A SURVEY OF STUDENT LIGHTING CONDITIONS AT THE UNIVERSITY OF WISCONSIN

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In the present era of social reforms and programs to improve the welfare of man, too little attention has been paid to the lighting conditions and their relations to the eyes and eyesight. From the time of the caveman to the present day our eyes have remained much the same, yet the tasks of mankind are much more complicated and severe. History has shown, in the evolution of modern lighting from torches to the incandescent bulb, that people have always striven for better light, but without any definite idea of its importance. It has been only in the last two decades that the correlation between light, lighting conditions, the eyes and general welfare has been discovered and assumed its importance.

"Three things are necessary in order to see or use the eyes. They are: The eyes, the book and the light. No matter how good your eyes are, you cannot see in the dark. You must have light for seeing and the better the light the better you can see. This is the only thing you can change about seeing. You cannot change your eyes, although glasses generally help you to see better. You cannot change the things to see, but you can nearly always have better light."[1] In this age of specialization and concentration, the eyes are usually under constant strain unless near perfect conditions of lighting are observed. That this factor is of all importance may be realized by the fact that "on the average one grade school child in every five and two college students in every five suffer from defective vision."[2] Unless there is some congenital defect of the eyes or rarely at this age a disease of the eye that impairs eyesight, nearly all cases of defective vision may be traced, we believe, to the abuse of the vision in the

1. The Story of Light. General Electric Company, C6212, page 7.
2. Ibid, page 11.

form of eyestrain caused by poor lighting conditions. It may be that artificial light itself plays a part in causing eyestrain, but to date there has been no concrete evidence for such a belief, and no way to evaluate it if there is such a possibility.

Inadequate and improper illumination not only cause defective vision but lower ones efficiency. When one is concentrating on a lengthy task, under poor conditions of illumination, the eyes begin to smart and burn and the light and accomodation reflexes are continually in play to keep the eyes focused and adjusted to the light. These reflexes become overworked and then fatigued, the mind wanders from the work at hand, accurate attention is lacking, nervous tension and strain are increased and one cannot perform this task as rapidly and accurately as could be done under good light. Thus, it may be seen that proper light and the proper conditions of illumination play a necessary part, a part that is constantly increasing in importance in our modern life not only by the fact that the physical welfare of the individual, per se, may be injured by the resulting eyestrain, but the individual's efficiency and in turn economic relations may be altered.

Although there has been some attempt to improve lighting conditions, especially in some of the bigger corporations and in some schools, we believe that more attention should be directed to this problem in every walk of life. This may be borne out by casually inspecting our surroundings, as for example any business shop, elementary school, institutions of higher learning, churches and places of public assemblage. The condition of elementary schools, with the old fashioned methods of lighting, is especially apalling. Many not only make little attempt to have good artificial lighting

but do not try even to make good use of the natural lighting (observe the size and position of the windows). This statement is true even of the newer schools erected or being erected.

Economic conditions being what they are at the present time have, no doubt, played a part in the neglect of remedying this situation. However, much can be done to improve lighting conditions at little additional expense, as increasing the wattage (electricity being quite reasonable today), changing light shades, burning of more lights, increasing the number of lamps and particularly attempting to eliminate glare, both direct and indirect and the elimination of shadow. With a little ingenuity much can be done and the benefits received from improved lighting would be remarkable. It is the distribution of the light that is so all important for eye comfort and avoidance of eye strain. In other words, scientific lighting depends upon the amount of light, uniformity of illumination, contrast, direct and indirect glare.

The purpose of our work was an attempt to prove some of the above points in our own limited sphere, that is to study by quantitative as well as qualitative means the several methods of lighting that are in use. We believe that we have accomplished our aim. To that end we made a survey of approximately ten per cent of the rooms used for living and studying by the students at the University of Wisconsin. Some of the rooms surveyed were University and some privately owned. We hope that our work and its results will stimulate the interest of school authorities, house owners, students, and in short all those who are in a position to rectify the existing evils of lighting conditions.

The measuring instrument used was a General Electric Foot Candle Meter, Number 10911, furnished by Professor Royce Johnson of the Department of Electrical Engineering at this University, whose help we hereby gratefully acknowledge. There is presumably a slight refractive error in reading the meter, although the instrument in itself is capable of measuring degree of intensity in hundredths of foot-candles. We do not believe this error in judgment is large (not more than ten per cent) as we both took readings and found that we agreed within that limit.

The ensuing definitions and explanations are offered as an aid in following our method in rating the various lighting conditions found:

1. On recommendation of various authorities[1,2,3] we have accepted fifteen foot-candles as the minimum quantity of light needed for the work or book surface and one-tenth of the work-lighting as the minimum for general illumination.

2. Work surface (or book surface) light is the intensity in foot-candles at the point immediately in front of student on the desk at which his work ordinarily rests.

3. Desk surface light is the intensity in foot-candles or an arbitrarily chosen point on the desk surface farthest from the source of light. "For an equal gain in visual effort, the amount of light utilized by the eye follows the geometric ratio, that is equal increments of seeing

1. Kraehenbuel, J.O.: Investigation of Student Study Lighting, University of Illinois Bulletin, 60, March 26, 1937, p.10.
2. Luckiesh and Moss: Science of Seeing. 1938, page 334.
3. General Electric Company Pamphlet, C697, pages 16 and 17.

require twice the amount of light."[1]

4. General surface light is the average of intensity in foot-candles at a point five feet from the floor on the wall opposite that which student faces while studying, and at ten other points in the room.

5. Glare is any light reflected from a polished surface, mirrors, books, papers and any other material that reflects light. We had originally intended to try to measure direct glare, that is light from exposed light bulbs, but we found that the majority of students had compensated for this by too many different types of devices such as shades, reflectors, and other means, to permit a close approximation of an accurate objective evaluation of this factor.

We devised the following as a rating scale for determining the lighting conditions and the rating of study lamps used. The factors considered in computing the score or grade were:

1. Quantity of Light.

A. Book Surface.

1. A - 30 foot-candles or more
2. B - 25 to 29 foot-candles
3. C - 20-24 foot-candles
4. D - 15 to 19 foot-candles
5. E - B elow 15 foot-candles fails to meet minimum requirements.

1. Kraenhenbuel, J.O.: Investigation of Student Lighting, Univ. of Illinois Bulletin, 60, March 26, 1937, page 16.

B. Desk Surface - to determine the steps of illumination in distribution on the surface, the lowest value of illumination is multiplied by two and the result again by two, and so on until the highest value of illumination is reached. Every multiplication by two or a part thereof, used to reach the highest value of illumination will be called a step, and these steps are rated according to the following scale. 1

1. A..... one step or less
2. B..... 2 to 1.9 steps
3. C..... 3 to 2.9 steps
4. D..... 4 to 3.9 steps
5. E..... 5 to 4.9 steps
6. Zero..... more than five steps.

C. Wall Surface. It is advisable to have on the wall surface faced twenty per cent of the illumination measured on the book surface.

1. A..... 18 to 20 per cent of individual case
2. B..... 15 to 17 per cent of individual case
3. C..... 12 to 14 per cent of individual case
4. D..... 10 to 12 per cent of individual case
5. E..... Below 10 per cent.

