presentation of Data

Schools of the Period of 1880 to 1884

Emerson—Built 1880

Total floor area for six rooms 4250.58 sq. ft.
Total clear glass area for six rooms 794.3 sq. ft.
Ratio of clear glass area to floor area $\frac{794.3}{4250.58} = 1$ to $5.35$

Average distance from the corner of the room to the first window — 5' 5.7".
Average distance between windows — 2' 3.5".
Average distance from the floor to the bottom of the lower pane — 3' 11".
Average distance from the top of the top pane to the ceiling — 1' 10".
Average number of panes to the window — 3.
Average distance from window side of room to opposite side — 23'.
Four corner rooms in all with windows in two sides.

Switzer—Built 1881

Total floor area for eight rooms — 6107.25 sq. ft.
Total clear glass area for eight rooms — 946 sq. ft.
Ratio of clear glass area to floor area $\frac{946}{6107.25} = 1$ to 6.46

Total area of frosted glass for eight rooms — 392 sq. ft.
Ratio of total glass area clear and frosted to floor area $\frac{1338}{6107.25} = 1$ to 4.58.

Average distance from corners of room to the first window — 4' 7".
Average distance between windows 2' 3.5".
Average distance from floor to bottom of lower pane — 3' 2".
Average distance from top of top pane to ceiling — 1' 6.3".
Average number of panes to the window — 3.
Average distance from window side of room to opposite side — 24' 3".
All eight corner rooms with windows in two sides.
EDISON -- built 1882

Total floor area for three rooms -- 1953 sq. ft.
Total clear glass area for three rooms 313.5 sq. ft.
Ratio of total glass area to floor area 313.5 -- 1 to 6.2

Average distance from corners of room to first window -- 8' 9".
Average distance between windows -- 3' 1".
Average distance from the floor to bottom of lower pane -- 2'4.6".
Average distance from top of top pane to ceiling -- 1' 10".
Average number of panes to the window -- 2.
Average distance from window side of room to opposite side -- 24'.

All three are corner rooms, two with windows on three sides
and one with windows on one side.

FOSTER -- built 1884

Total floor area for twelve rooms -- 8256 sq. ft.
Total clear glass area for twelve rooms -- 780 sq. ft.
Ratio of clear glass area to floor area 8256 -- 1 to 10.58

Total frosted glass area for twelve rooms 690 sq. ft.
Ratio of total glass area, clear and frosted to floor area 8256 -- 1 to 5.41

Average distance from corners to first window -- 2' 10".
Average distance between windows -- 2' 5".
Average distance from the floor to bottom of lower pane -- 2'5".
Average distance from top of top pane to ceiling -- 2' 10".
Average number of panes to the window -- 3.
Average distance from window side of room to opposite side -- 24'.

Eight are corner rooms with windows in three sides.

JACKSON -- built 1884

Total floor area for five rooms -- 3850 sq. ft.
Total clear glass area for five rooms 343.52 sq. ft.
Ratio of clear glass area to floor area 3350 -- 1 to 8.57

Total area of frosted glass for five rooms -- 116.32 sq. ft.
Ratio of total glass area, clear and frosted, to floor area 3850 -- 1 to 8.57

Average distance from corners to first window -- 8' 9".
Average distance between windows -- 2' 5".
Average distance from the floor to bottom of the lower pane -- 2' 11".
Average distance from the top of top pane to ceiling -- 2' 2.5".
Average number of panes to the window -- 3.
Average distance from window side of room to opposite side -- 24'3".
Four corner rooms with windows on two sides.
SCHOOLS OF THE PERIOD OF 1885 TO 1889

ADAMS -- built 1886

Total floor area for five rooms -- 4243.68 sq. ft.
Total clear glass area for five rooms -- 896.35 sq. ft.
Ratio of glass area to floor area 4243.68 -- 1 to 4.75

Average distance from the corners to first window -- 7' 7.8".
Average distance between windows 5' 5.6".
Average distance from the floor to bottom of lower pane -- 2'6".
Average distance from top of top pane to ceiling -- 3'4".
Average number of panes to the window -- 2.
Average distance from window side of room to opposite side -- 25'.

All are corner rooms -- four with windows on two sides and one with windows on three sides.

GARFIELD -- built 1886

Total floor area for eight rooms -- 6030.9 sq. ft.
Total clear glass area for eight rooms -- 1485 sq. ft.
Ratio of glass area to floor area 6030.9 -- 1 to 4.06.

Average distance from corners to first window -- 4' 11".
Average distance between windows -- 3'5".
Average distance from floor to bottom of lower pane -- 2' 2.3".
Average distance from top of top pane to ceiling -- 3' 3".
Average number of panes to the window -- 3.
Average distance from window side of room to opposite side -- 25'6".

All eight are corner rooms with windows in two sides.

IRVING -- built 1886

Total floor area for eight rooms -- 5796.24 sq. ft.
Total clear glass area for eight rooms -- 897.76 sq. ft.
Ratio of total glass area to total floor area 5796.24 -- 897.76

1 to 6.45.
Average distance from corners of room to first windows -- 6'6".
Average distance between windows 2'4".
Average distance from the floor to bottom of lower pane -- 2'14".
Average distance from the top of top pane to ceiling -- 2'14".
Average number of panes to the window -- 5.
Average distance from window side of room to opposite side -- 25'6".

All eight are corner rooms with windows on two sides.

**BRYANT -- built 1886.**

Number 9

Total floor area for eleven rooms -- 7705.82 sq. ft.
Total clear glass area for eleven rooms -- 702.22 sq. ft.
Ratio of total clear glass area to total floor area -- 7705.82 -- 1 to 10.97.
702.22
Total frosted glass area for eleven rooms -- 232.59 sq. ft.
Ratio of total glass area to total floor area -- 7705.82 -- 932.59
1 to 8.28.

Average distance from corners of room to first windows -- 5'1".
Average distance between windows -- 4'6.5".
Average distance from the floor to the bottom of lower pane -- 2'10".
Average distance from the top of top pane to ceiling -- 2'8".
Average number of panes to the window -- 14.33.
Average distance from window side of room to opposite side -- 24'8".

Ten are corner rooms, eight with windows in two sides, and two with windows in three sides.

**SPRINGFIELD -- built 1889.**

Number 10

Total floor area for eleven rooms -- 2755 sq. ft.
Total clear glass area for eleven rooms -- 388.5 sq. ft.
Ratio of total glass area to total floor area -- 2755 -- 388.5
1 to 7.35.

Average distance from corners of room to first windows -- 5'6".
Average distance between windows -- 4'6".
Average distance from the floor to bottom of lower pane -- 2'2".
Average distance from the top of top pane to ceiling 1'10".
Average number of panes to the window -- 2.77.
Average distance from window side of room to opposite side -- 25'.

There are six corner rooms, three with windows in two sides and three with windows in three sides.
SCHOOLS OF THE PERIOD OF 1890 TO 1894

BRUCE -- built 1890

Number 11

Total floor area for two rooms -- 1321.26 sq. ft.
Total clear glass area for two rooms -- 202 sq. ft.
Ratio of total glass area to total floor area -- \( \frac{1321.26}{202} \)

1 to 6.05.
Average distance from corners of room to first windows -- 7'.
Average distance between windows -- 3'5".
Average distance from the floor to bottom of lower pane -- 2'3".
Average distance from the top of top pane to ceiling -- 3'1".
Average number of panes to the window -- 2.
Average distance from window side of room to opposite side -- 24'6".
Two corner rooms with windows in two sides.

LONGFELLOW -- built 1890

Number 12

Total floor area for eight rooms -- 5720.7 sq. ft.
Total clear glass area for eight rooms -- 888.88 sq. ft.
Ratio of clear glass area to total floor area \( \frac{5720.7}{888.88} \)

1 to 6.44.
Total frosted glass area for eight rooms 244.44 sq. ft.
Ratio of total glass area to total floor area \( \frac{5720.7}{1133.52} \)

1 to 5.05.
Average distance from corners of room to first windows -- 7'7".
Average distance between windows -- 2'6.7".
Average distance from the floor to bottom of lower pane -- 2'10.6".
Average distance from the top of top pane to ceiling -- 1'8".
Average number of panes to the window -- 3.
Average distance from window side of the room to opposite side -- 23'.
All eight are corner rooms with windows in two sides.

DOUGLAS -- built 1890

Number 15

Total floor area for eight rooms -- 5524.48 sq. ft.
Total clear glass area for eight rooms -- 906.8 sq. ft.  
Ratio of clear glass to total floor area 5524.48 -- 1 to 6.02
\[ \frac{906.8}{5524.48} \]
Total frosted glass area for eight rooms -- 167.6.  
Ratio of total glass area to total floor area 5524.48 -- 1 to 5.14
\[ \frac{167.6}{5524.48} \]
Average distance from corners of room to first windows -- 3'3".
Average distance between windows -- 4'2".
Average distance from the floor to bottom of lower pane -- 2'5".
Average distance from the top of top pane to ceiling 1'6".
Average number of panes to the window 4.62.
Average distance from window side of room to opposite side -- 21'9".
All eight are corner rooms, seven with windows in two sides,  
and one with windows in one side.

**SCARRITT** -- built 1890  
**Number 14**
Total floor area for eight rooms -- 5888 sq. ft.  
Total clear glass area for eight rooms -- 782 sq. ft.  
Ratio of clear glass area to total floor area 5888 -- 1 to 7.53
\[ \frac{782}{5888} \]
Total frosted glass area for eight rooms -- 119.86 sq. ft.  
Ratio of total glass area to total floor area 5888 -- 1 to 6.53
\[ \frac{119.86}{5888} \]
Average distance from corners of room to first windows -- 6'3".
Average distance between windows 2' 7"
Average distance from the floor to bottom of lower pane -- 2' 8".
Average distance from the top of top pane to ceiling 1'10".
Average number of panes to the window -- 3.
Average distance from window side of room to opposite side -- 26'.
There are five corner rooms with windows in two sides.

