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Mechanical ability in a comprehensive high school

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MECHANICAL ABILITY IN A COMPREHENSIVE HIGH SCHOOL

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ANALYTICAL OUTLINE

ANALYTICAL OUTLINE (Cont.)

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CHAPTER I

INTRODUCTION

Current economic and social unrest and their concomitant problems have greatly increased the enrollment of the Secondary School. This has presented to educators another difficulty. What curriculum can one offer them?

The Commissioner of Education of Connecticut termed this additional group the "New 50%" and has inaugurated an extensive study of curriculum revision to cope with the situation.

Many of the pupils now in attendance, who might otherwise be working, are practically inclined and are desirous of vocational training which will bring visible, material results. Most of their parents are even more so inclined.

Further, since information about vocational education has been more widely disseminated, and the "hand-minded student" brought more prominently to the fore, a goodly portion of the public has acquired greater interest in the work of the Trade School. Keenness of competition and the need of specific vocational training, plus the apparent success of Trade School graduates, have instilled a desire in many communities to add this type of training to their educational program.

For some time, the Town of Enfield, Connecticut, has desired a Trade School. Organized effort and pressure, however, were not successful in convincing the State Legislature, and the establishment of one was denied. Still, enthusiasm is not wholly stifled and hopes for one exist.

Choice of Subject. When the writer was presented with the choice of a subject of research, he decided to employ some of the methods of Vocational Guidance to determine a few factors that might have some bearing on this problem of the Trade School.

In reviewing the possibilities, such questions arose as "How many would really like to attend a Trade School? What ability do they possess for this kind of training?" Consequently, a plan was formulated to discover the answers to these and other questions by an investigation carried on in the Enfield High School where potential Trade School candidates might be found.

A good cross sectional group of two hundred boys was chosen; these included Seniors, Juniors, Sophomores, and Freshmen who were of different ages and enrolled in various courses -- vocational, business, and academic.

The primary factor of the thesis centered in a test which is prognostic of mechanical ability, because any one who would attend a Trade School should possess this aptitude to a certain degree. A questionnaire was also included to enable the

investigator to find out who really desired to attend a Trade School. In addition, the writer thought it worthwhile to ascertain the general intelligence and the school standing of those under question.

The methods and materials employed are fully explained in the body of the thesis. While the research does not boast of being far-reaching or exhaustive of all possible angles, nevertheless, it is sincerely hoped that the information obtained about the different determinants that were investigated, compiled and compared, will be of interest and perhaps helpful in application to this project of a Trade School in Enfield.

Method of Procedure. Before the writer explains the immediate problem of the thesis and the results, he will review some of the general principles of vocational guidance, for since he is going to investigate abilities by tests and questionnaires, there are certain psychological facts upon which these have their foundation which it would be well to consider:

1. What is the nature of abilities?
2. How do we discover them?
3. What does it mean to know them?

Then with this background, the particular problem of the study can be considered.

CHAPTER II

THE NATURE AND ORIGIN OF APTITUDES

Nature. The knowledge of individual difference emphasizes the fact that people are unlike in intrinsic intelligence, in their interests, and in their aptitudes. Since the rise of individualism and increased specialization, recognition is being given to special traits or characteristics such as artistic, linguistic, mechanical, musical, literary, military, business, and inventive nature. Education is endeavoring to help the individual find his points of excellence and is trying to aid him in their development.

What is an Aptitude? One author explains an aptitude as indicated by pleasure and persistence. "What is done constantly and with pleasure during the performance, is an index of the inclination or interest and the ability of the performer." (1)

When we say that a person has certain aptitudes or abilities, we mean powers or capacities in his personality. He may be a good musician, a skilled mechanic, etc. Perhaps these qualities have as their functional base certain neural connections impressed with varying degrees of intensity upon the nervous system. And possibly they have a psychical or immaterial foundation. This matter is debatable and for our problem irrelevant.

Cohen (1) lists the range of aptitudes as follows: a. will, b. feeling, c. perception, d. thought, e. attention, f. memory, g. imagination. Also are included traits of: a. personality, b. temperament, c. character, d. intelligence, e. ability, f. knowledge, g. experience.

Aptitudes apparently may be native or acquired. Exactly which ones are inherited and which are acquired are doubtful. Possibly both heredity and environment have to do with all aptitudes but in different degrees. That certain abilities are acquired is quite evident and indications seem to show also that there are probably certain inborn traits, certain innate aptitudes, physical and psychical, which fit one for one vocation or another.