II. Quality of Light.

A. Glare - indirect

1. A - no glare
2. B - Specular image, diffuse source
3. C - Specular image shows source clearly.

"These ratings are determined by observing the reflection in a mirror placed in position of textbook."[2]

1. Kraenhenbuel, J.O.: Investigation of Student Study Lighting, University of Illinois Bulletin, 60, March 26, 1937.
2. Ibid.

B. Shadow

1. A - no shadow
2. B - very diffuse shadow
3. C - pronounced shadow
4. D - Shadow with decided contrast

The University of Illinois' method for determining shadow was followed. A piece of board, painted white, was used as a base. A round polished rod one-quarter inch in diameter and eight inches long was placed upright in the center of base. This board was placed in the center of the textbook.

To determine the total room rating the letter ratings were converted into points using the following values:

1. A - 20 points
2. B - 15 points
3. C - 10 points
4. D - 5 points
5. E - 0 points.

A total of one hundred points represented the score of a perfect study room.

We have included here one of the data sheets that was used, the data on the units surveyed and the summary of the data. Each of the unit symbols refers to a specific residence, rooming house, or dormitory. The following abbreviations have been used in the data sheet:

1. G.N. - Gooseneck lamp
2. I.E.S. - Illuminating Engineering Society Lamp.

I. Unit surveyed:

II. Type of lamp used:

III. Wattage:
- A. Study Wattage
- B. Room Total

IV. Quantity of Light:
- A. Book surface
- B. Desk surface Wall surface
- C. General

V. Quality of Light:
- A. Glare
- B. Shadow

VI. Rating:
- A. Work Lighting
- B. General Lighting
- C. Room rating on basis of factors measured.

VII. Subjective findings:
- A. Glasses How long
- B. Itching
- C. Burning
- D. Miscellaneous

UNIT NUMBER

1. Type of Lamp
2. Location
3. Source
4. Wattage - used on book surface
5. Wattage -used in room while studying
6. Maximum Wattage - obtainable with all lights in room
7. Glare
8. Shadow
9. Work Lighting
10. General Lighting
11. Grades
12. Glasses Worn
13. Symptoms complained of while studying

1. Type of Lamp

19 G.N.
18 I.E.S.
2 semi-Ind.
4 Desk lamps
3 Floor Lamps
46

2. Location

26 at left of study position
14 at right of study position
6 in center of study position
46

3. Source

8 used more than one source of light

4. Wattage - used on book surface

1. used below 50 watts
20 used between 50 and 100 watts
16 used between 101 and 150 watts
1 used more than 150 watts
38

5. Wattage - used in room while studying

2 used less than 100 watts
28 used between 100 and 250 watts
8 used more than 250 watts
38

6. Maximum Wattage -obtainable with all light in.room.

1 had less than 100 watts
10 had between 100 -200 watts
15 had between 200-300 watts
11 had between 300-400 watts
1 had over 400 watts
38

7. Glare

17 had "A" glare
18 had "B" glare
3 had "C" glare
38

8. Shadow.

9 had "A" shadow
13 had "B" shadow
16 had "C" or more shadow
38

9. Work Lighting.

23 adequate
15 Inadequate
38

10. General Lighting

31 adequate
7 inadequate
38

11. Grades.

2 were graded A or A-
14 were graded B+,B and B-
20 were graded C+,C and C-
2 were graded D+, D or lower

12. Glasses worn

0 less than 2 years
3 two to five years
1 over five years

13. Symptoms Complained of while studying.

2 had itching of eyes
0 had burning of eyes
0 had headaches
2 had sense of fatigue.

UNIT B

1. Type of Lamp

14 G.N.
16 I.E.S.
8 Desk lamps
1 Ceiling light
1 Floor lamp
3 Semi-Ind.
1 Polaroid
44

2. Location

22 at left of study position
14 at right of study position
8 at center of study position
44

3. Source

5 used more than one source of light.

4. Wattage - used on book surface.

12 used less than 50 watts
23 used between 50-100 watts
3 used between 101-150 watts
1 used over 150 watts.
39

5. Wattage - used in room while studying

10 used 100 watts or less
22 used 100-250 watts
7 used over 250 watts
39

6. Maximum Wattage-obtaina ble with all lights in room.

3 had 100 watts or less
12 had 100-220 watts
10 had 201-300 watts
9 had 301-400 watts
5 had over 400 watts
39

7. Glare

22 had "A" glare
9 had "B" glare
8 had "C" glare or more
39

8. Shadow

9 had "A" shadow
14 had "B" shadow
16 had "C" shadow or more
39

9. Work Lighting

22 had adequate
19 inadequate
39

10. General Lighting

28 adequate
11 inadequate
39

11. Grades

3 were graded A or A-
16 were graded B+,B or B-
13 were graded C+,C or C-
7 were graded D+,D, or lower
39

12. Glasses worn

2 less than two years
4 two to five years
7 over five years

13. Symptoms complained of while studying

2 had itching of eyes
2 had burning of eyes
2 had headaches
3 had blurring of vision
1 had sense of fatigue.

UNIT Fav

1. Type of Lamp

17 G.N.
13 I.E.S.
1 Semi-Ind.
3 Desk lamps
1 Floor lamp
1 Ceiling lamp
36

2. Location

22 at left of study position
9 at right of study position
5 at center of study position
36

2. Source

4 used more than one source of light

4. Wattage - used on book surface.

7 used less than 50 watts
18 used 50-100 watts
4 used 101-150 watts
3 used over 150 watts
32

5. Wattage -used in room while studying

22 used less than 100 watts
9 used 101-250 watts
1 used over 250 watts
32

6. Maximum Wattage -obtainable with all lights in room

3 had 100 watts or less
17 had 101-200 watts
10 had 201-300 watts
2 had 301-400 watts
32

7. Glare

11 had "A" glare
7 had "B" glare
14 had "C" glare
32

8. Shadow

12 had "A" shadow
1 had "B" shadow
19 had "C" shadow
32

9. Work Lighting

20 Adequate
12 Inadequate
32

10. General Lighting

18 Adequate
14 Inadequate
32

11. Grades

2 were graded A or A-
9 were graded B+, B or B-
18 were graded C+, C or C-
3 were graded D+, D or lower
32

12. Glasses worn

1 less than two years
1 two to five years
1 over five years

13. Symptoms complained of while studying

1 had itching of eyes
2 had blurring of eyes
1 had headaches.

UNIT Fr.

1. Type of Lamp

21 G.N.
9 I.E.S.
2 Desk lamps
1 Semi-Ind.
1 Floor lamp
34

2. Location.

22 at left of study position
9 at right of study position
3 at center of study position
34

3. Source

3 used more than one source of light.