**HAMILTON** -- built 1890  
**Number 15**
Total floor area for eight rooms -- 5888 sq. ft.  
Total clear glass area for eight rooms -- 866 sq. ft.  
Ratio of clear glass area to total floor area 5888 -- 1 to 6.8
\[ \frac{866}{5888} \]
Total frosted glass area for eight rooms -- 111 sq. ft.  
Ratio of total glass area to total floor area 5888 -- 1 to 6.02
\[ \frac{111}{5888} \]
Average distance from corners of room to first windows -- 7'1"
Average distance between windows 4'6"
Average distance from the floor to bottom of lower pane -- 3'
Average distance from the top of top pane to ceiling -- 3'10"
Average number of panes to the window -- 3.
All eight are corner rooms with windows in two sides.
Average distance from window side of room to opposite side -- 27'.

HORACE MANN -- built 1890

Number 16.

Total floor area for twelve rooms -- 8852.42 sq. ft.
Total clear glass area for twelve rooms -- 1354.4 sq. ft.
Ratio of clear glass area to total floor area 8852.42 -- 1354.4

1 to 6.53.
Total frosted glass area for 425.8 sq. ft.
Ratio of total glass area to total floor area 8852.42 -- 1780.2

1 to 4.92.
Average distance from corners of room to first windows -- 5'2"
Average distance between windows -- 4'2.5"
Average distance from the floor to bottom of lower pane -- 2'11".
Average distance from the top of top pane to ceiling -- 1'1".
Average number of panes to the window -- 5.
Seven corner rooms with windows on two sides.
Average distance from window side of room to opposite side -- 25'4".

GARFIELD -- built 1891

Number 17

Total floor area for eight rooms -- 5733.74 sq. ft.
Total clear glass area for eight rooms -- 822.22 sq. ft.
Ratio of clear glass to total floor area 5733.74 -- 1 to 6.97

Total frosted glass area for eight rooms -- 188.88 sq. ft.
Ratio of total glass area to total floor area 5733.74 -- 1011.1

1 to 5.67.
Average distance from corners of room to first windows -- 3'6"
Average distance between windows -- 2'7".
Average distance from the floor to bottom of lower pane -- 2'6".
Average distance from the top of top pane to ceiling -- 3'4½''.
Average number of panes to the window -- 3.
Average distance from window side of room to opposite side -- 25'6½''.
All eight are corner rooms with windows in two sides.
SCHOOLS OF THE PERIOD OF 1895 TO 1899

BRYANT -- built 1895

Number 18

- Total floor area for five rooms -- 3451.2 sq. ft.
- Total clear glass area for five rooms -- 524.24 sq. ft.
- Ratio of clear glass to total floor area: $\frac{3451.2}{524.24}$

1 to 6.54.

- Frosted glass area for five rooms -- 86 sq. ft.
- Ratio of total glass area to total floor area: $\frac{3451.2}{609.24}$

1 to 5.65.

- Average distance from corners of room to first windows = 4.7"
- Average distance between windows = 4'.4"
- Average distance from the top of top pane to ceiling = 2'
- Average number of panes to the window = 4.6
- Average distance from window side of room to opposite side = 24'.8"

There are four corner rooms, one with windows in three sides and three with windows in two sides.

HYDE PARK -- built 1896.

Number 19

- Total floor area for sixteen rooms = 12451.92 sq. ft.
- Total clear glass area for sixteen rooms = 1905.1 sq. ft.
- Ratio of clear glass area to total floor area = $\frac{12451.92}{1905.1}$

1 to 6.95.

- Average distance from corners of room to first windows = 5'.9"
- Average distance between windows = 6'.5"
- Average distance from the floor to bottom of lower pane = 3'.6"
- Average distance from the top of the top pane to ceiling = 1'.6"
- Average number of panes to the window = 2.5
- Average distance from the window side of room to opposite side = 26'.4"

There are fourteen corner rooms, all having windows in two sides.

PERRY HOME -- built 1896

Number 20

- Total floor area for four rooms = 2515.92 sq. ft.
- Total clear glass area for four rooms = 530.7 sq. ft.
Ratio of total glass area to total floor area $\frac{2516.92}{530.7} = 4.79$.

Average distance from corners of room to first windows -- 2'2".

Average distance between windows -- 2'4".

Average distance from the floor to bottom of lower pane -- 2'1".

Average distance from the top of top pane to ceiling -- 2'4".

Average number of panes to the window -- 15.

There are two corner rooms with windows in two sides.

Average distance from window side of room to opposite side -- 24'.

**MARTIN -- built 1897**

Total floor area for four rooms -- 3198 sq. ft.

Total clear glass area for four rooms -- 399.44 sq. ft.

Ratio of total glass area to total floor area $\frac{3198}{399.44} = 8$.

Average distance from corners of room to first windows -- 5'9".

Average distance between windows -- 7'.

Average distance from the floor to bottom of lower pane -- 5'7".

Average distance from the top of top pane to ceiling -- 2'.

Average number of panes to window -- 2.

Average distance from window side of room to opposite side -- 25'6".

All four are corner rooms with windows in two sides.

**IRVING -- built 1898**

Total floor area for four rooms -- 2873.76 sq. ft.

Total clear glass area for four rooms -- 447.5 sq. ft.

Ratio of total glass area to total floor area $\frac{2873.76}{447.5} = 6.42$.

Average distance from corners of room to first windows -- 5'6".

Average distance between windows -- 3' 8.5".

Average distance from the floor to bottom of lower pane -- 2' 5".

Average distance from the top of top pane to ceiling -- 2'5".

Average number of panes to the window -- 3.

Average distance from window side of room to opposite side -- 24'.

All four are corner rooms with windows in two sides.
SWITZER -- built 1899

Total floor area for seven rooms -- 4962.98 sq. ft.
Total clear glass area for seven rooms -- 650 sq. ft.
Ratio of clear glass area to total floor area $\frac{4962.98}{650} = 7.63$.

Total frosted glass area for seven rooms -- 183 sq. ft.
Ratio of total glass area to total floor area $\frac{4962.98}{333} = 5.97$.

Average distance from corners of room to first window -- 4' 10".
Average distance between windows -- 4' 1".
Average distance from the floor to bottom of lower pane -- 2' 10".
Average distance from the top of top pane to ceiling -- 1' 10".
Average number of panes to the window -- 3.
Average distance from window side of room to opposite side -- 25' 6".

All are corner rooms with windows on two sides.
SCHOOLS OF THE PERIOD OF 1900 TO 1904

HAMILTON -- built 1900

Total floor area for four rooms -- 2824 sq. ft.
Total clear glass area for four rooms 541.65 sq. ft.
Ratio of total glass area to total floor area \(\frac{2824}{541.65}\)

1 to 5.61.
Average distance from corners of room to first windows -- 6'-4".
Average distance between windows -- 3'-10".
Average distance from the floor to bottom of lower pane -- 3'-2".
Average distance from the top of the top pane to ceiling -- 2'-4".
Average number of panes to the window -- 5.
Average distance from window side of room to opposite side -- 24'.
Three are three corner rooms with windows in two sides.

IRVING -- built 1900

Total floor area for two rooms -- 1310.86 sq. ft.
Total clear glass area for two rooms 228.33 sq. ft.
Ratio of clear glass area to total floor area \(\frac{1310.86}{228.33}\)

1 to 5.74.
Total frosted glass area for two rooms -- 16 sq. ft.
Ratio of total glass area to total floor area \(\frac{1310.86}{244.33}\)

1 to 5.36.
Average distance from corners of room to first windows -- 2'-1".
Average distance between windows -- 1'-1".
Average distance from the floor to bottom of lower pane -- 2'-10".
Average distance from the top of top pane to ceiling -- 10".
Average number of panes to the window -- 6.
Average distance from window side of room to opposite side -- 24'-6".
Both are three corner rooms with windows on two sides.
LATHROP -- built 1900

Total floor area for ten rooms -- 8938.11 sq. ft.
Total clear glass area for two rooms -- 1779 sq. ft.
Ratio of total glass area to total floor area 8938.11 -- 1779
1 to 5.02.
Average distance from corners of room to first windows -- 8' 4.7".
Average distance between windows -- 2'5.5".
Average distance from the floor to bottom of lower pane -- 2'8".
Average distance from the top of top pane to ceiling -- 2'4".
Average number of panes to the window -- 3.
All ten are corner rooms with windows on two sides.
Nine are arched windows.
Average distance from window side of room to opposite side 27".

BRISTOL -- built 1901

Total floor area for seven rooms -- 5025.49 sq. ft.
Total clear glass area for seven rooms -- 1177 sq. ft.
Ratio of total glass area to total floor area 5025.49 -- 1177
1 to 4.27.
Average distance from corners of room to first windows -- 4' 2.5".
Average distance between windows 5' 8".
Average distance from the floor to bottom of lower pane -- 3'7".
Average distance from the top of top pane to ceiling -- 1'7".
Average number of panes to the window -- 3.
Average distance from window side of room to opposite side 24'6".
All seven are corner rooms with windows on two sides.