There is considerable discussion concerning the importance of heredity and environment in determining aptitudes, and the following views will give an idea of opinions about the subject.

Heredity. Our basic knowledge of heredity dates back to an Austrian monk named Gregor Mendel, about 1865. He formulated the Mendelian Laws of Heredity which very clearly explain the inheritance of various traits and "heredity splitting" into a number of unit characters. (2)

About the same year, Sir Francis Galton announced his law of Ancestral Inheritance which had been worked out sta-

tistically in a study of different families. Galton asserts that the two parents contribute between them on the average one-half of each inherited faculty, each of them contributing one-quarter of it. The four grandparents contribute between them one-quarter or each of them one-sixteenth, and so on.

Since then, many experiments have been performed which have added much information, some supporting inheritance of certain qualities, and others denying it.

The science of heredity has rather definitely established the inheritance of physical traits. It is also generally admitted that at birth man has, innately, various instincts and reflexes and a physical basis in which these reside. Whether mental and moral traits are passed on is not adequately proved. While some experimenters conclude in favor of this, others deny it.

(a) Galton and his followers, who style themselves the "Eugenists" by using a statistical method, have traced intelligence or crime in families. They maintain that many mental and physical defects pass on from generation to generation in the germ plasm and they advocate remedies to eliminate objectionable characteristics and the continuance of better ones.

(b) E. G. Conklin says, "There is no longer any question that some kinds of feeblemindedness, epilepsy and insanity are inherited, and that there is often an hereditary basis

for nervous and phlegmatic temperaments, for emotional, judicial, and calculating dispositions." (3)

(c) Vernon L. Kellogg in Mind and Heredity, pages 101-108, is quoted, "With direct inheritance of emotions and temperament, and with the inheritance of differences in the functioning of the ductless glands whose secretions powerfully effect both emotions and intelligence, we have an imposing array of inherited factors in mental and nervous makeup." (3)

(d) Thorndike, page 44 of Educational Psychology, argues that, "The importance to education theory of a recognition of the fact of original nature and of exact knowledge of its relation, shown in determining life's progress is obvious. The environment acts for the most part, not as a creating force but as a stimulating and selective---the results of our endeavors will forever be limited as a whole by---inborn talents and defects." (3)

(e) Brimhall and Cattell have made different studies using the same material, finding the frequency of eminence among the near and remote relatives of great men. While those near showed greater chances of success, Cattel says, "These great differences may be properly attributed in part to natural capacity and part to opportunity." (3)

(f) Starch summarizes as follows: "The general impression from all experimental, statistical and historical

material thus far accumulated on the problems of mental heredity would seem to be somewhat as follows---the ultimate achievement of any given individual is due to his original ability probably to the extent of 60 to 90%, and to actual differences in opportunity or external circumstances only to the extent of 10 to 40%---Nature predominates enormously over nurture only in the relative and not in the absolute sense. In fact in the absolute sense, nurture predominates enormously over nature. A Newton born among Australian bushmen would no doubt have become a remarkable bushman, but never a world renowned scientist. The necessary stimuli of environment must be at hand to train and develope original capacities." (4)

Environment. That many of our aptitudes are caused or at least greatly modified through environmental influence cannot be denied. By environment, the writer means all surroundings, including prenatal.

(a) Smallwood, Revely, and Bailey say, "We cannot think of any living thing apart from its surroundings, and a common sense tells us that these surroundings have a large influence on the way organisms grow, mature, change and adapt themselves." (5)

(b) Pyle speaks of various traits of social heredity which a child receives from his parents, but the present writer prefers to call them early environmental influences.

"Children live for many years with their parents and take on the beliefs, customs, traditions, politics and religion of their parents." (6)

(c) Dr. John Giesen, a skilled biologist, in his book, Backgrounds in Biology, disagrees with Galton and says: "We know that we do not inherit equally from all our ancestors; on the average we inherit about as many traits from our fathers as from our mothers, but inheritance from our grandparents is usually unequal and the further back we go the more ancestors we find who have contributed nothing to our inheritance." He says that Galton and his followers beg the question by assuming that certain mental traits are inherited in their statistical findings. "A character reappears because it is either hereditary or environmental, but statistics do not tell us which.

