AN EXPERIMENTAL STUDY TO DETERMINE IF NINTH GRADE STANDARDIZED ALGEBRA TESTS CAN BE USED TO MEASURE FATIGUE

by

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CHAPTER I

INTRODUCTION

This experimental study of the measurement of fatigue by the use of Standardized Algebra Tests was conceived by the author, then a classroom teacher, teaching High School Mathematics in the Morenci High School, for the sole purpose of trying to establish positive proof that there is or is not an evidence of fatigue or at least of a reliable difference between the achievement of early morning and late afternoon classes in high school algebra. To study this question the entire group was tested, paired, alternated six times in the hour schedule and tested on a cumulative basis.

The Problem and Definition of Terms

For many years Standardized Algebra Tests have been used: (1) to determine by the use of an ability test if ninth grade pupils are capable of successfully completing algebra if allowed to pursue the subject, (2) to compare the standing of any ninth grade group with National Norms and, (3) for diagnostic and remedial purposes.

The purpose of this study is not to get the information or results stated above, but rather to discover, first, whether or not classes in algebra would make different growth in algebraic achievement if they were taught the subject in the first hour rather than in the last hour of the day; and, second, whether or not fatigue (mental or bodily) could be indirectly measured by such a study. The author felt that this was important and planned the study for the purpose of finding answers to the first and second questions stated above.

Fatigue as defined in the Encyclopaedia Britannica is a condition of mind resulting from prolonged mental activity. It is characterized by an increasing inability to pay attention to things, failing memory, and inability to think. Fatigue can be tested by two methods, direct and indirect, the application to the person himself by some standardized test or the measurement of some existing phenomenon indicative of or susceptible to the presence of fatigue.

Fatigue in the dictionary of Philosophy and Psychology is defined as a qualitative state following upon continued mental activity which varies with each different function exercised and with the degree of mental concentration used. In experimentation, it is indicated by a steady decrease in delicacy of perception and readiness of judgment and is characterized by: (1) a weakening of attention, and (2) a diminished capacity of reproduction.

The term fatigue is used in this study to mean the loss of class growth in performance as shown by the results of standardized algebra tests.

CHAPTER II

A REVIEW OF STUDIES IN FATIGUE

Studies by Noted Psychologists and Educators

Many psychologists and educators have made studies of fatigue and some have found definite relations between poor school work and fatigue, while some have found no relation at all, or if any, so small an amount that no conclusive claim could be established, from the facts obtained, that fatigue as such enters into the picture of good or poor work in school subjects. Skinner, Gast and Skinner[1] define fatigue as a term used to denote the decreased capacity to perform work caused by work. Every activity tends to diminish capacity but also gives increased inefficiency for the same sort of activity; that is, practice and fatigue may be regarded as always present and always opposed. When work first starts, there is an increase in efficiency up to a certain point after which there are diminished returns for the amount of energy expended. The effect of practice seems to continue for long periods of time, while the effects of fatigue are generally of short duration. The attitude of the learner, or his purpose, plays an important part in the fatigue curve. The

1. Skinner, Gast and Skinner, Readings in Educational Psychology, Chapter XX.

individual who is working for himself, apparently, will not become fatigued as quickly as the individual who is working for someone else. Indeed it is very difficult to separate lassitude and ennui from fatigue. The psychologist observes three results from fatigue. In the first place, fatigue produces toxins in the blood which seriously interfere with the individual's efficiency; secondly, fatigue is characterized by the accumulation of certain waste products in the muscles; and thirdly, fatigue is thought to produce certain changes in the nucleus of brain cells. In view of these facts, it is evident that fatigue, whether physical or mental, is very real. On the other hand, it is very seldom that an individual in good health will suffer from fatigue produced by overwork. It is now believed by many uthorities that children seldom, if ever, suffer from fatigue produced by school activities.

Thorndike[2] says, "We feel mentally fatigued without being so". He claims that children's power of doing school work at the close of the day is as great as at the beginning. Proper air and light, proper posture and physical exercise, enough food and sleep, and work the purpose of which is rational, the difficulty of which is adapted by one's power, and the rewards of which are just, are the

2. Thorndike, E. L. Educational Psychology, Briefer Course, New York Teachers College, Columbia University, 1914, pp. 326-328.

best guarantees that work will not be unduly fatiguing.