HAMILTON -- built 1902

Total floor area for four rooms -- 3362.31 sq. ft.
Total clear glass area for four rooms -- 565.1 sq. ft.
Ratio of total glass area to total floor area 3362.31 -- 565.1
1 to 5.97
Average distance from corners of room to first windows -- 4'1".
Average distance between windows -- 4'10".
Average distance from the floor to bottom of lower pane -- 2'8".
Average number of panes to the window -- 4.
All four are corner rooms with windows in two sides. 
Average distance from window side of room to opposite side -- 23'.
**BRUCE -- built 1903**

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for two rooms</td>
<td>1366 sq. ft.</td>
</tr>
<tr>
<td>Total clear glass area for two rooms</td>
<td>804 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total clear glass area to total floor area</td>
<td>1366 to 6.62: 204</td>
</tr>
<tr>
<td>Total frosted glass area for two rooms</td>
<td>22 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total glass area to total floor area</td>
<td>1366 to 6.13: 220</td>
</tr>
<tr>
<td>Average distance from corners of room to first window</td>
<td>4'4&quot; ft.</td>
</tr>
<tr>
<td>Average distance between windows</td>
<td>1'9&quot; ft.</td>
</tr>
<tr>
<td>Average distance from the floor to bottom of lower pane</td>
<td>2'6&quot; ft.</td>
</tr>
<tr>
<td>Average distance from the top of top pane to ceiling</td>
<td>1'9&quot; ft.</td>
</tr>
<tr>
<td>Average number of panes to the window</td>
<td>6.</td>
</tr>
<tr>
<td>Both are corner rooms with windows in two sides</td>
<td></td>
</tr>
<tr>
<td>Average distance from window side of room to opposite side</td>
<td>26'6&quot; ft.</td>
</tr>
</tbody>
</table>

**H.T. WASHINGTON -- built 1904**

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for four rooms</td>
<td>3024 sq. ft.</td>
</tr>
<tr>
<td>Total clear glass area for four rooms</td>
<td>393 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total clear glass area to total floor area</td>
<td>3024 to 7.79: 393</td>
</tr>
<tr>
<td>Average distance from corners of room to first window</td>
<td>3'9.5&quot; ft.</td>
</tr>
<tr>
<td>Average distance between windows</td>
<td>3'11&quot; ft.</td>
</tr>
<tr>
<td>Average distance from the floor to bottom of lower pane</td>
<td>4'2&quot; ft.</td>
</tr>
<tr>
<td>Average distance from the top of top pane to ceiling</td>
<td>2'10&quot; ft.</td>
</tr>
<tr>
<td>Average number of panes to the window</td>
<td>6.</td>
</tr>
<tr>
<td>All four are corner rooms with windows in two sides</td>
<td></td>
</tr>
<tr>
<td>Average distance from window side of room to opposite side</td>
<td>24' ft.</td>
</tr>
</tbody>
</table>

**ATLANTA -- built 1904**

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for eight rooms</td>
<td>5776.48 sq. ft.</td>
</tr>
<tr>
<td>Total clear glass area for eight rooms</td>
<td>511.11 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total clear glass area to total floor area</td>
<td>5776.48 to 11.11: 511.11</td>
</tr>
<tr>
<td>Total frosted glass area for eight rooms</td>
<td>450 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total glass area to total floor area</td>
<td>5776.48 to 6.01: 951.11</td>
</tr>
<tr>
<td>Average distance from corners of room to first window</td>
<td>7'6.3&quot; ft.</td>
</tr>
<tr>
<td>Average distance between windows</td>
<td>2'6&quot; ft.</td>
</tr>
<tr>
<td>Average distance from the floor to bottom of lower pane</td>
<td>2'4&quot; ft.</td>
</tr>
<tr>
<td>Average distance from the top of top pane to ceiling</td>
<td>2'6&quot; ft.</td>
</tr>
<tr>
<td>Average number of panes to the window</td>
<td>6.</td>
</tr>
<tr>
<td>Six are corner rooms with windows in two sides</td>
<td></td>
</tr>
<tr>
<td>Average distance from window side of room to opposite side</td>
<td>24' ft.</td>
</tr>
</tbody>
</table>
Schools of the Period of 1905 to 1909.

**Humboldt** -- built 1905

<table>
<thead>
<tr>
<th>Description</th>
<th>Area</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for sixteen rooms</td>
<td>12284.05 sq. ft.</td>
<td>1 to 7.35</td>
</tr>
<tr>
<td>Total clear glass area for sixteen rooms</td>
<td>1070.55 sq. ft.</td>
<td></td>
</tr>
<tr>
<td>Ratio of total clear glass area to total floor area</td>
<td>12284.05 -- 1 to 7.35</td>
<td></td>
</tr>
<tr>
<td>Total frosted glass area for sixteen rooms</td>
<td>493.7 sq. ft.</td>
<td></td>
</tr>
<tr>
<td>Ratio of total glass area to total floor area</td>
<td>12284.05 -- 1 to 5.67</td>
<td></td>
</tr>
</tbody>
</table>

Average distance from corners of room to first windows -- 4'5".
Average distance between windows -- 4'8".
Average distance from the floor to bottom of lower pane -- 2'8".
Average distance from the top of top pane to ceiling -- 1'4".
Average number of panes to the window -- 5.
There are eight corner rooms, seven with windows in two sides and one with windows in one side.
Average distance from window side of the room to opposite side 25'6".

**Irving** -- built 1905

<table>
<thead>
<tr>
<th>Description</th>
<th>Area</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for four rooms</td>
<td>2877.60 sq. ft.</td>
<td>1 to 5.14</td>
</tr>
<tr>
<td>Total clear glass area for four rooms</td>
<td>660 sq. ft.</td>
<td></td>
</tr>
<tr>
<td>Ratio of total clear glass area to total floor area</td>
<td>2877.60 -- 1 to 5.14</td>
<td></td>
</tr>
</tbody>
</table>
| Average distance from corners of room to first windows -- 1'8".
| Average distance between windows -- 2'8".
| Average distance from the floor to bottom of lower pane -- 2'5".
| Average distance from the top pane to ceiling -- 2'1".
| Average number of panes to the window -- 3.
| There are no corner rooms.
| Average distance from window side of room to opposite side 24'6".

**Scarritt** -- built 1905

<table>
<thead>
<tr>
<th>Description</th>
<th>Area</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for eleven rooms</td>
<td>7689 sq. ft.</td>
<td></td>
</tr>
<tr>
<td>Total clear glass area for eleven rooms</td>
<td>1111.5 sq. ft.</td>
<td>1 to 7.09</td>
</tr>
<tr>
<td>Ratio of total clear glass area to total floor area</td>
<td>7689 -- 1 to 7.09</td>
<td></td>
</tr>
<tr>
<td>Total frosted glass area for eleven rooms</td>
<td>300 sq. ft.</td>
<td></td>
</tr>
<tr>
<td>Ratio of total glass area to total floor area</td>
<td>7689 -- 1 to 5.56</td>
<td></td>
</tr>
</tbody>
</table>
| Average distance from corners of room to first windows 5'10".
| Average distance between windows -- 2'3".
| Average distance from the floor to bottom of lower pane 2'8".
| Average distance from the top of top pane to ceiling 2'10".
| Average number of panes to the window -- 3.
| There are five corner rooms, all having windows in two sides.
| Average distance from window side of room to opposite side 25'.

**Number 32**
**HORIAN -- built 1906**

- Total floor area for sixteen rooms = 12884 sq. ft.
- Total clear glass area for sixteen rooms = 1666.66 sq. ft.
- Ratio of total clear glass area to total floor area: \( \frac{1666.66}{12884} \approx 1 \text{ to } 7.73 \)
- Total frosted glass area for sixteen rooms = 502.66 sq. ft.
- Ratio of total frosted glass area to total floor area: \( \frac{502.66}{12884} \approx 1 \text{ to } 25.94 \)

Average distance from corners of room to first windows = 4'7.6".
Average distance between windows = 4'.
Average distance from the top of top pane to ceiling = 1'6".
Average number of panes to the window = 5.

There are eight corner rooms all having windows in two sides.
Average distance from window side of room to opposite side = 25'6".

**CLAY -- built 1906**

- Total floor area for ten rooms = 7597.32 sq. ft.
- Total clear glass area for ten rooms = 970 sq. ft.
- Ratio of total clear glass area to floor area: \( \frac{970}{7597.32} \approx 1 \text{ to } 7.83 \)
- Total frosted glass area for ten rooms = 392 sq. ft.
- Ratio of total frosted glass area to total floor area: \( \frac{392}{7597.32} \approx 1 \text{ to } 19.12 \)

Average distance from corners of room to first windows = 4'5.5".
Average distance between windows = 3'10".
Average distance from the top of top pane to ceiling = 1'6".
Average number of panes to the window = 5.

There are two corner rooms with windows in two sides.
Average distance from window side of room to opposite side = 24.6".

**ADAMS -- built 1906**

- Total floor area for four rooms = 2944 sq. ft.
- Total clear glass area for four rooms = 444 sq. ft.
- Ratio of total clear glass area to total floor area: \( \frac{444}{2944} \approx 1 \text{ to } 6.63 \)

Average distance from corners of room to first windows = 2'10".
Average distance between windows = 2' 6.5".
Average distance from the floor to bottom of lower pane = 2' 8".
Average distance from the top of top pane to ceiling = 3'4".
Average number of panes to the window = 2.

There are no corner rooms.
Average distance from window side of room to opposite side = 23'.
MARTIN -- built 1906

Total floor area for two rooms = 1680 sq. ft.
Total clear glass area for two rooms = 206.66 sq. ft.
Ratio of total glass area to total floor area = \[ \frac{206.66}{1680} = 0.12 \]

Average distance from corners of rooms to first windows = 7'6".
Average distance between windows = 6'2".
Average distance from the floor to bottom of lower pane = 2'8".
Average distance from the top of top pane to ceiling = 2'4".
Average number of panes to the window = 2.
There are two corner rooms within two

LYKINS -- built 1907

Total floor area for eight rooms = 5888 sq. ft.
Total clear glass area for eight rooms = 963 sq. ft.
Ratio of total clear glass area to total floor area = \[ \frac{5888}{963} = 6.11 \]

Total frosted glass area for eight rooms = 152 sq. ft.
Ratio of total glass area to total floor area = \[ \frac{5888}{1115} = 5.28 \]

Average distance from corners of room to first windows = 6'8".
Average distance between windows = 2'10.5".
Average distance from the floor to bottom of lower pane = 2'8".
Average distance from the top of top pane to ceiling = 1'4".
Average number of panes to the window = 10.
All are corner rooms with windows in two sides.
Average distance from window side of room to opposite side = 23'.

ADAMS -- built 1908

Total floor area for four rooms = 2908 sq. ft.
Total clear glass area for four rooms = 430.4 sq. ft.
Ratio of total clear glass area to total floor area = \[ \frac{430.4}{2908} = 0.15 \]

Average distance from corners of room to first windows = 8'2".
Average distance between windows = 3'11".
Average distance from the top of top pane to ceiling = 3'11".
Average number of panes to the window = 3.
All are corner rooms with windows on two sides.
Average distance from window side of room to opposite side = 23'6".
FAIRMOUNT -- built 1909

Total floor area for four rooms -- 2585 sq. ft.
Total clear glass area for four rooms -- 432.4 sq. ft.
Ratio of total glass area to total floor area 2585 --
432.4

1 to 5.97.
Average distance from corners of room to first windows -- 1'8".
Average distance between windows -- 1'6".
Average distance from the floor to bottom of lower pane -- 3'9".
Average distance from the top of top pane to ceiling -- 1'3".
Average number of panes to the window -- 12.
There are two corner rooms in all with windows in two sides.
Average distance from window side of room to opposite side 23'6".