4. Wattage -used on book surface

8 used less than 50 watts
19 used between 50-100 watts
2 used between 100-150 watts
2 used more than 150 watts
31

5. Wattage

2 used less than 100 watts
28 used between 100-250 watts
1 used more than 250 watts
31

6. Maximum Wattage- obtainable with all lights in room

None had less than 100 watts
14 had between 100-200 watts
14 had between 200-300 watts
3 had between 300-400 watts.
31

7. Glare

15 had "A" glare
15 had "B " glare
1 had "C" glare
31

8. Shadow

5 had "A" shadow
10 had "B" shadow
16 had "C" shadow
31

9. Work Lighting.

20 adequate
11 inadequate
31

10. General Lighting

19 adequate
12 inadequate
31

11. Grades

2 were graded A or A-
10 were graded B+, B or B-
15 were graded C+, C or C-
3 were graded D+, D or lower
31

12. Glasses worn

None less than two years
1 two to five years
3 five years or more

13. Symptoms complained of while studying

2 had itching of eyes
2 had burning of eyes
4 had sense of fatigue
10 had headache.

UNIT G

1. Type of Lamp

29 G.N.
13 I.E.S.
1 Semi-ind.
43

2. Location

23 at left of study position
16 at right of study position
4 at center of study position
43

3. Source

3 used more than one source of light.

4. Wattage - used on book surface

3 used less than 50 watts
28 used between 50-100 watts
7 used between 101-150 watts
2 used more than 150 watts
40

5. Wattage - used in room while studying

9 used less than 100 watts
31 used between 100-250 watts
40

6. Maximum Wattage-obtainable with all lights in room

16 had between 100-200 watts
15 had between 200-300 watts
7 had between 300-400 watts
2 had over 400 watts
40

7. Glare

21 had "A" glare
15 had "B" glare
4 had "C" glare
40

8. Shadow

4 dad "A" shadow
15 had "B" shadow
21 had "C" shadow
40

9. Work Lighting

27 adequate
13 inadequate
40

10. General Lighting

20 adequate
20 inadequate
40

11. Grades

1 was graded "A"
11 were graded B+, B or B-
18 were graded C+, C or C-
10 were graded D+, D or less
40

12. Glasses worn

3 less than two years
3 two to five years
4 over five years

13. Symptoms complained of while studying

2 had itching of eyes
5 had burning of eyes
4 had sense of fatigue
4 had headaches

UNIT S

1. Type of Lamp

25 G.N.
4 I.E.S.
1 Desk lamp
1 Semi-Ind.
1 Wall lamp
1 Ceiling lamp
34

2. Location

21 at left of study position
6 at right of study position
7 at center of study position
34

3. Source

None used more than one source of light.

4. Wattage used on book surface

13 used less than 50 watts
17 used between 50-100 watts
1 used between 101-150 watts
3 used over 150 watts
34

5. Wattage used in room while studying.

3 used less than 100 watts
25 used between 100-250 watts
6 used more than 250 watts
34

6. Maximum wattage-obtainable with all lights in room.

1 had less than 100 watts
22 had less than 100-200 watts
4 had less than 201-300 watts
6 had over 400 watts
34

7. Glare

19 had "A" glare
9 had "B" glare
6 had "C" glare or more
34

8. Shadow

8 had "A" shadow
3 had "B" shadow
23 had "C" shadow
34

9. Work Lighting

16 adequate
18 Inadequate
34

10. General Lighting

24 Adequate
10 Inadequate
34

11. Grades

2 was graded A+, A or A-
19 were graded B+, B or B-
13 were graded D+, D or D-
34

12. Glasses worn.

3 less than two years
5 two to five years
4 more than five years

13. Symptoms complained of while studying

5 had itching of eyes
5 had burning of eyes
5 had sense of fatigue
1 had headaches.

1. Type of Lamp
17 G.N.
6 I.E.S.
2 Desk lamps
2 semi-ind.
27

2. Location
8 at right of study position
13 at left of study position
6 at center of study position
27

2. Source
Four used more than one source of light

4. Wattage used on book surface
5 used less than 50 watts
15 used between 50-100 watts
3 used between 101-150 watts
23

5. Wattage -used in room while studying.
16 used 100 watts or less
7 used 100-250 watts
23

6. Maximum wattage obtainable with all lights in room.
4 had 100 watts or less
11 had 101-200 watts
8 had 201-300 watts
23

7. Glare
9 had "A" glare
5 had "B" glare
9 had "C" glare or more
23

8. Shadow
7 had "A" shadow
6 had "B" shadow
10 had "C" shadow or more
23

9. Work Lighting
13 Adequate
10 Inadequate
23

10. General Lighting
13 Adequate
10 Inadequate
23

11. Grades
2 were graded A or A-
6 were graded B+, B or B-
12 were graded C+, C or C-
3 were graded D+, D or D-
23

12. Glasses worn
1 less than two years
1 two to five years

13. Symptoms complained of while studying

1 had itching of the eyes
2 had burning of the eyes
3 had sense of fatigue
4 had headaches.

UNIT V

1. Type of Lamp

14 G.N.
16 I.E.S.
2 Desk lamps
2 Semi-Ind.
34

2. Location

9 at right of study position
23 at left of study position
2 at center of study position
34

3. Source

2 used more than one source of light

4. Wattage - used on book surface

4 used less than 50 watts
19 used between 50-100 watts
9 used between 101-150 watts

5. Wattage used in room

3 used less than 100 watts
29 used between 100-250 watts
32

6. Maximum Wattage obtainable with all lights in room.

17 used 100-200 watts.
10 used between 201-300 watts
5 used between 301-400 watts
32

7. Glare

14 had "A" glare
16 had "B" glare
2 had "C" glare or more
32

8. Shadow

7 had "A" shadow
12 had "B" shadow
13 had "C" shadow or more
32

9. Work Lighting.

17 Adequate
15 Inadequate
32

10. General Lighting

29 Adequate
3 Inadequate
32

11. Grades

3 were graded A+, A or A-
13 were graded B+, B or B-
15 were graded C+, C or C-
1 was graded D+, D or lower
32

12. Glasses worn

2 two to five years
3 over five years

13. Symptoms complained of while studying

1 had headache.

UNIT F.A.

1. Type of Lamp

22 G.N.
8 I.E.S.
1 Desk lamp
2 Floor lamps
1 Semi-Ind.
1 Wall light
35

2. Location

22 at left of study position
10 at right of study position
3 at center of study position
35

3. Source

7 used more than one source of light.

4. Wattage used on book surface

18 used between 50-100 watts
3 used between 101-150 watts
5 used less than 100 watts
2 used more than 150 watts
28

5. Wattage used in room while studying.

2 used less than 100 watts
26 used less than 100-250 watts
28

6. Maximum Wattage -obtainable with all lights.

1 had less than 100 watts
15 had between 100-200 watts
10 had between 200-300 watts
2 had b etween 300-400 watts
28

7. Glare

12 had "A" glare
13 had "B" glare
3 had "C" or more glare
28

8. Shadow

5 had "A" shadow
5 had "B" shadow
18 had "C" shadow or more
28

9. Work Lighting

17 Adequate
11 Inadequate
28

10. General Lighting

20 Adequate
8 Inadequate
28

11. Grades

0 had A+, A or A-
10 had B+, B or B-
17 had C+, C or C-
1 had D+, D or D-
28

12. Glasses worn

1 from two to five years
1 over five years

13. No symptoms of eyestrain.

UNIT H

1. Type of Lamp

7 G.N.
13 I.E.S.
1 Desk Lamp
2 Semi-Ind.
1 Poaroid
24

2. Location

18 at left of study position
3 at right of study position
3 at center of study position
24

3. Source

None used more than one source of light.