"A family may quickly lose the inheritance of a famous or infamous ancestor. A poem expresses this well---

Oh chromosomes, my chromosomes,
How sad is my condition!
My grandsire's gift for writing well
Has gone to some lost polar cell
And so I write this doggerel
I cannot do much better."

Then he sums up his arguments about environment as

follows: "I fail to see anything in our present knowledge of heredity and development that would force us to change our fundamental conceptions of the value of training, education, and the importance of good environment in the broadest sense of the word." (2)

Conclusions. From the foregoing arguments, it is plain to see that both heredity and environment play a part in determining abilities. Cattell concludes: "When it is asked how far the result is due to each of these factors, the question is in a sense ambiguous."

Guyer also follows the same idea in saying, "To wrangle over the question which is more important heredity or environment is about as idle a procedure as to argue which is more important, the stomach or something to put in the stomach. Man would soon come to grief without either. So too, the question of human development is not one of heredity alone, nor of environment alone; both are necessary and must work hand in hand." (3)

In Relation to Mechanical Ability. Experience clearly shows that some people naturally manipulate, visualize, and rationalize mechanical components. Others do not. It is apparently a special aptitude. Dr. Johnson O'Connor states the case of two honor graduates of an engineering school who took a mechanical test. One required 30 seconds, the other a half hour. (7) This would indicate something predisposed

in one and not in the other. Yet with training, the second one acquired the speed of the first one, thus illustrating the value of experience or training for an aptitude. The one who had the innate quality may not have inherited it from his father, because even though his father were skilled, this skill would not be passed on, for acquired characteristics are not inherited. Still, he may have inherited a predisposition or capacity for the skill which, when placed in the proper environment, was developed. Dr. O'Connor says that mechanical aptitude is found in an individual from his very early years, so that he might just as well have been "Born that way". (7) But to determine whether the mechanical aptitude evident is due to heredity or environment is difficult in its last analysis. The more important object is to determine its presence or non-presence and then counsel in accordance.

CHAPTER III

THE MEASUREMENT OF APTITUDES

1. Enumeration, discussion, and evaluation of various ways of testing.

Intelligence Tests. One of the duties of a teacher is to test from time to time the amount and kinds of abilities that have been acquired. For many years, teachers have employed the general method of giving questions in an oral or written test in review of work that has been covered. But our first real work in testing ability, as we understand testing today, dates back to the general intelligence testing of Binet, in France, about 1907. The mental test since then has made considerable advance and today several forms are used. During the World War, it was used very extensively and many school authorities throughout the country have administered it to their students.

The intelligence test is based upon the theory that intelligence consists of a group of innate capacities that can be objectively measured. Some, however, do not believe this and maintain that the tests do not show "simon-pure native endowment, but the results of the application of this native endowment to the individual's environment." (8)

In the tests, general intelligence is separated into different elements and the Stanford Revision of the Binet test, which was used in this study, is divided into ten

different tests for which a definite time allotment is given. (A copy of the test is on the opposite page.) This particular test takes about forty minutes to administer.

The intelligence test tries to discover and grade differences in general native ability between various individuals. By use of a mental scale we are able to locate a person's mental placement, or as it has been sometimes called, his I. Q. The Intelligence quotient is the ratio of the person's mental age to his chronological age. The classification is as follows:

I. Q.	
Above 140	Near genius or genius
120-140	Very superior
110-120	Superior
90-110	Normal or average
80- 90	Dullness
70- 80	Border line deficiency, sometimes classed dullness, sometimes feeblemindedness
Below 70	Definite feeblemindedness (9)

War testing extended their use. During the War, 1,700,000 draft soldiers were given intelligence tests under the two forms called Army Alpha and Army Beta. These were devised by a committee appointed by the American Psychological Association. The tests proved of great value in segregating men who were not capable of military service and enabled the testers to find others who might be sent to of-

ficers' training camps.

The extensive use of these during the War widely broadened the scope of testing and many rather unwisely attempted to apply the tests to situations where they could not be applied and interpreted their results incorrectly.

Studies have been made to show that intelligence for different vocations follows a set standard, but such information is not totally reliable because it has also been found that in the investigation of occupations, intelligence in all its degrees is evident in each field of endeavor.