MR. WASHINGTON -- built 1909

Total floor area for four rooms -- 2772 sq. ft.
Total clear glass area for four rooms -- 591 sq. ft.
Ratio of total glass area to total floor area 2772 -- 1 to
591
Average distance from corners of room to first windows --
2' 4.5"
Average distance between windows -- 11"
Average distance from the floor to bottom of lower pane --
4'3"
Average distance from the top of top pane to ceiling -- 1'3"
Average number of panes to the window -- 2.
There are no corner rooms.
Average distance from window side of room to opposite side,
22'.

Number 41

Number 42
SCHOOLS OF THE PERIOD OF 1910 TO 1914

BENJAMIN HARRISON -- built 1910

Number 43

Total floor area for nine rooms -- 6020 sq. ft.
Total clear glass area for nine rooms -- 1289 sq. ft.
Ratio of total glass area to total floor area \( \frac{6020}{1289} = 1 \) to 6.22

Average distance from corners of room to first window -- 1'9".
Average distance between windows -- 3' 8".
Average distance from the floor to bottom of lower pane -- 2'4".
Average distance from the top of pane to ceiling -- 10".
Average number of panes to the window -- 25.3

There are two corner rooms in all with windows in one side.
Average distance from window side of room to opposite side -- 24'6".

JAMES -- built 1910

Number 44

Total floor area for seventeen rooms -- 12294.42 sq. ft.
Total clear glass area for seventeen rooms -- 2361.5 sq. ft.
Ratio of total glass area to total floor area -- \( \frac{12294.42}{2263.1} = 1 \) to 5.43

Average distance from corners of room to first window -- 2'4".
Average distance between windows -- 2'2".
Average distance from the floor to bottom of lower pane -- 2'10.6".
Average distance from the top of top pane to ceiling -- 1'3".
Average number of panes to the window -- 3.8

There are five corner rooms in all with windows in one side only.
Average distance from window side of room to opposite side -- 24'.

ALLEN -- built 1911

Number 45

Total floor area for fourteen rooms -- 11164.9 sq. ft.
Total clear glass area for fourteen rooms -- 2140.83 sq. ft.
Ratio of total glass area to total floor area -- \( \frac{11164.9}{2140.83} = 1 \) to 5.25.

Average distance from corners of room to first windows -- 2'6.5".
Average distance between windows -- 2' 1.5".
Average distance from the floor to bottom of lower pane -- 2'4.3"

Average distance from the top of top pane to ceiling -- 1'11".
Average number of panes to the window -- 6.

There are four corner rooms having windows in one side and one having windows in three sides.
Average distance from window side of room to opposite side -- 24'6"/
LYKING -- built 1911

Total floor area for two rooms = 1320 sq. ft.
Total clear glass area for two rooms = 192 sq. ft.
Ratio of total clear glass area to total floor area 192

1 to 6.35.
Total frosted glass area for two rooms = 180 sq. ft.
Ratio of total glass area to total floor area 1320 = 1 to 3.55

Average distance from corners of room to first windows = 4'3".
Average distance between windows = 3'2".
Average distance from the floor to bottom of lower pane = 2'6".
Average distance from the top of top pane to ceiling = 2'4".
Average number of panes to the window = 3.
There are two corner rooms with windows in two sides.
Average distance from window side of room to opposite side = 24'6".

MARTIN -- built 1912

Total floor area for two rooms = 1518 sq. ft.
Total clear glass area for two rooms = 236.56 sq. ft.
Ratio of total clear glass area to total floor area = 236.56

1 to 6.75.
Average distance from corners of room to first windows = 6'4".
Average distance between windows = 5'1.5.
Average distance from the floor to bottom of lower pane = 3'.
Average distance from the top of top pane to ceiling = 2'4".
Average number of panes to the window = 2.
Both are corner rooms with windows on two sides.
Average distance from window side of room to opposite side = 24'.

VAN HORN -- built 1912

Total floor area for thirteen rooms = 11020.8 sq. ft.
Total clear glass area for thirteen rooms = 1642.4 sq. ft.
Ratio of total clear glass area to total floor area = 1642.4

1 to 7.35.
Total frosted glass area for thirteen rooms = 415.48 sq. ft.
Ratio of total glass area to total floor area = 11020.88

1 to 5.77
Average distance from corners of room to first windows = 2'8".
Average distance between windows = 1'8".
Average distance from the floor to bottom of lower pane = 2'8".
Average distance from the top of top pane to ceiling = 1'3"
There are six corner rooms with windows in one side only.
Average distance from window side of room to opposite side = 25'.
SCARRITT -- built 1912

Total floor area for one room = 2494 sq. ft.
Total clear glass area for one room = 385.47 sq. ft.
Ratio of total glass area to total floor area = \(\frac{2494}{385.47}\)

1 to 6.47.

Total frosted glass area for one room = 575 sq. ft.
Ratio of total glass area to total floor area = \(\frac{2494}{442.97}\)

1 to 5.62.

Average distance from corners of room to first window = 3'5''.
Average distance between windows = 1'11''.
Average distance from the floor to bottom of lower pane = 2'8''.
Average distance from the top of top pane to ceiling = 1'10''.
Average number of panes to the window = 6.
Corner room with windows in two sides.
Average distance from window side of room to opposite side 24'8''

CLAY -- built 1912

Total floor area for eight rooms = 6612.96 sq. ft.
Total clear glass area for eight rooms = 910 sq. ft.
Ratio of total clear glass area to total floor area = \(\frac{6612.96}{910}\)

1 to 6.95.

Total frosted glass area for eight rooms = 270.63 sq. ft.
Ratio of total glass area to total floor area = \(\frac{6612.96}{1180.33}\) 1 to 5.55.

Average distance from corners of room to first window = 5'7''
Average distance between windows = 3'10''.
Average distance from the floor to bottom of lower pane = 2'8''
Average distance from the top of top pane to ceiling = 1'6''
Average number of panes to the window = 5
There are four corner rooms in all with windows in two sides.
Average distance from window side of room to opposite side = 24'3''

E.G. WHITE -- built 1913

Total floor area for seven rooms = 5558.58 sq. ft.
Total clear glass area for seven rooms = 437 sq. ft.
Ratio of total clear glass area to total floor area = \(\frac{5558.58}{437}\)

1 to 12.72.

Total frosted glass area for seven rooms = 437 sq. ft.
Ratio of total glass area to total floor area = \(\frac{5558.58}{674}\)

1 to 6.36.

Average distance from corners of room to first window = 2'6''
Average distance between windows = 3'4''
Average distance from the floor to bottom of lower pane = 2'4''
Average distance from the top of top pane to ceiling = 1'6''
Average number of panes to the window = 18
There are two corner rooms with windows in one side only.
Average distance from window side of room to opposite side = 24'8''
BLENEHEIM -- built 1913

Total floor area for two rooms -- 1404.42 sq. ft.
Total clear glass area for two rooms -- 150.07 sq. ft.
Ratio of total clear glass area to total floor area = $\frac{1404.42}{150.07}$

1 to 9.33.
Total frosted glass area for two rooms -- 102 sq. ft.
Ratio of total glass area to total floor area = $\frac{1404.42}{102}$

1 to 5.6.
Average distance from corners of room to first windows -- 4'11".
Average distance between windows -- 4' 1.2".
Average distance from the floor to bottom of lower pane -- 2'5".
Average distance from the top of top pane to ceiling -- 2'7".
Average number of panes to the window -- 5.
Both are corner rooms with windows in two sides.
Average distance from window side of the room to opposite side 21'2

JOSEPH S. CHICK -- built 1913

Total floor area for four rooms -- 2704.5 sq. ft.
Total clear glass area for four rooms -- 456 sq. ft.
Ratio of total clear glass area to total floor area = $\frac{2704.5}{456}$

1 to 5.92.
Total frosted glass area for four rooms -- 124.66 sq. ft.
Ratio of total glass area to total floor area = $\frac{2704.5}{456}$

1 to 4.65.
Average distance from corners of room to first windows -- 4'9".
Average distance between windows -- 5'7".
Average distance from the floor to bottom of lower pane -- 2'6".
Average distance from the top of top pane to ceiling -- 2'4".
Average number of panes to the window -- 6.5.
All are corner rooms with windows in two sides.
Average distance from window side of the room to opposite side 21'2

SCHITZER -- built 1914

Total floor area for one room -- 1035 sq. ft.
Total clear glass area for one room -- 160 sq. ft.
Ratio of total clear glass area to total floor area = $\frac{1035}{160}$

1 to 6.47 sq. ft.
Total frosted glass area for one room -- 54 sq. ft.
Ratio of total glass area to total floor area = $\frac{1035}{160}$

1 to 4.83.
Average distance from corners of room to first windows -- 4'10".
Average distance between windows -- 3'10".
Average distance from the floor to bottom of lower pane -- 2'5".
Average distance from the top of top pane to ceiling -- 1'6".
Average number of panes to the window -- 3.
This is a corner room with windows on two sides.
Average distance from window side of room to opposite side 23'9.
MCCOY - built 1914

Total floor area for fourteen rooms = 11740 sq. ft.
Total clear glass area for fourteen rooms = 1761.23 sq. ft.
Ratio of total clear glass area to total floor area = \( \frac{1761.23}{11740} \)

1 to 6.8.

Total frosted glass area for fourteen rooms = 264.4 sq. ft.
Ratio of total glass area to total floor area = \( \frac{11740}{2115.03} \)

1 to 5.77

Average distance from corners of room to first windows = 3'2".
Average distance between windows = 2'10".
Average distance from the floor to bottom of lower pane = 3'5".
Average distance from the top of top pane to ceiling = 1'13".
Average number of panes to the window = 9.
There are six corner rooms with windows in two sides.
Average distance from window side of room to opposite side = 25'6".