Hugo Munsterberg[3] in his text on "General and Applied Psychology" says that both the stages of fatigue and the most economical restoration of the mental energies can be examined by experimental methods. The objective measurement of fatigue is pedagogically the more important, as the subjective feeling of fatigue is rather unreliable. His experiments seem to indicate that mathematics and those lessons which involve physical activity such as physical exercise and singing have the greatest fatiguing influence, next to them the languages, after them the natural sciences, and then the technical subjects. While the fatigue steadily grows, yet it is wise to put the most difficult subjects into the beginning of the day as the first period is needed for the adjustment and warming up. But certainly the last hours of the day ought to be left open for the easiest subjects. The younger pupils become fatigued much more rapidly than the older ones. But, above all, a pupil is the more fatigued by a piece of work which he is unable to master.

Colvin[4] summarized the most important results of the different tests of fatigue and ennui as follows:

"1. There is considerable experimental

3. Munsterberg, H., Psychology--General and Applied, pp. 384-5.
4. Colvin, Stephen S., The Learning Process, pp. 275-280.

evidence that injurious fatigue is not common among school children. It is quite probable that the whole question of fatigue in the schools has been greatly over-estimated. It is true, however, that there is often a feeling of boredom and lassitude, but these are primarily due to the tediousness of the situation, or to the lack of interest. Regardless of their cause, they should be remedied.

"2. Another effective remedy for so-called mental fatigue is the ignoring of feeling of weariness and distraction. The younger the child is, the more likely he is to quit work at the onset of the tired feeling. He should be taught to habituate himself to ignore such conditions. Experiments show that if he were to continue his work for an hour or two many of these symptoms of weariness would disappear. He would have what James calls 'second wind'. At least as far as adults are concerned, there is little foundation for the prevalent belief that they cannot continue for long periods of time to do efficient mental work. With children, however, it is probably unwise to demand of them sustained attention over long periods of time. The pupils have not accustomed themselves to ignore the accompanying ennui that makes the work distasteful and, consequently, ineffective. On the other hand, there is a possibility of the child being injured by real fatigue.

"3. Pleasant work seems to be much less fatiguing than unpleasant. This is probably due to the fact that pleasure tends to activate the vitality of an organism, and displeasure to lower it. Furthermore, the tests for fatigue do not distinguish between physiological fatigue and mere dissatisfaction, unwillingness to do the work, or the lack of interest in it. These latter factors do not exist when the work is pleasant.

"4. Physical work is apparently more fatiguing than mental work; consequently, pupils get very little relief from mental activities by engaging in gymnastics or similar activities. Whether the fatigue be mental or physical, the remedy appears to be complete rest. Furthermore, since some of the mental fatigue is due to interest in the work, a change from mental to physical work may bring relief.

"5. Learning conducted on the level of habits seems less fatiguing than learning with sustained attention. The greater demand the activity makes on active attention, the greater appears to be the waste in physical energy due to distraction.

"6. When fatigued, the individual is less capable of forming associations and thinking. Work of any high degree of significance cannot be accomplished when the person is fatigued or when he is suffering from the irksomeness of his task. On the whole, experiments seem to indicate that the afternoon hours are somewhat less favorable to school work than the morning hours and also that the first hour of the morning is not so effective as those immediately following.

"7. Normal fatigue resulting from the performance of school activities is quite different from the symptoms of mental fatigue found in the case of nervous exhaustion. The former type of fatigue is a normal experience, while the latter type which accompanies nervous exhaustion requires the service of a specialist.

"8. The teacher can guard against the fluctuations of attention and the distractions attendant upon mental work by organizing the activities so that they present a system of related and meaningful parts."

In his doctorial dissertation "Fatigue and Its Effects Upon Control" Isaac E. Ash[5] states that fatigue is a comprehensive term which embraces immediate and temporary changes of either functional or organic character as a result of activity within the organism itself. Fatigue lessens the further activities of the organism. Fatigue produces a loss of efficiency in the worker and a

5. Ash, I. E. "Fatigue and Its Effects Upon Control." Archives of Psychology, University of Wisconsin, 1914, Nov. I.

lessening of the capacity to work.

The amount of fatigue is dependent not only on the amount of work done but also on the particular mental state of the worker. Health, nutrition, interest, temperature, light and time of day have important bearings on fatigue. Because muscular fatigue lends itself better to direct observation and experimentation than does mental fatigue, the phenomena of muscular fatigue are better known than mental fatigue.