Summary. Although the increased belief in these tests seems to be warranted, still, many people are sceptical of their value. Intelligence is such a difficult thing upon which to lay one's hand definitely, and is so varied in individuals, that a test which attempts to form a mold and then measure positively and one hundred percent accurately is not possible to obtain. However, educators appear to be in agreement that these intelligence tests are fairly reliable measures and are of significance. These tests do give some valuable ideas about an individual which when used with other information obtained can be considered in educational or vocational guidance. They appear to have a high correlation, (about .70) with scholastic records; and the results have been applied to many thousands and checked against valid criteria. (10)

Other Tests. Besides general intelligence, psychologists realized that there were many other factors concerning an individual's makeup that should be taken into consideration. These other factors were characteristics of personality which have been termed special aptitudes. While there are those who do not believe in the existence of special capacities, Poffenberger asserts that a careful study of the question would show that these do exist. But regardless of the discussion as to the existence of special abilities, numerous tests of special aptitudes have been devised which cover a wide field.

Cohen classifies the tests that have been constructed as follows: (11)

A. General Tests

1. Appearance--Elements include neatness, posture, walk, carriage, attitude, and habits.
2. Language--Elements include extent and use of vocabulary; choice of words.
3. Habits--Cheerfulness, punctuality, and accuracy.
4. Physical--Health, defects, susceptibility to disease.
5. Psychical--Mental, intelligence.
6. Psychophysical--Reactions.
7. Psychoanalytical--Thoughts, subconscious states, and dreams.
8. Technical or Trade Tests--Knowledge of tools, terms, and processes.

B. Physical Tests

1. Grip of hand.

2. Capacity of lungs.

3. Sensitiveness to touch.

4. Eyesight.

5. Hearing.

6. Endurance, and other tests.

C. Educational Tests

1. For general Intelligence.

2. For literacy.

D. Tests for Special Abilities

1. Aptitude Tests.

2. Trade Tests.

Poffenberger names four methods by which these aptitude tests are constructed: (12)

1. Sampling

A sample of specimen of the actual work required in an occupation is chosen and the person's ability to do this is recorded. To exemplify, typing, card filing, and checking tests might be mentioned. The factor that must be regarded carefully is that the sample be truly representative. There is a charge that the experienced person has an advantage.

2. Empirical Method

This method finds out by "trial and error"; that is, by testing out a great variety of functions, the discovering of which ones are essential in an occupation. A check is made between performance in the test and performance in the occupation. When the correlation between the two is high, the test may be considered good.

This method has two objections in that it is laborious (1) because so many tests have to be tried and many discarded and (2) because perhaps the best tests are not discovered.

3. Analytical Method

The analytic method consists essentially of the analysis of an activity into the elementary functions which comprise it, and the preparation of devices for testing or measuring these separate elementary functions. The Seashore test of Musical ability is the best example of this type. He has devised measures for some thirty processes involved in musical ability. Psychographs or pictures show the performance in the test. It displays the musical makeup of the person in pitch discrimination, rhythm, etc.

4. The Analogy Method

The analogy method requires the construction of a test situation which is analogous to but not identical with the

actual occupation. The elements are reconstructed into a pattern to which the candidate responds as a whole. The danger of the test is that it may become like a sample test and give too much weight to training. The Viteles Motorman test is a good example. It consists in operating levers by hand and foot in response to a system of signals that are thrown on a screen.

It would appear that no one of these four principles underlying the construction is entirely adequate when used alone, and that the ideal test will be evolved from a combination of all the methods.

Explanation of Other Tests

Trade Tests--measure experience and training more than innate capacity. During the War, these tests came into use very extensively. They are supposed to show what a man knows or can do in an occupation in which he has had some experience. This giving of an applicant a tryout on the job under inspection shows a rather reliable estimate of a man's ability or efficiency in that particular trade. A high degree of accuracy in selecting personnel is claimed for them. They are generally given when a group is trying for a job because they are quicker and less expensive.

The Army Trade test enabled the officers in charge to classify those who professed to be electricians, plumbers,

etc., from apprentices to masters.

Three forms of the tests were used. One was an oral test which included several questions that needed only a short answer. Another form consisted of several pictures of tools required in trades. The third was an actual performance. Those who wanted to be truck drivers were given an actual test in driving one.

Some of the questions are as follows: (13)

For a Cook

1. What is added to milk to keep it from curdling when making creamed tomato soup?
2. What do you put on fried sweet potatoes to make them brown?
3. What do you put in soup stock to make it clear?