4. Wattage - used on book surface

2 used 50 watts or less
18 used 50-100 watts
3 used 100-150 watts
1 used over 150 watts
24

5. Wattage -used for room while studying.

3 used 100 watts or less
19 used 100-200 watts
2 used 250-300 watts
24

6. Maximum Wattage obtainable with all lights in room.

13 had 101-200 watts
9 had 201-300 watts
2 had 301-400 watts
24

7. Glare

18 had "A" glare
5 had "B" glare
1 had "C" glare
24

8. Shadow

6 had "A" shadow
10 had "B" shadow
8 had "C" shadow mor more
24

9. Work Lighting

16 Adequate
8 Inadequate
24

10. General Lighting

16 Adequate
8 Inadequate
24

11. Grades

2 were graded A
17 were graded B+, B or B-
4 were graded C+, C or C-
1 were graded D
24

12. Glasses worn

4 less than two years
4 two to five years

13. Symptoms complained of while studying

2 itching of eyes
2 burning of eyes
2 headaches
2 sense of fatigue
3 photophobia.

UNIT L.F.

1. Type of Lamp

23 G.N.
11 I.E.S.
2 Semi-Ind.
1 Wall light
2 Desk lamps
1 Floor lamp
40

2. Location

23 at left of study position
12 at right of study position
5 at center of study position
40

3. Source

2 used more than one source of light.

4. Wattage - used on book surface

23 used between 50-100 watts
11 used between 101-150 watts
4 used between 150-200 watts
38

5. Wattage - used in room while studying.

5 used less than 100 watts
28 used between 100-250 watts
5 used more than 250 watts
38

6. Maximum Wattage - obtainable with all lights in room.

2 had 100 watts or less
21 had 100-200 watts
14 had 200-300 watts
1 had over 400 watts
38

7. Glare

20 had "A" glare
15 had "B" glare
3 had "C" glare
38

8. Shadow

6 had "A" shadow
13 had "B" shadow
19 had "C" shadow or more
38

9. Work Lighting

28 Adequate
10 Inadequate
38

10. General Lighting

32 Adequate
6 Inadequate
38

11. Grades

1 has graded A
19 were graded B+, B or B-
15 were graded C+, C or C-
3 were graded D or lower
38

12. Glasses worn

4 - less than two years
5 - two to five years
5 over five years

13. Symptoms complained of while studying

5- itching of eyes
7- burning of eyes
6- sense of fatigue
2- headaches

1. Type of Lamp
5 I.E.S.
28 G.N.
1 Semi-Ind.
1 Floor lamp
35

2. Location
20 at left of study position
12 at right of study position
3 at center of study position
35

3. Source
3 used other sources of light than the study lamp

4. Wattage - used on book surface
7 used less than 50 watts
19 used between 50-100 watts
4 used between 101-150 watts
2 used between 150-200 watts
32

5. Wattage used in room while studying.
12 used less than 100 watts
17 had between 100-250 watts
3 used over 250 watts
32

6. Maximum Wattage -obtainable with all lights in room.
2 had 100 watts or less
23 had 101-200 watts
4 had 201-330 watts
3 had 301-400 watts
32

7. Glare
9 had "A" glare
13 had "B" glare
10 had "C" glare
32

8. Shadow
6 had "A" shadow
2 had "B" shadow
24 had "C" shadow
32

9. Work Lighting
21 Adequate
11 Inadequate
32

10. General Lighting
19 Adequate
13 Inadequate
32

11. Grades
3 were graded A or A-
5 were graded B+, B or B-
18 were graded C+, C or C-
6 were graded D or lower
32

12. Glasses worn
1 - for more than five years.

13. No symptoms of eyestrain.

1. Type of Lamp.
6 I.E.S.
31 G.N.
1 Desk lamp
2 Semi-Ind.
40

2. Location
27 at left of study position
11 at right of study position
2 at center of study position
40

3. Source

None used more than one source of light.

4. Wattage used on book surface
19 used less than 50 watts
19 used between 50-100 watts
2 used more than 150 watts
40

5. Wattage - used in room while studying.
19 used less than 100 watts
19 used between 101-250 watts
2 had more than 250 watts
40

6. Maximum Wattage-obtainable with all light in room.
5 had 100 or less watts
25 had between 101-200 watts
8 had between 201-300 watts
1 had between 301-400 watts
1 had over 400 watts
40

7. Glare
18 had "A" glare
16 had "B" glare
6 had "C" glare
40

8. Shadow
5 had "A" shadow
9 had "B" shadow
26 had "C" shadow
40

9. Work Lighting
23 Adequate
17 Inadequate
40

10. General Lighting
21 Adequate
19 Inadequate
40

11. Grades
10 were graded B+, B or B-
25 were graded C+, C or C-
5 were graded D or lower
40

11. Glasses worn
3 - less than two years
3 - two to five years
3 - over five years

13. Symptoms complained of while studying
2 had itching eyes
4 had burning eyes
4 had sense of fatigue
3 had headaches.

UNIT R

1. Type of Lamp

11 I.E.S.
16 G.N.
3 Desk lamps
7 Semi-Ind.
37

2. Location

22 at left of study position
11 at right of study position
4 at center of study position
37

3. Source

4 used more than one source of light.

4. Wattage used on book surface

11 used less than 50 watts
18 used between 50-100 watts
3 used between 101-150 watts
1 used between 150-200 watts
33

5. Wattage used in room while studying.

22 used 100 or less watts
10 used between 101-250 watts
1 used more than 250 watts
33

6. Maximum Wattage -obtainable with all lights in room.

5 had 100 or less watts
13 had 101-200 watts
12 had 200-300 watts
3 had 300-400 watts
33

7. Glare

8 had "A" glare
19 had "B" glare
6 had "C" glare
33

8. Shadow

10 had "A" shadow
10 had "B" shadow
13 had "C" shadow
33

9. Work Lighting

20 Adequate
13 Inadequate
33

10. General Lighting

15 Adequate
18 Inadequate
33

11. Grades

4 were graded A or A-
8 were graded B+, B or B-
16 were graded C+, C or C-
5 were graded D or lower
33

12. Glasses worn

2 - less than two years
2 - two to five years

13. No symptoms of eyestrain.

1. Type of Lamp
- 9 I.E.S.
- 20 G.N.
- 1 Semi-Ind.
- 30

2. Location
- 19 at left of study position
- 6 at right of study position
- 5 at center of study position
- 30

3. Source
None used more than one source of light.

4. Wattage used on book surface
- 4 used less than 50 watts
- 21 used between 50-100 watts
- 4 used between 101-150 watts
- 1 used over 150 watts
- 30

5. Wattage -used in room while studying.
- 8 used less than 100 watts
- 22 used between 100-250 watts
- 30

6. Maximum Wattage-obtainable with all lights in room.
- 3 had 100 watts or less
- 19 had 100-200 watts
- 7 had 200-300 watts
- 1 had 350 watts
- 30

7. Glare
- 18 had "A" glare
- 10 had "B" glare
- 2 had "C" glare
- 30

8. Shadow
- 6 had "A" shadow
- 6 had "B" shadow
- 18 had "C" shadow
- 30

9. Work Lighting
- 26 Adequate
- 4 Inadequate
- 30

10. General Lighting
- 19 Adequate
- 11 Inadequate
- 30

11. Grades
- 3 were graded A or A-
- 15 were graded B+, B or B-
- 11 were graded C+, C or C-
- 1 was graded D
- 30

12. Glasses worn
- 3 - less than two years
- 1 - two to five years

13. Symptoms complained of while studying
- 2 - itching of eyes
- 2 - burning of eyes
- 2 - sense of fatigue
- 2 - headaches.