LONGFELLOW - built 1914

Total floor area for four rooms = 2849 sq. ft.
Total clear glass area for four rooms = 444.44 sq. ft.
Ratio of total clear glass area to total floor area = \( \frac{444.44}{2849} \)

1 to 6.41.

Total frosted glass area for four rooms = 122.22
Ratio of total glass area to total floor area = \( \frac{2849}{558.66} \)

1 to 5.03.

Average distance from corners of room to first windows = 5'3".
Average distance between windows = 2'6".
Average distance from the floor to bottom of first pane = 3'6".
Average distance from the top of top pane to ceiling = 1'6".
Average number of panes to the window = 3.
There are four corner rooms in all with windows on two sides.
Average distance from window side of room to opposite side = 23'5".

EMERSON - built 1914

Total floor area for six rooms = 4548.25 sq. ft.
Total clear glass area for six rooms = 1067.27 sq. ft.
Ratio of total glass area to total floor area = \( \frac{4548.25}{1067.27} \) 1 to 4.26.

Average distance from corners of room to first windows = 3'1.8".
Average distance between windows = 1'6.4".
Average distance from the floor to bottom of lower pane = 3'5".
Average distance from the top of top pane to ceiling = 5'6.5".
Average number of panes to the window = 6.
There are no corner rooms.
Average distance from window side of room to opposite side = 24'.
Total floor area for twenty-six rooms = 21771.69 sq. ft.
Total clear glass area for twenty-six rooms = 2466.91 sq. ft.
Ratio of total clear glass area to total floor area = \( \frac{21771.69}{2466.91} = 1 \) to 0.82.

Total frosted glass area for twenty-six rooms = 1501.27 sq. ft.
Ratio of total glass area to total floor area = \( \frac{21771.69}{21771.69 + 1501.27} = 1 \) to 0.07.

Average distance from corners of room to first windows = 4'7.5".
Average distance between windows = 4'1".
Average distance from the floor to bottom of lower pane = 3'7".
Average distance from the top of top pane to ceiling = 1'1".
Average number of panes to the window = 3.5.
There are twelve corner rooms in all, three having windows in two sides and nine having windows in one side only.
Average distance from window side of room to opposite side = 24'.
SCHOOLS OF THE PERIOD OF 1915 TO 1919.

MARK Twain -- built 1915

| Total floor area for fourteen rooms | 10899.51 sq. ft. |
| Total clear glass area for fourteen rooms | 374.66 sq. ft. |
| Ratio of total clear glass area to total floor area | 10899.51 / 374.66 = 1 to 29. |

Total flowered mass glass skylight area for fourteen rooms 2857.77 sq. ft.

Ratio of total glass area to total floor area 10899.51 / 374.66 = 1 to 3.6.

Average distance from corners of room to first windows -- 4'6".
Average distance between windows -- 7'5".
Average distance from the floor to bottom of lower pane -- 3'1".
Average distance from the top of top pane to ceiling -- 3'4".
Average number of panes to the window -- 18.44.

There are seven corner rooms in all with windows in one side.
There are five rooms with arched windows and skylight.

Average distance from windows side of room to opposite side 26'.

KENSINGTON -- built 1915

| Total floor area for twelve rooms | 8557.12 sq. ft. |
| Total clear glass area for twelve rooms | 498 sq. ft. |
| Ratio of total clear glass area to total floor area | 8557.12 / 498 = 1 to 17.18. |

Average distance from corners of room to first windows -- 4'9.3".
Average distance between windows -- 6'8.6".
Average distance from the floor to bottom of lower pane -- 2'10.5".
Average distance from the top of top pane to ceiling -- 2'2.6".
Average number of panes to the window -- 14.2.

There are seven corner rooms in all with windows in two sides.
There are flowered mass skylights in five rooms.

Average distance from window side of room to opposite side 23'8".

BRYANT -- built 1915

| Total floor area for eighteen rooms | 13639.64 sq. ft. |
| Total clear glass area for eighteen rooms | 2341 sq. ft. |
| Ratio of total clear glass area to total floor area | 13639.64 / 2341 = 1 to 5.83. |

Total frosted glass area for eighteen rooms 230 sq. ft.

Ratio of total glass area to total floor area 13639.64 / 2341 = 1 to 5.3.

Average distance from corners of room to first windows -- 4'3".
Average distance between windows -- 1'10".
Average distance from the floor to bottom of lower pane -- 3'4".
Average distance from the top of top pane to ceiling -- 1' 6".
Average number of panes to the window -- 14.66.

There are 9 corner rooms in all, 3 having windows in 2 sides and 6 having windows in one side only.

Average distance from window side of room to opposite side 23'8".
MT. WASHINGTON -- built 1915

Total floor area for two rooms = 1320 sq. ft.
Total clear glass area for two rooms = 174.76 sq. ft.
Ratio of total clear glass area to total floor area = 1320 to 7.54 = 174.76
Total frosted glass area for two rooms = 41.42 sq. ft.
Ratio of total glass area to total floor area = 1 to 5.1
Average distance from corner of room to first window = 3'5".
Average distance between windows = 3'4".
Average distance from the floor to bottom of lower pane = 3'3"
Average distance from the top of top pane to ceiling = 2'.
Average number of panes to the window = 6.
Both are corner rooms with windows in two sides.
Average distance from window side of room to opposite side = 20'.

FAIRBANKS -- built 1915

Total floor area for eight rooms = 5544 sq. ft.
Total clear glass area for eight rooms = 943.12 sq. ft.
Ratio of total glass area to total floor area = 5544 to 5.88
Average distance from the corner of room to first window = 4'.
Average distance between windows = 4'5".
Average distance from the floor to bottom of lower pane = 2'6".
Average distance from the top of top pane to ceiling = 2'6".
Average number of panes to the window = 6.
All eight are corner rooms having windows in one side only.
Average distance from window side of room to opposite side = 21'.

MT. WASHINGTON -- built 1916.

Total floor area for nine rooms = 7264 sq. ft.
Total clear glass area for nine rooms = 660.76 sq. ft.
Ratio of total glass area to total floor area = 7264 to 6.25
Average distance from corners of room to first window = 3'6.4".
Average distance between windows = 1'8".
Average distance from the floor to bottom of lower pane = 2'0.6".
Average distance from the top of top pane to ceiling = 9".
There are no corner rooms.
Average distance from window side of room to opposite side = 24'.

Number 62

Number 63

Number 64.
MARLBOROUGH -- built 1917

Total floor area for six rooms = 3612 sq. ft.
Total clear glass area for six rooms = 628.24 sq. ft.
Ratio of total glass area to total floor area = \(\frac{628.24}{3612}\) = 1 to 5.74.

Average distance from corners of room to first windows = 5'4".
Average distance between windows = 3'6".
Average distance from the floor to bottom of lower pane = 2'6".
Average number of panes to the window = 6.
All six are corner rooms; two having windows in two sides, and four having windows in one side only.
Average distance from window side of room to opposite side 21'.

GARFIELD -- built 1918

Total floor area for two rooms = 1674.24 sq. ft.
Total clear glass area for two rooms = 273.33 sq. ft.
Ratio of total glass area to total floor area = \(\frac{1674.24}{273.33}\) = 1 to 5.16.

Average distance from corners of room to first windows = 4'9".
Average distance between windows = 1'8".
Average distance from the floor to bottom of lower pane = 2'10".
Average distance from the top of top pane to ceiling = 1'
Average number of panes to the window = 6.
Both are corner rooms with windows in one side only.
Average distance from window side of room to opposite side 20'6".

BLENHEIM -- built 1919

(Same as building built in 1913)
Total floor area for two rooms = 1404.42 sq. ft.
Total clear glass area for two rooms = 150.37 sq. ft.
Ratio of total clear glass area to total floor area = \(\frac{1404.42}{150.37}\) = 1 to 5.6.

Total fronted glass area for two rooms = 102 sq. ft.
Ratio of total glass area to total floor area = \(\frac{1404.42}{232.57}\) = 1 to 5.6.

Average distance from corners of room to first windows = 4'4".
Average distance between windows = 4'1.2"
Average distance from the floor to bottom of lower pane = 2'5".
Average distance from the top of top pane to ceiling = 3'7".
Average number of panes to the window = 6.
Both are corner rooms with windows in two sides.
Average distance from window side of room to opposite side 24'.
MAUNCHESTER -- built 1919.

Number 68.

Total floor area for sixteen rooms = 11976 sq. ft.
Total clear glass area for sixteen rooms = 1051.61 sq. ft.
Ratio of total clear glass area to total floor area = 11976 - 1 to 11.36

Total floored mase skylights for sixteen rooms = 1402.61 sq. ft.
Ratio of total glass area to total floor area 11976 - 1 to 4.9

There are six corner rooms, two having windows in three sides and
four having windows in one side. All rooms have skylights.

BENJAMIN HARRISON -- built 1919.

Number 69.

Total floor area for four rooms = 3054 sq. ft.
Total clear glass area for four rooms = 336.68 sq. ft.
Ratio of total clear glass area to total floor area 3054 - 1 to 9.07

Total mase glass area for four rooms = 200.87 sq. ft.
Ratio of total glass area to total floor area 200.87 - 1 to 5.56

There are six corner rooms, two having windows in three sides and
four having windows in one side. All rooms have skylights.

WENDALL PHILLIPS -- 1919.

Number 19.

Total floor area for four rooms = 2329 sq. ft.
Total clear glass area for four rooms = 436.11 sq. ft.
Ratio of total clear glass area to total floor area 2329 - 1 to 6.48.

Total frosted glass area for four rooms = 144.44 sq. ft.
Ratio of total glass area to total floor area 2329 = 1 to 9.55.

All four are corner rooms with windows in one side only.

SCHOOLS OF THE PERIOD OF 1920-1927

H. C. KUMET — built 1920

Total floor area for fourteen rooms — 10,016 sq. ft.
Total clear glass area for fourteen rooms — 385.5 sq. ft.
Ratio of total clear glass area to total floor area \( \frac{385.5}{10016} \) 1 to 2.6.
Total frosted glass area for fourteen rooms — 4255 sq. ft.
Ratio of total glass area to total floor area \( \frac{4255}{10016} \) 1 to 2.46.