Investigators in the problem of mental fatigue are confronted with trying to measure something for which they have no objective measuring unit.

James,[6] in the introductory paragraph of the remarkable essay, "On Vital Reserves", opens up to us new "levels of energy" which are usually "untapped". He writes:

> "Everyone knows what it is to start a piece of work, either intellectual or muscular, feeling stale--or cold. The process of warming up gets particularly striking in the phenomenon known as 'second wind'. On usual occasions we make a practice of stopping an occupation as soon as we meet the first effective layer (so to call it) of fatigue. We have then walked, played or worked enough or we desist. But if an unusual necessity forces us to press onward, a surprising thing occurs. The fatigue gets worse up to a certain critical point, when gradually or suddenly it passes away, and we are fresher than before. We have evidently tapped a level of new energy, marked until then by the fatigue-obstacle usually obeyed. There may be layer after layer of this experience.

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6. James. W. On Vital Reserves, pp. 6-7.

Again turning to Thorndike in "Mental Work and Fatigue" we find on the whole that the biological theory seems the most probable to account for the effect of fatigue on continuous mental work. The behavior which results in certain products such as sums done, dictations written, paragraphs translated and the like, is subject to the laws of all behaviour, and to no others. Whether one relaxes, intermits or stops work, the immediate reason is not that he has not the "energy" to go on with it, but that he feels more comfortable to relax, intermit, or stop it.

From all these discussions it seems then that fatigue is present in all work, that it can not be measured accurately and that many studies show that it is a very hard subject to pin down and predict in any measurable quantity.

Many contradictions are made, some say morning is better, some say late afternoon is better, but none seem to be willing to be positive about their findings.

Fatigue and Feelings of Fatigue

Cameron[7] says that all continuous activity, whether at play or at work, is accompanied by the phenomena of fatigue, as a result of which the work deteriorates in

7. Cameron, Ed H. Educational Psychology, pp. 34-35

quality and is slowed up. Usually, though not always, fatigue is accompanied by feelings of fatigue or weariness. Feelings of fatigue are in many instances quite at variance with the speed and quality of work. It is found that in continuous work, feelings of fatigue may be present without any corresponding deterioration of the work itself, and that work often diminishes solely as the result of its being prolonged, but without any feelings of fatigue on the part of the worker.

Bagley[8] claims that, despite the numerous researches concerning the factors of fatigue and their operation in the school, this is still a dark chapter in school hygiene. It is extremely difficult to segregate the "central" form from the "peripheral" factors--to devise a test that will adequately measure the exhaustion of the nerve cells rather than the fatigue of the muscles or the mere feeling of "tiredness", which may not in the least mean nervous exhaustion.

He concludes that the following principles appear to be fairly well established.

> "1. Certain types of work induce more fatigue than other types of work. All authorities seem to agree that mathematics, gymnastics, foreign, and especially ancient, languages are more fatiguing than the mother tongue, geography, and history.

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8. Bagley, W. C. The Educative Process, pp. 340-343

"2. In general, it would seem that the fatigue studies are (a) those involving a great deal of muscular effort, (b) those involving abstract judgements, and (c) those involving drill in form; while the less fatiguing subjects are predominantly those in which the thought of content is uppermost, and those involving objective factors.

"3. The curve of work capacity presents a form of a series of waves, indicating that the function is rhythmic. The best work is not done at the very outset, but only after a certain inertia has been overcome or a certain momentum gained.

"4. The daily work curve on a 'free day'--such as our Sunday--was found to decrease gradually at noon, then again to rise again at two o'clock to a point somewhat above the morning maximum, then to fall rapidly until about five o'clock, when it reached the low point for the afternoon. On a schoolday, however, the curve in the morning declines much more rapidly, and reaches a lower point at noon; the afternoon high point is much lower than on a free day, and the afternoon decline is not quite so rapid."

Pyle,[9] in 1938, writing on fatigue in the "Psychology of the Common Branches" seems to believe that fatigue study is beyond measuring or divining. He goes on to say:

"Fatigue--One of the causes (from length of drill periods, exercises, speed tests, specific drills, et cetera) just indicated is that of fatigue when nervous work is done, i. e. when nerve processes take place, fatigue toxins are produced; then toxins interfere with the learning process. This is as far as our definite knowledge goes. It is probable that the things we have discussed under the heads of attention, interest, pleasure, and fatigue are all different aspects of the same fundamental neural phenomena, the exact nature of which is not yet known."