UNIT T

1. Type of Lamp

12 I.E.S.
29 G.N.
3 Desk lamps
1 Semi-Ind.
45

2. Location

31 at left of study position
12 at right of study position
2 at center of study position
45

3. Source

5 used more than one source of light.

4. Wattage - used on book surface

11 used 50 watts or less
26 used 50-100 watts
1 used 100-150 watts
2 used 150-200 watts
40

5. Wattage - used in room while studying.

16 used 100 watts or less
24 used 100-250 watts
40

6. Maximum Wattage -obtainable with all lights in room.

3 had 100 watts or less
18 had 100-200 watts
15 had 201-300 watts
2 had 300-400 watts
2 had over 400 watts
40

7. Work Lighting

24 Adequate
16 Inadequate
40

8. General Lighting

22 Adequate
18 Inadequate
40

9. Glare

20 had "A" glare
9 had "B" glare
11 had "C" glare
40

10. Shadow

8 had "A" shadow
5 had "B" shadow
27 had "C" shadow
40

11. Grades

1 was graded A
13 were graded B+, B or B-
22 were graded C+,C or C-
4 were graded D+, D or lower
40

12. Glasses worn

2 - less than two years
3 - two to five years
2 - over five years

13. No symtoms of eyestrain.

UNIT A

1. Type of Lamp

81 I.E.S.
6 G.N.
2 Floor lamps
1 Desk lamp
90

2. Location

22 at left of study position
14 at right of study position
54 at center of study position
90

3. Source

6 used more than one source of light.

4. Wattage - used on book surface

75 used between 50-100 watts
2 used between 100-150 watts
7 used over 150 watts

84

5. Wattage - used in room while studying.

28 used less than 100 watts
50 used between 100-250 watts
6 used over 250 watts
84

6. Maximum Wattage - obtainable with all lights in room.

2 had between 100-200 watts
58 had between 201-300 watts
24 had between 301-400 watts
84

7. Glare

71 had "A" glare
10 had "B" glare
3 had "C" glare
84

8. Shadow

43 had "A" shadow
36 had "B" shadow
5 had "C" shadow or more
84

9. Work Lighting

62 Adequate
22 Inadequate
84

10. General Lighting

62 Adequate
22 Inadequate
84

11. Grades

5 were graded A or A-
58 were graded B+,B or B-
21 were graded C+, C or C-
84

12. Glasses worn

3 - less than two years
2 - two to five years
1 - over five years

13. Symptoms complained of while studying

1 had itching of eyes
1 had burning of eyes

UNIT B

1. Type of Lamp

3 had goosenecks
82 had I.E.S. lamps
1 floor lamp
86

2. Location

28 at left of study position
20 at right of study position
38 at center of study position
86

3. Source

4 used more than one source of light

4. Wattage - used on book surface

1 used less than 50 watts
78 used between 50-100 watts
3 used over 150 watts
82

5. Wattage used in room while studying

38 used less than 100 watts
42 used between 100-150 watts
2 used over 250 watts
82

6. Maximum Wattage, obtainable with all lights in room.

7 had between 100-200 watts
59 had between 201-300 watts
14 had b etween 301-400 watts
2 had used over 400 watts
82

7. Glare

66 had "A" glare
12 had "B" glare
4 had "C" glare
82

8. Shadow

42 had "A" shadow
33 had "B" shadow
7 had "C" shadow
82

9. Work Lighting

58 Adequate
24 Inadequate
82

10. General Lighting

39 Adequate
43 Inadequate
82

11. Grades

4 were graded A or A-
48 were graded B+, B or B-
23 were graded C+, C or C-
7 were graded D+, D or lower
82

12. Glasses worn

1 - from two to five years
2 - over five years

13. Symptoms complained of while studying

3 had itching of the eyes
2 had burning of the eyes

UNIT C

1. Type of Lamp

3 had Goosenecks
77 had I.E.S.
2 had ceiling lights only
1 had Semi-Indirect
83

2. Location

18 at left of study position
9 at right of study position
56 at center of study position
83

3. Source

5 used more than one source of light

4. Wattage used on book surface

73 used between 50-100 watts
3 used between 101-150 watts
2 used over 150 watts
78

5. Wattage used in room while studying.

47 used less than 100 watts
29 used between 101-250 watts
2 had over 250 watts
78

6. Maximum Wattage - obtainable with all lights in room.

4 had between 100-200 watts
60 had between 201-300 watts
12 had between 301-400 watts
2 had over 400 watts
78

7. Glare

59 had "A" glare
14 had "B" glare
5 had "C" glare
78

8. Shadow

50 had "A" shadow
24 had "B" shadow
4 had "C" shadow
78

9. Work Lighting

75 had Adequate
3 Inadequate
78

10. General Lighting

77 Adequate
1 Inadequate
78

11. Grades

29 were graded A or A-
46 were graded B+, B or B-
3 were graded C+, C or C-
78

12. Glasses worn

2 - less than two years
1 - two to five years
3 - over five years

13. No symptoms of eyestrain.

UNIT Y

1. Type of Lamp

34 Goosenecks
48 had I.E.S.
34 ceiling lights
18 Desk lamps
6 Wall brackets
6 Semi-Ind.
3 Floor lamps
149

2. Location

74 at left of study position
26 at right of study position
49 at center of study position
149

3. Source

18 used more than one source for work lighting.

4. Wattage used on book surface

55 used less than 50 watts
57 used between 50-100 watts
12 used between 101-150 watts
7 used over 150 watts
131

5. Wattage used in room while studying.

19 used less than 100 watts
92 used between 100-250 watts
20 used over 250 watts
131

6. Maximum Wattage obtainable with all lights in room

23 had between 1 00-200 watts
72 had between 201-300 watts
32 had between 301-400 watts
4 had over 500 watts
131

7. Glare

61 had "A" glare
39 had "B" glare
31 had "C" glare
131

8. Shadow

45 had "A" shadow
25 had "B" shadow
61 had "C" shadow
131

9. Work Lighting

74 had Adequate
57 Inadequate
131

10. General Lighting

43 Adequate
88 Inadequate
131

11. Grades

2 were graded A or A-
30 were graded B+,B or B-
57 were graded C+, C or C-
42 were graded D+, D or lower
131

12. Glasses Worn

11 - less than two years
12 - two to five years
16 - over five years

13. Symptoms complained of while studying

10 had itching of eyes
10 had burning of eyes
4 had headaches
3 had tiring of eyes
2 had blurring of vision.

UNIT AA

1. Type of Lamp

62 had I.E.S. lamps
3 Desk lamps
2 had floor lamps
1 Semi-Indirect
1 wall bracket
69

2. Location

46 at left of study position
20 at right of study position
3 at center of study position
69

3. Source

2 used more than one source of light.