Average distance from corners of room to first windows — 4'6''
Average distance between windows — 3'5.6''
Average distance from the top of top pane to ceiling — 1'11''.
Average distance from the floor to bottom of lower pane — 3'1''
Average number of panes to window — 16.6.
There are four corner rooms in all having windows in one side only.
Average distance from window side of room to opposite side 24'3''. Ten rooms with skylights.

GARFIELD — built 1920.

Total floor area for two rooms — 1410.36 sq. ft.
Total clear glass area for two rooms — 125.83 sq. ft.
Ratio of total clear glass area to total floor area \( \frac{125.83}{1410.36} \) 1 to 11.2.
Total frosted glass area for two rooms — 47.5 sq. ft.
Ratio of total glass area to total floor area \( \frac{47.5}{1410.36} \) 1 to 30.42.

Average distance from corners of room to first windows — 2'5''.
Average distance between windows — 2'1''.
Average distance from top of top pane to ceiling — 3'5''.
Average number of panes to window — 3.
Both are corner rooms with windows in one side.
Average distance from window side of room to opposite side 23'.

IRVING — built 1920

Total floor area for four rooms — 2898 sq. ft.
Total clear glass area for four rooms — 527.77 sq. ft.
Ratio of total clear glass area to total floor area \( \frac{527.77}{2898} \) 1 to 5.49.

Average distance from corners of room to first windows — 3'3''.
Average distance between windows — 1' 8.6''.
Average distance from the floor to bottom of lower pane — 2'6''.
Average distance from the top of top pane to ceiling 2'.
Average number of panes to the window — 13.
There are no corner rooms.
Average distance from window side of room to opposite side 24'4''.
HELSIOn — built 1921

Total floor area for ten rooms = 6788.94 sq. ft.
Total clear glass area for ten rooms = 1682.62 sq. ft.
Ratio of total glass area to total floor area = 6788.94 : 1 to 4.03
Average distance from corners of room to first windows = 2'1".
Average distance between windows = 1'6".
Average distance from the floor to bottom of lower pane = 3'2".
Average distance from the top of top pane to ceiling = 1'8".
Average number of panes to the window = 6.
There are six corner rooms in all with windows in two sides.
Average distance from window side of room to opposite side = 26'.

HAMILTON — built 1922

Total floor area for two rooms = 1400 sq. ft.
Total clear glass area for two rooms = 197.5 sq. ft.
Ratio of total clear glass area to total floor area = 1400 : 107.3
1 to 7.29.
Total frosted glass area for two rooms = 72.66 sq. ft.
Ratio of total glass area to total floor area = 1400 : 259.96
5.33.
Average distance from corners of room to first windows = 2'6".
Average distance between windows = 1'10".
Average distance from the floor to bottom of lower pane = 3'5".
Average distance from the top of top pane to ceiling = 10".
Average number of panes to the window = 9.
There are no corner rooms.
Average distance from window side of room to opposite side = 23'.

HUMBOLDT — built 1922.

Total floor area for two rooms = 2684.91 sq. ft.
Total clear glass area for two rooms = 470.87 sq. ft.
Ratio of total glass area to total floor area = 2684.91 : 470.87
1 to 5.7.
Average distance from corners of room to first windows = 3'3".
Average distance between windows = 2'8".
Average distance from the floor to bottom of lower pane = 2'6".
Average distance from the top of top pane to ceiling = 7".
Average number of panes to the window = 6.
There is one corner room with windows in two sides.
Average distance from window side of the room to the opposite side = 23'2".
ASKEN -- built 1923

Total floor area for fifteen rooms = 11771.33 sq. ft.
Total clear glass area for fifteen rooms = 655.16 sq. ft.
Ratio of total clear glass area to total floor area

\[
\frac{11771.33}{655.16} = 1 \text{ to } 17.94
\]

Total frosted glass area for fifteen rooms = 1848 sq. ft.
Total frosted glass area for fifteen rooms = 11771.33 - 1 to 4.7.

Average distance from corners of room to first windows = 5'11".
Average distance between windows = 2'10".
Average distance from the floor to bottom of lower pane = 3'4".
Average distance from the top of top pane to ceiling = 1'8".
Average number of panes to the window = 11.5.
There are eight corner rooms with windows in one side only.
Eight rooms have skylights.
Average distance from window side of room to opposite side = 23'8".

KENNEDON -- built 1923

Total floor area for six rooms = 3904.42 sq. ft.
Total clear glass area for six rooms = 626.67 sq. ft.
Ratio of total clear glass area to total floor area

\[
\frac{3904.42}{626.67} = 1 \text{ to } 6.23
\]

Total frosted glass area for six rooms = 262.5 sq. ft.
Ratio of total glass area to total floor area = \( \frac{3904.42}{689.17} = 1 \text{ to } 4.39 \)

Average distance from corners of room to first windows = 1'4".
Average distance between windows = 2'1".
Average distance from the floor to bottom of lower pane = 3'1".
Average distance from the top of top pane to ceiling = 1'2".
Average number of panes to window = 20.
There are two corner rooms in all with windows in one side only.
Average distance from window side of room to opposite side = 24'.

FRANCIS MILLARD -- built 1923

Total floor area for ten rooms = 7721.37 sq. ft.
Total clear glass area for ten rooms = 919 sq. ft.
Ratio of total clear glass area to total floor area

\[
\frac{7721.37}{919} = 1 \text{ to } 8.4
\]

Total frosted glass area for ten rooms = 1050 sq. ft.
Ratio of total glass area to total floor area = \( \frac{7721.37}{1999} = 1 \text{ to } 3.85 \)

Average distance from corners of room to first windows = 2'9".
Average distance between windows = 2'7".
Average distance from the floor to bottom of lower pane = 2'10".
Average distance from the top of top pane to ceiling = 1'3".
Average number of panes to the window = 13.6.
There are seven corner rooms in all, two having windows in two sides and five having windows in one side only.
Five rooms have flowered maze skylights.
Average distance from window side of room to opposite side - 24'.

**KUMPE -- built 1923**

<table>
<thead>
<tr>
<th>Description</th>
<th>Number 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for four rooms</td>
<td>2788 sq. ft.</td>
</tr>
<tr>
<td>Total clear glass area for four rooms</td>
<td>138.62 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total clear glass area to total floor area</td>
<td>1 to 20.11</td>
</tr>
<tr>
<td>Total flowered maze skylight area for four rooms</td>
<td>504 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total glass area to total floor area</td>
<td>1 to 4.34</td>
</tr>
<tr>
<td>Average distance from corners of room to first windows</td>
<td>4'6&quot;</td>
</tr>
<tr>
<td>Average distance between windows</td>
<td>10'10&quot;</td>
</tr>
<tr>
<td>Average distance from the top of top pane to ceiling</td>
<td>1'11&quot;</td>
</tr>
<tr>
<td>Average number of panes to the window</td>
<td>22</td>
</tr>
<tr>
<td>All four rooms have skylights - no corner rooms</td>
<td></td>
</tr>
<tr>
<td>Average distance from window side of room to opposite side</td>
<td>24'</td>
</tr>
</tbody>
</table>

**H. E. COOK -- built 1923.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Number 81</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for twelve rooms</td>
<td>8904.13 sq. ft.</td>
</tr>
<tr>
<td>Total clear glass area for twelve rooms</td>
<td>530.6 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total clear glass area to total floor area</td>
<td>1 to 16.18</td>
</tr>
<tr>
<td>Total frosted skylight area for eight rooms</td>
<td>2079 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total glass area to total floor area</td>
<td>1 to 8.46</td>
</tr>
<tr>
<td>Average distance from corners of room to first windows</td>
<td>8'7&quot;</td>
</tr>
<tr>
<td>Average distance between windows</td>
<td>5'4&quot;</td>
</tr>
<tr>
<td>Average distance from the floor to bottom of lower pane</td>
<td>5'5.4&quot;</td>
</tr>
<tr>
<td>Average distance from the top of top pane to ceiling</td>
<td>1'11.4&quot;</td>
</tr>
<tr>
<td>Average number of panes to the window</td>
<td>11.7</td>
</tr>
<tr>
<td>There are five corner rooms in all, two having windows in two sides</td>
<td></td>
</tr>
<tr>
<td>and three having windows in one side only.</td>
<td></td>
</tr>
<tr>
<td>Eight rooms have skylights and there are forty arched windows.</td>
<td></td>
</tr>
<tr>
<td>Average distance from window side of room to opposite side</td>
<td>25'3&quot;</td>
</tr>
</tbody>
</table>

**GRACELAND -- built 1923**

<table>
<thead>
<tr>
<th>Description</th>
<th>Number 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for six rooms</td>
<td>3442.48 sq. ft.</td>
</tr>
<tr>
<td>Total clear glass area for six rooms</td>
<td>678.47 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total glass area to total floor area</td>
<td>1 to 5.07</td>
</tr>
<tr>
<td>Average distance from corners of room to first windows</td>
<td>2'6&quot;</td>
</tr>
<tr>
<td>Average distance between windows</td>
<td>2'2&quot;</td>
</tr>
<tr>
<td>Average distance from the floor to bottom of lower pane</td>
<td>3'2&quot;</td>
</tr>
<tr>
<td>Average distance from the top of top pane to ceiling</td>
<td>1'5&quot;</td>
</tr>
<tr>
<td>Average number of panes to the window</td>
<td>9</td>
</tr>
<tr>
<td>There are four corner rooms with windows in two sides.</td>
<td></td>
</tr>
<tr>
<td>Average distance from window side of room to opposite side</td>
<td>24'1&quot;</td>
</tr>
</tbody>
</table>
Total floor area for thirteen rooms = 9556.46 sq. ft.
Total clear glass area for thirteen rooms = 764.8 sq. ft.
Ratio of total clear glass area to total floor area $\frac{764.8}{9556.46} = 1$ to 12.5.