9. Pyle, W. H. The Psychology of the Common Branches, pp. 268.

Again, turning to Pyle,[10] in an earlier study we find that more space is given to the study of fatigue in the chapter on "Fatigue and Learning", but no positive agreements have been reached, as the phenomena of fatigue are so complex, and so combined with all sorts of other phenomena that any experimenter finds it difficult to assign results to their proper causes. Moreover, an adequate measure of fatigue, universally applicable, has not been discovered. Many of the physiological phenomena due to fatigue are also produced by other causes. Fatigue produces inability to work, but the work curve also falls because of many other causes, such as loss of interest, monotony, et cetera. And in spite of the fact that the psychology of fatigue can not be finally and definitely written, there is a respectable body of facts fairly well established.

The fatigue of an organ is merely a reduced capacity to function brought on by work. In the functioning of the various organs of the body, their tissues are torn down and the products of the katabolic processes are eliminated by various excreting organs. When work is of such amount that the waste products can not be eliminated as fast as produced, they are scattered over the body by the circulation and produce the effect of fatigue. This effect is

10. Pyle, H. P. The Psychology of Learning, Chap. XII.

essentially incapacity to work. That the toxic substances produced in our bodies by the functioning of its organs lower their capacity to function is definitely known, but just how they produce this incapacity is not known. It seems pretty clear that it is a nervous phenomenon. The fatigue poisons seem to lessen the conductivity of the nerves, thereby lowering their functioning capacity. Fatigue is, therefore, loss of ability to work, not so much because of lack of energy as because the energy is not available.

Measures of Fatigue

Nearly every sort of mental and physical performance has been used as a measure of fatigue. In the earlier work some kind of physical test was usually used, especially aesthesiometry and dynamometry. The attempt was also made to determine the presence of fatigue by changes in the circulation and respiration. While fatigue does produce definite changes in both circulation and respiration, these changes are also produced by other causes, and are intimately connected with the emotions. Therefore, when these changes occur, it is difficult to know what factor or what combination of factors has produced them. In practice, it is difficult to use any of the physiological methods with any degree of certainty. The school teacher is concerned with the fatigue of children resulting from mental work.

As a measure of mental fatigue, certain mental tests have proven far more successful than any of the physiological methods. A fairly successful method of measuring general mental fatigue is to take the measure of some simple mental function after first bringing the function to maximum efficiency through practice. For example, we can use auditory memory span for digits. We first bring this span to its maximum through practice. Then we apply the test as a measure on fatigue on the assumption that fatigue will narrow the memory span. This is typical of the more successful fatigue experiments. The purpose of bringing the function up to its maximum efficiency before using a measure of its efficiency as a criterion of fatigue is to prevent practice effects from off-setting the effects of fatigue.

Variation in Efficiency during the School Day

Similar to the question of fatigue is the problem of the change of working efficiency during the course of the day. This is not precisely the same question, although it is related to the question of fatigue. After we awake in the morning from sleep, we have recuperated from the fatigue of the preceding day, but are not able to do our most efficient work of the day. During sleep the functioning of the various organs of the body is suspended or partially suspended. After we awake, it takes some time for them to rise to their maximum efficiency. Winch,[11] using arithmetical reasoning as a measure of efficiency, studied children of both sexes and various ages and found that at 11:30 A.M. they do on the average 5.6 percent better than at 9:40 A.M. In the poor neighborhood school, however, he obtained different results. The pupils were the children of laborers and got up earlier than the others, and reached a maximum efficiency earlier than the children who got up later.

The extensive studies of Gates,[12] are in agreement with those of Winch. Gates' first study was with fifth and sixth grade school children. He used as tests of efficiency, addition, multiplication, completion, cancellation, and speed and accuracy of movement. His results are shown graphically in Figure 1.

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11. Winch, W. H. "Mental Adaptation during the School Day as Measured by Arithmetical Reasoning." Journal of Educational Psychology IV, 1913: pp. 17-18, 71-84.
12. Gates, A. I. "Variations in Efficiency during the Day, together with Practice Effects, Sex Differences and Correlations." University of California Publications in Psychology II No. 1, 1916, pp. 1-156.