4. Wattage used on book surface

2 used less than 50 watts
58 used between 50-100 watts
6 used between 100-150 watts
1 used over 150 watts
67

5. Wattage used in room while studying.

12 used less than 100 watts
54 used between 100-250 watts
1 used over 250 watts
67

6. Maximum Wattage obtainable with all lights in room.

12 had b etween 100-200 watts
50 had between 201-300 watts
5 had between 301-400 watts
67

7. Glare

57 had "A" glare
8 had "B" glare
2 had "C" glare
67

8. Shadow

47 had "A" shadow
13 had "B " shadow
7 had "C" shadow
67

9. Work Lighting

55 Adequate
12 Inadequate
67

10. General Lighting

63 Adequate
4 Inadequate
67

11. Grades

2 were graded A or A-
58 were graded B+, B or B-
5 were graded C+, C or C-
2 were graded D+, D or lower
67

12. Glasses worn

1 - two to five years
1 - over five years

13. No symptoms of eyestrain

1. Type of Lamp
24 I.E.S.
1 Floor lamp
25

2. Location
1 at left of study position
1 at right of study position
23 at center of study position
25

3. Source
None used more than one source of light.

4. Wattage used on book surface
25 used between 50-100 watts

5. Wattage used in room while studying.
10 used 100 watts
15 used 101-250 watts
25

6. Maximum Wattage obtainable with all lights in room.
12 had between 100-200 watts
10 had between 201-300 watts
3 had over 300 watts
25

7. Glare
25 had "A" glare

8. Shadow
12 had "A" shadow
11 had "B" shadow
2 had "C" shadow
25

9. Work Lighting
19 Adequate
6 Inadequate
25

10. General Lighting
15 Adequate
10 Inadequate
25

11. Grades
19 were graded B+, B or B-
6 were graded C+, C or C-
25

12. Glasses worn
0

13. No symptoms of eyestrain.

UNIT Ho

1. Type of Lamp

23 I.E.S.
4 G.N.
2 Desk lamps
29

2. Location

6 at left of study position
4 at right of study position
19 at center of study position
29

3. Source

3 used more than one source of light

4. Wattage used on book surface

25 used between 50-100 watts
1 used between 100-150 watts
26

5. Wattage used in room while studying.

6 used less than 100 watts
16 used between 101-250 watts
4 used over 250 watts
26

6. Maximum Wattage obtainable with all lights in room.

13 had between 101-200 watts
6 had between 201-300 watts
7 had between 301-440 watts
26

7. Glare

22 had "A" glare
4 had "B" glare
26

8. Shadow

7 had "A" shadow
14 had "B" shadow
5 had "C" shadow
26

9. Work Lighting

14 Adequate
8 12 Inadequate
26

10. General Lighting

17 Adequate
9 Inadequate
26

11. Grades

10 were graded B+,B or B-
14 were graded C+, C or C-
2 were graded D+ and D
26

12. Glasses worn

o wore glasses

13. No symptoms of eyestrain.

1. Type of Lamp
25 I.E.S.
1 G.N.
1 Desk Lamp
27

2. Location
11 at left of study position
7 at right of study position
9 at center of study position
27

3. Source
None used more than one source of light

4. Wattage used on book surface
2 used less than 50 watts
23 used between 50-100 watts
2 used between 101-250 watts
27

5. Wattage used in room while studying.
5 used less than 100 watts
14 used between 101-250 watts
8 used between 250-350 wtts
27

6. Maximum Wattage obtainable with all lights in room.
6 had between 100-200 watts
21 had between 201-300 watts
27

7. Glare
27 had "A" glare

8. Shadow
6 had "A" shadow
18 had "B" shadow
3 had "C" shadow or more
27

9. Work lighting
9 Adequate
18 Inadequate
27

10. General Lighting
17 Adequate
10 Inadequate
27

11. Grades
19 were graded B+, B or B -
6 were graded C+, C or C-
2 were graded D+ or D
27

12. Glasses worn
None wore glasses

13. No symptoms of eyestrain

UNIT S.T.

1. Type of Lamp
19 I.E.S.
4 G.N.
23

2. Location
4 at left of study position
3 at right of study position
16 at center of study position
23

3. Source
2 used more than one source of light.

4. Wattage used on book surface
2 used less than 50 watts
19 used between 50-100 watts
21

5. Wattage used in room while studying.
2 used less than 100 watts
17 used between 100-250 watts
2 used between 250-300 watts
21

6. Maximum Wattage obtainable with all lights in room.
13 used between 100-200 watts
8 used between 201-300 watts
21

7. Glare
17 had "A" glare
1 had "B" glare
3 had "C" glare
21

8. Shadow
5 had "A" shadow
12 had "B" shadow
4 had "C" shadow
21

9. Work Lighting
8 Adequate
13 Inadequate
21

10. General Lighting
18 Adequate
3 Inadequate
21

11. Grades
10 were graded B+, B or B-
10 were graded C+, C or C-
1 was graded D
21

12. Glasses worn
0 wore glasses

13. No symptoms of eyestrain.

UNIT M

1. Type of Lamp

19 I.E.S.
1 G.N.
20

2. Location

4 at left of study position
4 at right of study position
12 at center of study position
20

3. Source

None used more than one source of light.

4. Wattage used on book surface

1 used less than 50 watts
19 used between 50-100 watts
20

5. Wattage used in room while studying

2 used less than 100 watts
17 used between 101-200 watts
1 used over 250 watts
20

6. Maximum Wattage obtainable with all lights in room.

3 had between 101-200 watts
14 had between 201-300 watts
2 had between 301-400 watts
1 used over 400 watts
20

7. Glare

19 had "A" glare
1 had "B" glare
20

8. Shadow

12 had "A" shadow
7 had "B" shadow
1 had "C" shadow
20

9. Work Lighting

14 Adequate
6 Inadequate
20

10. General Lighting

13 Adequate
7 Inadequate
20

11. Grades

1 was graded A
11 were graded B+, B or B-
8 were graded C+, C or C-
20

12. Glasses worn

1 - less than two years
4 - two to five years

13. No symptoms of eyestrain

UNIT Fi

1. Type of Lamp

7 G.N.
3 I.E.S.
3 Wall brackets
3 Semi-Ind.
1 Desk lamp
17

2. Location

12 at left of study position
4 at right of study position
1 at center of study position
17

3. Source

1 used more than one source of light.

4. Wattage used on book surface

1 used less than 50 watts
14 used between 50-100 watts
1 used between 100-150 watts
16

5. Wattage used in room while studying.

1 used less than 100 watts
15 used between 101-250 watts
16

6. Maximum Wattage obtainable with all lights in room.

10 had between 100-200 watts
3 had between 201-300 watts
3 had between 301-400 watts
16

7. Glare'

4 had "A" glare
4 had "B" glare
8 had "C" glare
16

8. Shadow

5 had "A" shadow
11 had "C" shadow or more
16

9. Work Lighting

8 Adequate
8 Inadequate
16

10. General Lighting

6 adequate
10 Inadequate
16

11. Grades

1 was graded A
3 were graded B+, B or B-
9 were graded C+, C or C-
3 were graded D or lower
16

12. Glasses Worn

1 less than 2 years
2 two to five years

13. Symptoms complained of while studying

3 had itching of eyes
2 had burning of eyes
4 had headaches
2 had sense of fatigue.