Total floor area for twelve rooms = 7496.34 sq. ft.
Total clear glass area for twelve rooms = 1929.16 sq. ft.
Ratio of total clear glass area to total floor area $\frac{1929.16}{7496.34} = 1$ to 4.11

Average distance from corners of room to first windows = 3'.
Average distance between windows = 3'11".
Average distance from the floor to bottom of lower pane = 3'2.7".
Average distance from the top of top pane to ceiling = 1'3.6".
Average number of panes to the window = 10.8.
There are nine corner rooms in all with windows in one side only.
There are six rooms having flowered mass skylights.
Average distance from window side of room to opposite side = 23'9".

Total floor area for one room = 612 sq. ft.
Total clear glass area for one room = 114 sq. ft.
Ratio of total glass area to total floor area $\frac{114}{612} = 1$ to 5.36.

Average distance from corners of room to first windows = 4'.
Average distance between windows = 1'.
Average distance from the floor to bottom of lower pane = 4'7".
Average distance from the top of top pane to ceiling = 2'8".
Average number of panes to the window = 3.
Corner room with windows in one side only.
Average distance from window side of room to opposite side = 18'.

Total floor area for twelve rooms = 7496.34 sq. ft.
Total clear glass area for twelve rooms = 1929.16 sq. ft.
Ratio of total clear glass area to total floor area $\frac{1929.16}{7496.34} = 1$ to 4.11

Average distance from corners of room to first windows = 4' 6.5".
Average distance between windows = 1'1".
Average distance from the floor to bottom of lower pane = 2'5".
Average distance from the top of top pane to ceiling = 1'5".
Average number of panes to the window = 10.
There are seven corner rooms in all with windows in one side only.
Average distance from window side of room to opposite side = 23'1"
Total floor area for eight rooms - 6163.10 sq. ft.
Total clear glass area for eight rooms - 700 sq. ft.
Ratio of total clear glass area to total floor area 6163.10 -- 1 to 8.6.
Total frosted glass area for eight rooms - 475 sq. ft.
Ratio of total glass area to total floor area 6163.10 - 1 to 5.25.
Average distance from corners of room to first windows - 3'.
Average distance between windows - 1'10".
Average distance from the floor to bottom of lower pane - 3'6".
Average distance from the top of top pane to ceiling - 11".
Average number of panes to the window -- 16.
There are no corner rooms.
Average distance from window side of room to opposite side - 24'3".

Total floor area for six rooms - 3984 sq. ft.
Total clear glass area for six rooms - 747.5 sq. ft.
Ratio of total clear glass area to total floor area 3984 - 1 to 5.33.
Average distance from corner of rooms to first windows - 4'6".
Average distance between windows - 10".
Average distance from the floor to bottom of lower pane - 3'2".
Average distance from the top of top pane to ceiling - 1'6".
Average number of panes to the window -- 12.
There are four corner rooms in all with windows in one side only.
Average distance from window side of room to opposite side 21'.

Total floor area for fifteen rooms - 9839 sq. ft.
Total clear glass area for fifteen rooms - 2003.55 sq. ft.
Ratio of total clear glass area to total floor area 9839 - 1 to 4.91.
Average distance from corners of room to first windows - 3'1.5".
Average distance between windows - 2'2".
Average distance from the floor to bottom of lower pane - 3'.
Average distance from the top of top pane to ceiling - 1'8".
Average number of panes to the window - 6.
There are four corner rooms with windows in one side only.
Average distance from window side of room to opposite side 24'4".
E.G. WHITE -- built 1925

Number 89

Total floor area for four rooms = 2879.12 sq. ft.
Total clear glass area for four rooms = 275 sq. ft.
Ratio of total clear glass area to total floor area 2879.12 = 1 to 7.68.

Total frosted glass area for four rooms = 301 sq. ft.
Ratio of total glass area to total floor area 2879.12 = 1 to 4.24.

Average distance from corners of room to first windows = 9''
Average distance between windows = 3'2''.
Average distance from the floor to bottom of lower pane = 2'11''.
Average distance from the top of top pane to ceiling = 1'6''.
Average number of panes to the window = 20.
There are no corner rooms.
Average distance from window side of room to opposite side 24'10''.

BLENHEIM -- built 1925.

Number 90

Total floor area for four rooms = 2471.6 sq. ft.
Total clear glass area for four rooms = 405 sq. ft.
Ratio of total clear glass area to total floor area 2471.6 = 1 to 6.11.

Total opaque glass area for four rooms = 75 sq. ft.
Ratio of total glass area to total floor area 2471.6 = 1 to 5.15.

Average distance from corners of room to first windows = 5'7''.
Average distance between windows = 1'2''.
Average distance from the floor to bottom of lower pane = 2'5''.
Average distance from the top of top pane to ceiling = 2'7''.
Average number of panes to the window = 7.
There are two corner rooms in all with windows in one side only.
Average distance from window side of room to opposite side 21''.

TROOST -- built 1925

Number 91

Total floor area for sixteen rooms = 11315.34 sq. ft.
Total clear glass area for sixteen rooms = 804.94 sq. ft.
Ratio of total clear glass area to total floor area 11315.34 = 1 to 14.05.

Total flowered mace skylight area for sixteen rooms = 2833.54 sq. ft.
Ratio of total glass area to total floor area 11315.34 = 1 to 3.11.

Average distance from corners of room to first windows = 6'3.6''
Average distance between windows = 1'11''.
Average distance from the floor to bottom of lower pane 3'2''.
Average distance from the top of top pane to ceiling = 2'5''.
Average number of panes to the window = 13.
There are five corner rooms in all, two having windows in two sides and three having windows in one side.
Average distance from window side of room to opposite side 23'7''.
Twelve rooms with skylights.
NORTHEAST JUNIOR HIGH -- built 1925

Total floor area for thirty-three rooms - 22524.43 sq. ft.
Total clear glass area for thirty-three rooms - 4895.56 sq. ft.
Ratio of total glass area to total floor area 4895.56 --1 to 4.6.
Average distance from corners of room to first windows - 2'7"
Average distance between windows - 2'
Average distance from the floor to bottom of lower pane - 3'3"
Average distance from the top of top pane to ceiling - 1'2"
Average number of panes to the window - 12.
There are eighteen corner rooms, fourteen having windows in two sides and four having windows in one side.
Average distance from window side of room to opposite side 23'3"

WEST JUNIOR HIGH -- built 1925

Total floor area for twenty-two rooms - 14097.14 sq. ft.
Total clear glass area for twenty-two rooms - 2659.72 sq. ft.
Ratio of total glass area to total floor area 14097.14 --1 to 5.3
Average distance from corners of room to first windows - 3'8"
Average distance between windows - 2'9"
Average distance from the floor to bottom of lower pane - 3'8.6"
Average distance from the top of top pane to ceiling - 2'1"
Average number of panes to the window - 12.
Average distance from window side of room to opposite side 23'6"
There are nine corner rooms, all having windows in two sides.

BENJAMIN HARRISON -- built 1926

Total floor area for four rooms - 3366.62 sq. ft.
Total clear glass area for four rooms - 575.2 sq. ft.
Ratio of total glass area to total floor area 3366.62 --1 to 5.85
Average distance from corners of room to first windows - 1'10"
Average distance between windows - 2'4.6"
Average distance from the floor to bottom of lower pane - 2'8.6"
Average distance from the top of top pane to ceiling - 1'1"
Average number of panes to the window - 14.
Two corner rooms in all with windows in one side only.
Average distance from window side of room to opposite side 23'7"
**NICHOLS** — built 1926.

<table>
<thead>
<tr>
<th>Details</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for six rooms</td>
<td>3606.36 sq. ft.</td>
</tr>
<tr>
<td>Total clear glass area for six rooms</td>
<td>596 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total glass area to total floor area</td>
<td>1 to 5.19</td>
</tr>
<tr>
<td>Average distance from corners of room to first windows</td>
<td>4'5&quot;</td>
</tr>
<tr>
<td>Average distance between windows</td>
<td>10&quot;</td>
</tr>
<tr>
<td>Average distance from the floor to bottom of lower pane</td>
<td>2'4&quot;</td>
</tr>
<tr>
<td>Average distance from the top of top pane to ceiling</td>
<td>1'4&quot;</td>
</tr>
<tr>
<td>Average number of panes to the window</td>
<td>12</td>
</tr>
</tbody>
</table>

There are four corner rooms with window in one side only.
Average distance from window side of room to opposite side | 21'8" |

**BLENHEIM** — built 1926.

<table>
<thead>
<tr>
<th>Details</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for eleven rooms</td>
<td>7206.16 sq. ft.</td>
</tr>
<tr>
<td>Total clear glass area for eleven rooms</td>
<td>1681.7 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total glass area to total floor area</td>
<td>1 to 4.33</td>
</tr>
<tr>
<td>Average distance from corners of room to first windows</td>
<td>3'2&quot;</td>
</tr>
<tr>
<td>Average distance between windows</td>
<td>1'5&quot;</td>
</tr>
<tr>
<td>Average distance from the floor to bottom of lower pane</td>
<td>3'</td>
</tr>
<tr>
<td>Average distance from the top of top pane to ceiling</td>
<td>1'3&quot;</td>
</tr>
<tr>
<td>Average number of panes to the window</td>
<td>9</td>
</tr>
</tbody>
</table>

There are four corner rooms in all having windows in one side only.
Average distance from window side of room to opposite side | 20'9" |

**SEVEN OAKS** — built 1926.

<table>
<thead>
<tr>
<th>Details</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total floor area for thirteen rooms</td>
<td>9059.98 sq. ft.</td>
</tr>
<tr>
<td>Total clear glass area for thirteen rooms</td>
<td>1664.33 sq. ft.</td>
</tr>
<tr>
<td>Ratio of total glass area to total floor area</td>
<td>1 to 5.79</td>
</tr>
<tr>
<td>Average distance from corners of room to first windows</td>
<td>2'7&quot;</td>
</tr>
<tr>
<td>Average distance between windows</td>
<td>1'8&quot;</td>
</tr>
<tr>
<td>Average distance from the floor to bottom of lower pane</td>
<td>3'3&quot;</td>
</tr>
<tr>
<td>Average distance from the top of top pane to ceiling</td>
<td>1'1&quot;</td>
</tr>
<tr>
<td>Average number of panes to the window</td>
<td>9.23</td>
</tr>
</tbody>
</table>

There are six corner rooms in all with windows in one side only.
Average distance from window side of room to opposite side | 24'6" |
FAIRMOUNT LAKE — built 1926

Total floor area for four rooms = 2454.11 sq. ft.
Total clear glass area for four rooms = 530.62 sq. ft.
Ratio of total glass area to total floor area \( \frac{2454.11}{530.62} = 1 : 1.76 \)

Average distance from corners of room to first windows = 3'1"
Average distance between windows = 2'2"
Average distance from the floor to bottom of lower pane = 3'6"
Average distance from the top of top pane to ceiling = 10"
Average number of panes to the window = 12.