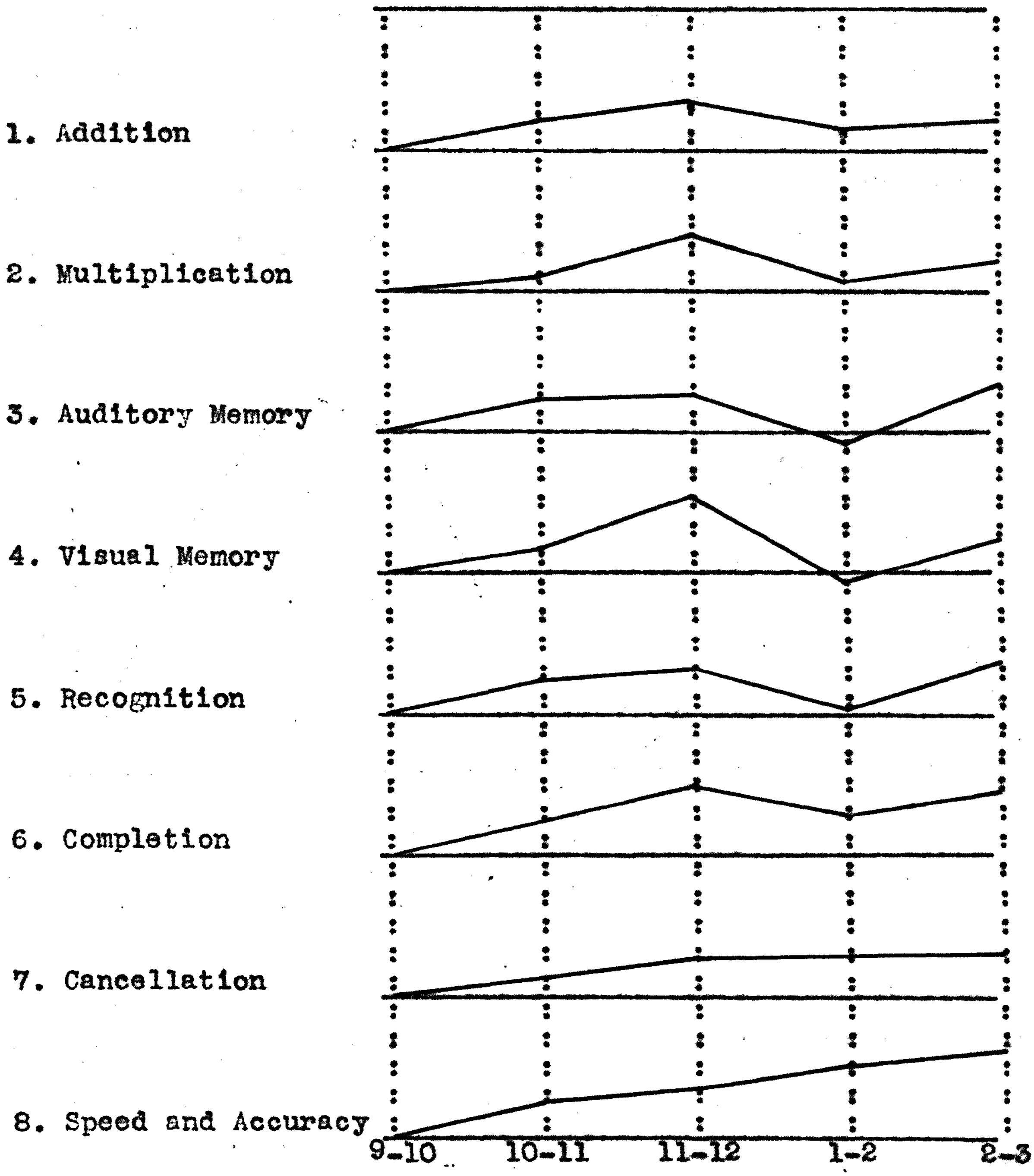

Figure 1. Fatigue and Efficiency, Fifth and Sixth Grade from Gates.

Gates performed similar experiments with 165 college students. With these students he used as tests, auditory memory, visual memory, substitution, recognition, and logical memory. The combined results of all the tests are shown by the final tabulation of the averages in Figure 2.