SUMMARY

1. Type of Lamp

632 I.E.S.
396 Goose Necks
56 Desk Lamps
41 Semi-Indirect
40 Ceiling Lights
22 Floor lamps
13 Wall brackets
2 Polaroid
1202

2. Location

580 at left of study position
274 at right of study position
348 at center of study position
1202

3. 1202 locations but only 1111 study light units. 91 used more than one source of light.

4. Wattage used on book surface

284 used 50 watts or less
694 used 50-100 watts
89 used 101-150 watts
44 used over 150 watts
1111

5. Wattage used in room while studying.

493 used 100 watts or less
539 used 101-250 watts
79 used more than 250 watts
1111

6. Maximum Wattage obtainable with all lights in room.

29 used less than 100 watts
364 used 101-200 watts
526 used 201-300 watts
163 used 301-400 watts
29 used over 400 watts
1111

7. Glare

673 had "A" glare
286 had "B" glare
152 had "C" glare
1111

8. Shadow

387 had "A" shadow
327 had "B" shadow
397 had "C" shadow
1111

9. Work Lighting

727 Adequate
384 Inadequate
1111

10. General Lighting

717 Adequate
394 Inadequate
1111

11. Grades

75 had grade of A or A-
507 had grade of B+, B or B-
404 had grade of C+, C or C-
125 had grade of D+, D or lower
1111

12. Glasses Worn

37 - less than two years
53 - between two to five years
68 - over five years
158

13. Symptoms complained of while studying

43 burning of eyes
42 itching of eyes
32 sense of fatigue
22 headaches
5 blurring of eyes
2 photophobia
1 chronic conjunctivitis
1 dizziness

1. Of the 632 I.E.S. lamps found the wattage used was:

1	used a wattage of 50
17	used a wattage of 60
6	used a wattage of 75
531	used a wattage of 100
8	used a wattage of 125
2	used a wattage of 140
65	used a watt age of 150
2	used a wattage over 150
632	

The grades were:

72	had "A" rating
419	had "B" rating
129	had "C" rating
12	had "D" rating
632	

2. Of the 396 Goose Necks found The wattage used was

1	used 25
131	used 40
18	used 50
201	used 60
6	used 75
5	used 80
19	used 100
15	used over 100
396	

The grades were:

1	had "A" rating
79	had "B " rating
234	had "C" rating
82	had "D" rating

3. Of the 56 Desk Lamps found, the wattage used was

2	used 25
27	used 40
11	used 50
12	used 60
3	used 100
1	used over 100
56	

The grades were:

0	had "A" rating
4	had "B" rating
27	had "C" rating
25	had "D" rating
56	

4. Of the 40 Ceiling lights found, the wattage used was

1	used 25
23	used 50
9	used 60
2	used 95
3	used 100
2	used over 100
40	

The grades were:

0	had "A" rating
8	had "B" rating
20	had "C" rating
12	had "D" rating
40	

5. Of the 41 Semi-Indirect lights found, the wattage used was

2	used 40
3	used 50
17	used 60
17	used 100
1	used 150
1	used over 150
41	

The grades were:

1	had "A" rating
19	had "B" rating
20	had "C" rating
1	had "D" rating
41	

6. Of the 22 Floor Lamps used

the wattage used was	The grades were:
2 used 40	0 had "A" rating
3 used 50	6 had "B" rating
8 used 60	11 had "C" rating
2 used 75	5 had "D" rating
1 used 90	22
2 used 100	
4 used over 100	
22	

7. Of the 13 Wall Brackets used

the wattage used was	The grades were:
4 used 40	0 had "A" rating
4 used 50	9 had "B" rating
4 used 60	4 had "D" rating
1 used 90	13
13	

8. There were two polaroids found, each using 100 watts and both getting a grade of "C".

9. Of the 1202 light fixtures found -

632	or	52.58%	were I.E.S.
396	or	32.94%	were Goosenecks
56	or	4.65%	were Desk lamps
40	or	3.32%	were Ceiling Lights
41	or	3.41%	were Semi-Indirect
22	or	1.83%	were Floor lamps
13	or	1.08%	were Wall Brackets
2	or	0.16%	were polaroid lights
1202	or	99.97%	

10. Of the 1111 study units graded -

75	or	6.75%	had A
507	or	45.63%	had B
404	or	36.36%	had C
125	or	11.25%	had D
1111		99.99%	

11. It is of interest to note that there were almost again as many I.E.S. lamps as Goose-necks.

Of the 632 I.E.S. Units				Of the 396 Goose-Necks			
72	or	11.07%	received "A"	1	or	.29%	had "A"
419	or	66.29%	received "B"	79	or	19.95%	had "B"
129	or	20.41%	received "C"	234	or	59.09%	had "C"
12	or	1.89%	received "D"	82	or	20.70%	had "D"
632		99.66%		396		99.98%	

12. Of the 56 Desk Lamps

0	or	0%	had "A" rating
4	or	7.14%	had "B" rating
27	or	48.21%	had "C" rating
25	or	44.64%	had "D" rating
56		99.99%	

13. Of the 41 Semi-Indirect Fixtures

1	or	2.43%	had "A" rating
19	or	46.34%	had "B" rating
20	or	48.78%	had "C" rating
1	or	2.43%	had "D" rating
41	or	99.98%	

14. Of the 40 Ceiling Fixtures

0	or	0%	had "A" rating
8	or	20.00%	had "B" rating
20	or	50%	had "C" rating
12	or	30%	had "D" rating
40		100%	

15. Of the 22 Floor Lamps

0	or		had "A" rating
6	or	27.27%	had "B" rating
11	or	50%	had "C" rating
5	or	22.72%	had "D" rating
22		99.99%	

16. Of the 13 Wall Brackets

None	had	"A"	rating
None	had	"B"	rating
9	or	69.23%	had "C" rating
n4	or	30.76%	had "D" rating
13		99.99%	

17. Of the two Polaroids both or 100% had a "C" rating

SUMMARY

On summarizing the facts obtained, we feel that the following observations are of special interest.

1. It was found that 65.5 per cent of the students had an average illumination of 15 foot-candles on the work surface, while 34.5 per cent fell below the minimum requirements. Of the 65.5 per cent of students with an adequate amount of light on the work surface (minimum requirement 15 foot-candles), 20 per cent had an illumination of 30 foot-candles or better; 28 per cent had an illumination of 25 foot-candles or better; 30 per cent had an illumination between 20 and 25 foot-candles; 22 per cent had an illumination between 15 and 20 foot-candles.

2. It was found that while only 22.4 per cent of the desks or tables used to study had a glossy surface, 39.4 per cent of the surfaces reflected specular images. This brings out the fact that even though a surface may appear satisfactory, it still may be a source of glare.

3. It was found that 34.9 per cent of the lighting plans used were free from shadow, while 65.1 per cent caused definite shadowing on the book surface.

4. Most students placed their study lamps to the left of the work surface (52.4 per cent). The center position was next favored (31.6 per cent) with the right position least chosen (15 per cent).