There are four corner rooms with windows in one side only.
Average distance from window side of room to opposite side = 23'.

RESERVEY — built 1926

Total floor area for six rooms = 4661.64 sq. ft.
Total clear glass area for six rooms = 847 sq. ft.
Ratio of total glass area to total floor area \( \frac{4661.64}{847} = 1 : 5.5 \)

Average distance from corners of room to first windows = 2'6"
Average distance between windows = 2'6"
Average distance from the floor to bottom of lower pane = 3'6"
Average distance from the top of top pane to ceiling = 1'3"
Average number of panes to the window = 10.

There are two corner rooms with windows in two sides.
Average distance from window side of room to opposite side = 22'6'.

JAMES — built 1927

TOTAL FLOOR AREA for one room = 1333 sq. ft.
Total clear glass area for one room = 252.22 sq. ft.
Ratio of total glass area to total floor area \( \frac{1333}{252.22} = 1 : 5.06 \)

Average distance from the corners of room to first windows = 2'7"
Average distance between windows = 2'2"
Average distance from the floor to bottom of lower pane = 2'6"
Average distance from the top of top pane to ceiling = 5'.
Average number of panes to the window = 6.
Corner room with windows in three sides.
Average distance from window side of room to opposite side = 24'.

JAMES — built 1927

Number 100
LONGFELLOW — built 1927

Total floor area for six rooms — 3677.75 sq. ft.
Total clear glass area for six rooms — 609 sq. ft.
Ratio of total glass area to total floor area \( \frac{3677.75}{609} \) = 1 to 6.04
Average distance from corners of room to first windows — 4'
Average distance between windows — 11'
Average distance from the floor to bottom of lower pane — 3'6"
Average distance from the top of top pane to ceiling — 1'
Average number of panes to the window — 12.
There are four corner rooms with windows in one side only.
Average distance from window side of room to opposite side — 22'6"

PERSHING — built 1927

Total floor area for six rooms — 3943.68 sq. ft.
Total clear glass area for six rooms — 740.5 sq. ft.
Ratio of total glass area to total floor area \( \frac{3943.68}{740.5} \) = 1 to 5.33
Average distance from corners of room to first windows — 4'6"
Average distance between windows — 10"
Average distance from the top of top pane to ceiling — 1'6"
Average distance from the floor to bottom of lower pane — 4'6"
Average number of panes to the window — 12.
There are no corner rooms.
Average distance from window side of room to opposite side — 23'6"

HORACE HAMM — built 1927

Total floor area for two rooms — 2264.99 sq. ft.
Total clear glass area for two rooms — 322.77 sq. ft.
Ratio of total clear glass area to total floor area \( \frac{2264.99}{322.77} \) = 1 to 6.02.
Total frosted glass area for two rooms — 145.42 sq. ft.
Ratio of total glass area to total floor area \( \frac{2264.99}{145.42} \) = 1 to 4.83.
Average distance from corners of room to first windows — 4'8"
Average distance between windows — 2'2"
Average distance from the floor to bottom of lower pane — 3'1"
Average number of panes to the window — 5.
Both are corner rooms with windows in two sides.
Average distance from window side of room to opposite side 23'8".
### Comparative Chart Showing the Composite Average of the Total Number of Rooms for Each Building Period

<table>
<thead>
<tr>
<th>Number of rooms</th>
<th>34</th>
<th>43</th>
<th>54</th>
<th>49</th>
<th>41</th>
<th>63</th>
<th>130</th>
<th>97</th>
<th>260</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of clear glass to floor</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ratio total clear and frosted glass to floor</td>
<td>7.97</td>
<td>7.2</td>
<td>6.7</td>
<td>6.5</td>
<td>6.6</td>
<td>7</td>
<td>6.10</td>
<td>12</td>
<td>6.6</td>
</tr>
<tr>
<td>Avg. dist. corner of room to first window</td>
<td>5'</td>
<td>6'</td>
<td>5'6&quot;</td>
<td>5'1&quot;</td>
<td>6'4&quot;</td>
<td>7'3&quot;</td>
<td>4&quot;</td>
<td>4'5&quot;</td>
<td>3'9&quot;</td>
</tr>
<tr>
<td>Avg. distance between windows</td>
<td>7&quot;</td>
<td>4'</td>
<td>3'1&quot;</td>
<td>5'1&quot;</td>
<td>3'5&quot;</td>
<td>3'4&quot;</td>
<td>3'</td>
<td>1'4&quot;</td>
<td>2'8&quot;</td>
</tr>
<tr>
<td>Avg. dist. floor to bottom of lower pane</td>
<td>5'10&quot;</td>
<td>3'9&quot;</td>
<td>2'7&quot;</td>
<td>3'1&quot;</td>
<td>3'</td>
<td>2'9&quot;</td>
<td>2'1&quot;</td>
<td>3</td>
<td>3'3&quot;</td>
</tr>
<tr>
<td>Avg. dist. top of top pane to ceiling</td>
<td>2'12&quot;</td>
<td>2'7&quot;</td>
<td>2'1&quot;</td>
<td>1'10&quot;</td>
<td>2'3&quot;</td>
<td>1'1&quot;</td>
<td>1'6&quot;</td>
<td>2'2&quot;</td>
<td>1'6&quot;</td>
</tr>
<tr>
<td>Avg. number of panes to the window</td>
<td>2.9</td>
<td>5.7</td>
<td>3.6</td>
<td>3.9</td>
<td>4.1</td>
<td>5</td>
<td>6.6</td>
<td>12.9</td>
<td>11.7</td>
</tr>
<tr>
<td>Corner rooms with windows in one side</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>23</td>
<td>35</td>
</tr>
<tr>
<td>Corner rooms with windows in two sides</td>
<td>16</td>
<td>31</td>
<td>45</td>
<td>39</td>
<td>38</td>
<td>29</td>
<td>16</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Corner rooms with windows in three sides</td>
<td>10</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Avg. dist. from window side of room to opposite side</td>
<td>23'</td>
<td>24'6&quot;</td>
<td>24'6&quot;</td>
<td>25'5&quot;</td>
<td>24'7&quot;</td>
<td>24'6&quot;</td>
<td>24'1&quot;</td>
<td>23&quot;</td>
<td>11&quot;</td>
</tr>
<tr>
<td>Percent of rooms with windows in one side</td>
<td>24</td>
<td>14</td>
<td>17</td>
<td>12</td>
<td>225</td>
<td>0</td>
<td>73</td>
<td>543</td>
<td>77</td>
</tr>
<tr>
<td>Percent of rooms with windows in two sides</td>
<td>47</td>
<td>72</td>
<td>63</td>
<td>75</td>
<td>927</td>
<td>456</td>
<td>225</td>
<td>104</td>
<td>157</td>
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<tr>
<td>Percent of rooms with windows in three sides</td>
<td>29</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>225</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No. rooms with skylights</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>86</td>
<td>53</td>
</tr>
<tr>
<td>No. rooms between rooms with windows in one side</td>
<td>7</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>3</td>
<td>44</td>
<td>72</td>
<td>44</td>
<td>153</td>
</tr>
<tr>
<td>No. arched windows</td>
<td>21</td>
<td>17</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>4</td>
<td>0</td>
<td>5</td>
<td>40</td>
</tr>
</tbody>
</table>
CHAPTER SIX
A BRIEF SUMMARY

The chief aim of this study is to give the reader a complete and accurate picture of the status of classroom window lighting from 1880 to 1927 inclusive, in the elementary public schools of Kansas City, Missouri. One hundred and three building projects, comprising more than eight hundred classrooms, are used as a basis for this study. All data were taken from actual measurements, made personally by the author, and the standards for comparison are those of prominent writers on classroom lighting.

The preceding comparative chart shows the general trend in lighting in periods of five years each, except the last period which is seven years. Comparisons can be made easily from this chart with the standards on page 18.

Upon making comparisons, one will find the following:

1. Kansas City elementary schools did not quite meet the one-to-five ratio of glass to floor area until the period of 1920-1927.

2. In the period of 1920-1927 the ratio of glass to floor area was one to three and six-tenths.

3. The average distance from the corners of the rooms to first windows did not meet the standards until 1910.

4. Windows have been well placed with relation to floor and ceiling throughout the whole period of study.

5. There has been a growing tendency to place all of the windows in one side of the room which is proper for best lighting.
In 1880, only twenty-four per cent of the rooms had windows in one side. Only one corner room, out of twenty-seven studied in 1880, was found having windows in one side, while eighty-two out of one-hundred-twenty-seven were found in the period of 1920 to 1927.

6. The average distance from the window side of the room to the opposite side has practically met the standard in all periods.

Upon the whole, we might make the general conclusion that the lighting of classrooms in the Kansas City, Missouri elementary schools closely approached the standards from 1880 until 1920. The classrooms of the last seven years practically meet the standards in every respect with the exception of unilateral lighting. Many corner rooms in the buildings of 1927 have windows in two sides. The tendency, however, as shown by the comparative chart, is in the favor of unilateral lighting of classrooms.
14. Hamlin, A.D.F. and Others Modern School Houses
15. Rowe, Stuart H. The Lighting of School Rooms, Longmans, Green, and Co. N.Y. 1904.
17. Bucx, Frances Williston and Jesse D. Health and School
18. McIsaac, Isabel, The Elements of Hygiene for Schools, Macmillan Company, N.Y.
SUGGESTED READINGS