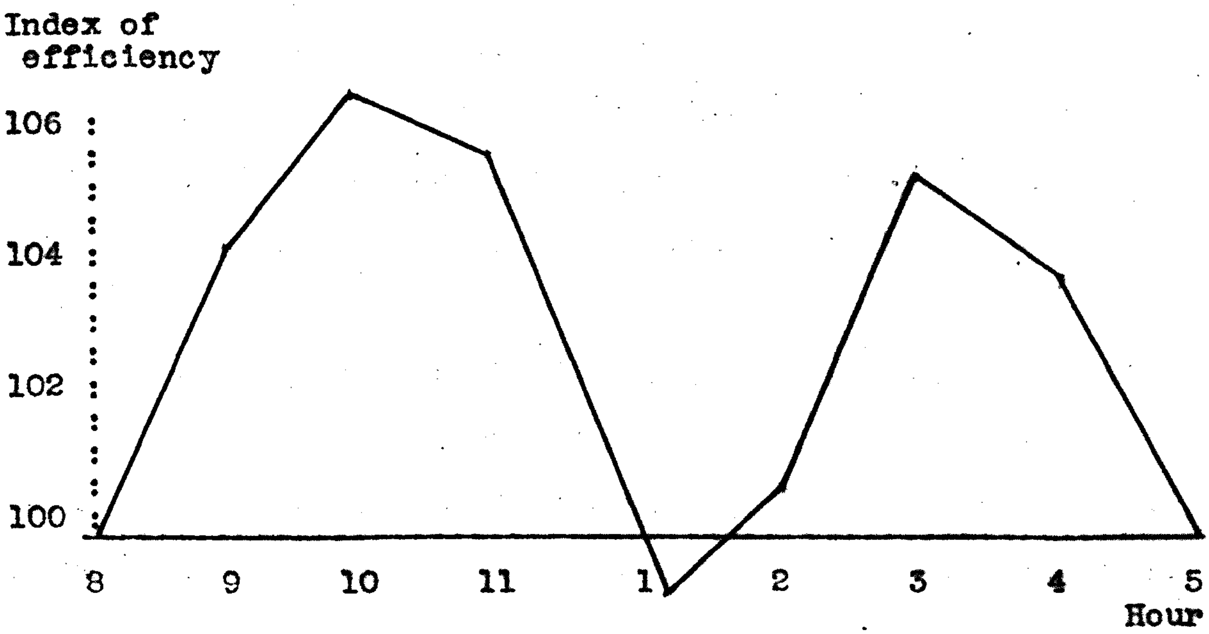

Figure 2. Fatigue and Efficiency, 165 College Students from Gates.

The results are much the same as those obtained from the children. The first record of the day is called 100 and the other records are expressed in terms of percents of the initial record. The practical significance of these studies on the course of diurnal efficiency is as follows: Neither children nor adults are capable of their best work early in the morning. They gradually come into full swing of their power, and just before noon are able to do their best work of the day. Just after noon, their powers are at the lowest ebb for mental work, with some increase in efficiency toward the end of the school day. In arranging the school work of the day, then, the most difficult work should be placed at the last morning period; the least difficult just after noon.

The work of several investigators makes it appear that mental fatigue comes earlier than physical fatigue, under the same conditions of mental and physical work. If one works hard at mental work, fatigue comes earlier than if one works at hard physical work in a field where he is habituated.

According to Mursell,[13] as far as arranging the daily program is concerned, there is no reason, on the basis of an increasing intellectual disability, for placing the difficult subjects early in the day and the easy subjects late. What really changes is not the basic capacity to work, but rather the feelings of the pupil. So the thing to aim at would be to have the most interesting and interestingly taught subjects placed late in the day.

Summary

In this chapter of orientation many angles are discussed relative to the importance and in many cases the un-importance of fatigue and the placement of any school

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13. Mursell, J. L. The Psychology of Secondary School Teaching, p. 444.

subject at the most profitable time of day. Gates' study with the children in the grades and also with those of college levels found some evidence in favor of the second school hour and the last hour of the schoolday.

When confronted with the teaching of night school to adults, it has been found that in almost all cases the night school student is too tired, from manual labor, to have much interest in night school studies. Whether this is a case of fatigue of boredom or even emotional fatigue remains a question to be solved.

CHAPTER III

ANALYSIS AND INTERPRETATION OF THE TESTING PROGRAM

The tests used in the experiment were the following:

1. Lee Test of Algebraic Ability, prepared by Murray J. Lee, Director of Research, Burbank, California.
2. Breslich Algebra Survey Forms A and B prepared by E. R. Breslich, School of Education, University of Chicago.