5. The Committee of the Illuminating Engineering Society has found that a height of approximately 25 inches, with proper lighting equipment, will provide the most nearly satisfactory uniform diffusion of light over the work

surface. We found that 34.6 per cent of the students had light sources closer to the work surface.

6. The wall surface illumination is important in that when the student glances up, the light and accomodation reflexes are constantly adjusting the eyes to the changes in intensity of the light. In respect of this factor, then, it is desirable to have from 10-20 per cent as much illumination on the wall surface faced as there is on the work surface. It was found that 52.3 per cent of the wall surfaces had the necessary proportion of illumination, while 47.7 per cent did not come within even the minimum requirements.

7. According to the standards of the Illuminating Engineering Society, the general lighting of the room should be at least 10 per cent of the work surface illumination. It was determined that 35.3 per cent of the rooms examined failed to meet the requirement.

8. It was found that approximately 100 watts per study lamp would illuminate a study position properly, all things being equal. 25.4 per cent of the students used 50 watts or less, 62.4 per cent used between 50 and 100 watts (48 per cent burned just a 50 watt globe and 52 per cent more than 50 watts).

9. It was found that 44.4 per cent of the rooms burned a total wattage of 100 watts or less while studying, 48.4 per cent burned between 101 and 250 watts, and 7.2 per cent used more than 250 watts.

10. The maximum wattage in each room was determined, even though it was not

utilized. 2.5 per cent had less than a total of 100 watts, 32.8 per cent had a total between 101 and 200 watts, 47.7 per cent had a total between 201 and 300 watts, 14.5 per cent had a total between 301 and 400 watts, and 2.5 per cent had a total of over 400 watts. It may be seen from these figures that the majority of students have sufficient wattage, although it may not be in use, to help properly light their rooms.

11. After all factors were weighed, the rooms surveyed were graded. 6.75 per cent of the rooms were graded "A", perfect or near perfect illumination according to our methods of weighing the factors of proper lighting; 45.63 per cent were graded "B", representing good adequate conditions of illumination; 36.36 per cent were graded "C", representing only fair conditions of illumination and just compatible for study with the resulting possibility of eyestrain; 11.25 per cent were graded "D" or lower, representing poor requirement for adequate illumination and not compatible for study conditions.

12. We believe, as a result of this investigation, that the statement made by Luckiesh and Mass "the quality of lighting is even more important than the quantity of light" is a very good one. For if one notes the results given above that while the quantity of light and the minimum number of foot-candles for proper lighting was adequate in the majority of cases, the quality of lighting in the form of uniformity of illumination, glare and shadow was not up to standard requirements. This factor lowered the ranking given each room on its total grading measurably.

13. It was found that students and the persons in charge of the student residencies are getting "light conscious" apparently, for of the total

number of rooms and lighting equipment surveyed, 632 or 52.58 per cent were furnished with I.E.S. lamps. Of these I.E.S. lamps, 11.07 per cent received "A" ratings; 66.29 per cent "B" ratings, 20.41 per cent "C" ratings and 1.89 per cent "D" ratings. The lower grades received by these lamps may be largely attributed to the inadequate wattage burned and the improper position of lamps and particularly to reflected glare and in some cases shadow.

14. 396 or 32.94 per cent of the rooms examined had goose-neck lamps for lighting equipment. Of these units 29 per cent were graded "A", 19.95 per cent "B", 59.09 per cent "C" and 20.7 per cent "D". While a goose-neck lamp with even a bulb of low wattage (25 watts) will give adequate work surface illumination, it fails miserably without adjustments to meet the standards of uniformity of illumination.

15. 56 or 4.65 per cent of the rooms used desk lamps. Of these lamps none received an "A" rating, 46.34 per cent "B", 48.78 per cent "C" and 2.43 per cent "D".

16. 41 rooms or 2.43 per cent used semi-indirect lamps. Of these lamps 2.43 per cent received "A" rating, 46.34 per cent "B", 48.78 per cent "C" and 2.43 per cent "D".

17. 40 rooms or 3.32 per cent used ceiling lights as the source of light for work surface illumination. Of these none received an "A" rating, 20 per cent were graded "B", 50 per cent "C" and 30 per cent "D".

18. 22 rooms or 1.83 per cent used floor lamps as study equipment. Of these none were graded "A", 27.2 per cent received "B", 50 per cent "C" and 22.72 per cent "D".

19. 13 rooms or 1.68 per cent had wall brackets as a source of light. Of these none received an "A" rating or "B" rating, 69.23 per cent were graded "C" and 30.76 per cent "D".

20. Two rooms or 0.16 per cent used polaroid lights. Both received only a "C" rating.

21. Many of these rooms surv eyed were unoccupied while we were working, so it was impossible to gain an accurate total as to the number of students wearing glasses or having symptoms of eyestrain while studying. Those noted on the foregoing records were persons actually met and questioned as to these factors.

RECOMMENDATIONS

In some of the units surveyed, the desks or tables used for study had polished green-topped surfaces which proved to be an irritating source of glare. This may be overcome by using gray blotters on the desks.

Some of the units were equipped with I.E.S. lamps, but in some instances one I.E.S. lamp was made to suffice for two desks. This resulted in inadequate lighting for both surfaces. Possibly higher wattages would help in those cases. In other instances, the tops of the I.E.S. lamps were shaded with cardboard. This materially reduced the efficiency of the lights. In still other instances I.E.S. lamps were furnished but with instructions not to use the 100-150 watt globe ordinarily used in them. Also in a few cases I.E.S. were furnished but not used.

As far as direct glare was concerned most students met the problem

by use of shades and reflectors. However, the incidence of indirect or reflected glare was quite prevalent.

CONCLUSIONS

While we freely admit the danger inherent in drawing conclusions from statistics and generalities, we believe the foregoing figures reveal several items of interest. We conclude from this study that proper lighting can be obtained by observing the following factors:

1. One should use at least a 100 watt bulb as the source of work surface light.
2. The lamp should be 25-30 inches from the surface of desk and in the center position to avoid shadow.
3. There should be uniformity of illumination over the entire desk surface.
4. The wall surface faced should have at least 10 per cent and preferably 20 per cent of the work surface illumination.
5. The general lighting of the room should be at least 10 per cent of the work lighting.
6. All sources of direct glare should be eliminated and reflected glare kept to the minimum.

While we are not advocating the universal use of I.E.S. lamps, we believe that they are the easiest and most certain means to meet the requirements that go to make up proper illumination, namely the quantity of light and quality of lighting.

We may say in a general way that the average university student uses either an I.E.S. lamp or a goose-neck lamp and only one source of light for his book surface. He uses a bulb of an intensity between 50 and 100 watts in this fixture, but will be burning enough lamps in the room while studying to consume between 100 and 250 watts.

We think that all attempts to promote proper illumination should be centered on the quality of lighting for the quantity of light seems in the majority of instances to meet the minimal requirements.

We do not conclude that itching, burning of the eyes, photophobia and headaches are necessarily symptoms of eyestrain due to improper illumination, because other factors such as the personal element, ventilation and heating must be considered in making any such evaluation.

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(by J. O. Kraehenbuehl, author).

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