The entire ninth grade, 58 pupils in all, was given the Lee Test of Algebraic Ability during the first week of school. The group was then divided into two groups, A and B, of as nearly equal ability as could be expected in a small high school, when they were paired on the basis of the raw scores. These two groups of 25 pupils each (eight were lost in the grouping) were alternated for instruction from first hour to last hour of the schoolday every six weeks, six times per year and tested at the end of every six week period by use of Breslich Algebra Survey Test which has six parts for the first semester and six parts for the second semester and is prepared in two forms, A and B, as follows:

Parts for first semester, A or B,

1. Algebraic concepts
2. Algebraic processes

3. Solving equations

4. Solving problems

5. Fractions

6. Functional relationship

Parts for second semester, A or B,

1. Algebraic concepts

2. Changing algebraic equations to simpler form

3. and 4. Solving equations and deriving equations from problems

5. Formulas and graphs

6. Factoring

The data thus collected by these several tests was carefully analyzed in order to learn whether or not greater growth was dependent upon the hour in which instruction was given.

TABLE I

SUMMARY OF DATA COLLECTED

Test	Group	Period of Instruction
Lee	A and B	
Breslich A	3 for A	Morning
Breslich A	3 for A	Afternoon
Breslich B	3 for B	Morning
Breslich B	3 for B	Afternoon

By using A and B of the Breslich Test during both semesters there was no chance for either group to coach the other.

The following results were obtained and tabulated in Tables II and III.

TABLE II

RESULTS FROM LEE AND BRESLICH TESTS, GROUP A

Test		Mean	S. D.
Lee		81.4	21.10
	Morning	10.42	5.81
Breslich	Afternoon	8.18	5.266
6 week	Morning	8.5	7.48
Survey	Afternoon	8.98	3.888
Test	Morning	8.9	5.78
	Afternoon	8.02	6.44
Combined	Morning	26.14	16.956
Score	Afternoon	21.66	12.156

$r_{A\bar{P}} = .84$ $PE_r = .039$

$D = 4.48$ $SD_d = 1.88$ $\frac{D}{SD_d} = 2.38$

TABLE III

RESULTS FROM LEE AND BRESLICH TESTS, GROUP B

Test		Mean	S. D.
Lee		77.4	16.24
	Afternoon	7.3	5.02
Breslich	Morning	4.56	3.19
6 week	Afternoon	6.74	5.054
Survey	Morning	4.204	5.62
Test	Afternoon	5.98	4.974
	Morning	2.44	3.485
Combined	Morning	15.1	9.28
Score	Afternoon	18.62	13.216

$r_{AP} = .84$ $PE_r = .039$

$D = 3.52$ $SD_d = 1.44$ $\frac{D}{SD_d} = 2.44$

The growth of Group A in Algebraic achievement, as measured by the appropriate parts of the Breslich Test, appears to be greater in those periods in which they received instruction in the morning in two out of three six-week periods, and when the cumulative growth made in the morning and afternoon periods was computed the difference in group gain in favor of morning instruction was found to be 4.48 and the sigma of difference in means was 1.88.

The ratio of difference to sigma of difference was 2.38 which was not great enough to be statistically reliable, but was great enough to show that the chances were 99 in 100 that this group actually gained more in achievement when they received instruction in the morning than they did when the instruction came in the afternoon. In Group B the results seem to be just the opposite. This group while not making as great a gain at any time as did Group A, seemed to make greater growth in gain in every six-week period in which their instruction came in the afternoon.

Their cumulative growth in the afternoon showed a group gain over the morning growth of 3.52 points while the sigma of difference of means was 1.44.

The ratio of difference in means to the sigma of the difference was 2.44 which was not large enough to be statistically reliable, but it showed that the chances were as many as 99.2 in 100 that their gain was greater in the afternoon periods than in the morning.

Since one group gained more in the morning periods and the other gained almost equally more in the afternoon periods the only conclusion must be that the time of day in which instruction was given was not a determining factor in the situation and there is nothing in the experiment which throws any light in determining why Group A gained more in the morning and Group B in the afternoon.

It was true that Group A was made up of students who were slightly superior to those in Group B, as shown throughout the study, and that may have been a cause but more likely the differences found were merely chance differences.

This negative result is in harmony with other studies which have been quoted in Chapter II and it may reasonably be concluded that there is no difference between the desirability of hour 8-9 and 2-3 for carrying on instruction in Algebra. There is no evidence found in this study that fatigue interferes with afternoon learning.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Logically it should be expected that there would be a definite best time for placing any subject in the school day. This study, however, does not show any positive proof that early morning or late afternoon has a decided effect on the learning of Algebra of high school grade. From the interpretation of the statistical data derived from the several tests, the A group seem to neutralize the gain of the B group and the reverse is true. This, however, is in harmony with other studies. As far as it is known the best time of day or night depends upon the habits and environment of the individual person. Some suggestions and experiments, as outlined in Chapter II, are available regarding the best time for study, but they must be taken only as the facts proved them to be, not definite enough to make absolute use of them in the making of daily schedules.

It is frequently claimed that the individual is able to learn more readily in the morning. In this study Group A seemed to show this phenomenon, while Group B did better in the afternoon, but in neither case was the difference statistically reliable. We can only conclude that the difference in the time of instruction was not a determining factor in the growth of either group, but that the differences were chance results.

Suggestion: It would be interesting if a study could be made where the pupils would go to school from 9 A.M. to 2 P.M. or 8 A.M. to 1 P.M., continuing their studies right through the lunch period without taking food to see if the drop in efficiency for the hour 1-2, as shown in Gates' Figure 1, page 17, would be eliminated.

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APPENDIX A

RAW SCORES FROM LEE AND BRESLICH TESTS, GROUP A

Pupil	Lee	Breslich							
		Morning			S*	Afternoon			S*
1	117	14	24	29	67	21	15	10	36
2	116.3	23	11	10	44	18	13	8	41
3	116.2	18	27	16	61	14	18	17	49
4	105.4	20	17	22	59	12	15	14	41
5	99.1	21	17	3	41	9	9	10	28
6	98.4	17	16	7	40	9	13	9	31
7	95.9	12	15	11	38	14	10	12	36
8	92.9	7	10	16	33	14	3	3	20
9	91.1	7	12	8	27	9	13	8	30
10	90.1	15	3	4	22	9	8	5	22
11	89.1	12	4	3	19	10	4	0	14
12	82.7	9	11	0	20	4	6	0	10
13	81.7	10	1	4	15	11	13	2	26
14	79.3	14	2	9	25	6	6	1	13
15	78	6	6	3	15	9	7	0	16
16	74.7	9	3	5	17	6	5	1	12
17	74.6	6	8	9	23	2	6	1	9
18	68.4	9	4	2	15	4	10	3	17
19	66.5	7	4	2	13	4	8	4	16
20	65.5	6	5	8	19	4	5	4	13
21	65	4	1	0	5	7	13	0	20
22	55	3	5	6	14	4	6	0	10
23	53.8	4	3	0	7	0	9	0	9
24	44	4	5	3	12	0	5	1	6
25	40	4	4	2	10	0	6	1	7

* Totals for morning or afternoon on Breslich Test.

APPENDIX B

RAW SCORES FROM LEE AND BRESLICH TESTS, GROUP B

Pupil	Lee	Breslich							
		Morning			S*	Afternoon			S*
1	109.9	10	18	14	42	23	20	19	62
2	107.5	9	13	6	28	12	14	9	35
3	103.4	2	10	8	20	14	16	11	41
4	101.2	10	11	0	21	14	6	0	20
5	98	11	8	1	20	12	6	10	28
6	94.5	6	13	3	22	7	16	6	29
7	87.6	6	10	1	17	12	7	0	19
8	85.5	6	10	1	17	9	8	3	20
9	84.5	7	9	5	21	8	8	17	33
10	84	7	7	8	22	7	6	7	20
11	81.7	7	10	2	19	7	3	0	10
12	75.7	4	9	0	13	6	7	4	17
13	75.3	4	11	1	16	9	2	6	17
14	72.1	2	2	0	4	7	6	0	13
15	68	4	6	0	10	6	3	6	15
16	65.7	2	6	0	8	9	2	0	11
17	64.3	4	7	2	13	4	4	0	8
18	63.5	2	12	6	20	8	2	0	10
19	63	4	2	1	7	1	4	2	7
20	62.3	2	4	0	6	5	2	0	7
21	62	0	6	1	7	0	8	0	8
22	62	3	6	1	10	1	4	6	11
23	61.8	2	1	0	3	1	4	5	10
24	61.8	0	3	0	3	4	2	9	15
25	51.5	0	4	0	4	2	1	0	3

* Totals for morning or afternoon on Breslich Test.

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