For a Carpenter

This test included a series of pictures of tools, the question for each one being, "What do you call that?" Pictures are included of such things as a jack plane, spoke shave, saw clamp, draw knife, ripping chisel, scraper and miter. The applicant must name these.

The charge brought by both Myers and Burtt against these tests is that they measure only present efficiency and not possible improvement. From a vocational guidance standpoint, they would not be especially helpful.

Commercial Tests are Many in Number. There are tests for stenographers, clerks, typists, secretaries, which include the fundamental requirements of these different forms of work. Among three of the best known of these are the Thurstone-Clerical test, the I. E. R. General Clerical test, and the O'Rourke Clerical Aptitude test.

The Thurstone test as an example of one of these has eight parts. They include:

1. Concentration in checking for errors:

e.g.,
17+4 = 21
13+3 = 10
16+4 = 22
3+18 = 21

2. Incorrect spelling. The person is told to underscore all incorrect spelling; 3. arithmetic problems; 4. and tests which call for the placing of names in boxes with a city name, from a list on the side that has several names and their cities; 5. underlining of three or four letters in a whole group of letters, etc.

The following is another example:

Have You Clerical Ability?

1st Column	2nd Column	Same	Different
go	go	____	____
of	or	____	____
ox	ox	____	____
an	in	____	____
me	me	____	____
him	his	____	____
out	out	____	____
but	tub	____	____
girt	grit	____	____

keep	keep	____	_____
metre	meter	____	_____
mangy	mangy	____	_____
riblet	riblet	____	_____
gashes	gushes	____	_____
resift	refist	____	_____
sutelte	sutlete	____	_____
seismic	seismic	____	_____
languor	languor	____	_____
conduce	conduct	____	_____
protends	portends	____	_____

All of these require speed and accuracy, and, whereas they may be somewhat significant in determining a few of the factors needed for such work, the opinion seems to be that there are many opportunities for improvement.

Other Interesting Attempts to Measure

Burtt lists tests for: (15)

Aviators. These involved mental alertness tests, evaluation of certain items in a personal history blank especially with reference to athletic activities, the extent of swaying as the subject stayed at attention with a pointer attached to the top of his head writing on smoked paper, the angle through which a subject's chair could be tilted very slowly before he was aware of the direction of the tilt, changes in breathing and hand tremor after a revolver shot.

Telephone Operators. Memorizing numbers is required; card sorting, crossing out certain letters on a page, a motor coordination test and speed of association. It was

shown that those who were good in the test were generally more proficient in actual work.

Motormen. Motormen have been tested as to color-blindness, visual acuity, and steadiness. Their knowledge of traffic rules has been found by miniature cars on a street and intersection. A questionnaire also is included, to illustrate:

----If a passenger bawls you out when you do not deserve it, what would you do?

---Call the conductor to help put him off the car?

---Shout back at him.

---Say nothing to him, but report the accident to your superintendent.

---Explain quietly to the man that he is wrong.

Automobile Drivers. These are of diverse types, such as answering questions covering pictures that show traffic law violations, measuring of reaction time by numerous devices, operation of pedals, moving of toy vehicles, etc.

Character Tests. The exact nature of character does not seem to be well defined. Attempts have been made to measure honesty, aggressiveness, self-confidence, credulity, etc.; and the Downey Will Temperament test appears to be the only character test which tries to catalogue general character. Evidence seems to show that character traits are specific.

Those tested act differently under several situations. For example, a test to determine confidence of people has been given (16). It was decided that in order to make it worthwhile, it should be given in many situations; but the variety was so great that it was hard to express the average degree of confidence in a single individual.

In an attempt to reduce accidents, the Chicago Yellow Cab Company developed a test to determine recklessness, carelessness, emotional instability, and lack of foresight. Many other personality tests have been formed, but they have not yet reached a stage of development where they can be of real practical value.

Social Tests. Certain social tests have been devised to determine whether a person is an introvert or extrovert. Good salesmen should be extroverts. One test consists in marking off descriptions that apply best to an individual; for example,--Like a crowd, Like a few people around, Prefer to be alone, etc.

Another test involves responses made to words. (17) For example, the tester will say "chair" and the tested is supposed to say the first word that comes to his mind. A certain reply is calculated to show introvert characteristics and another extrovert. These tests are not fully standardized yet.

Summary. The number and kinds of tests are certainly extensive, and they can be of valuable assistance. Guidance should begin with tests, for they will help in a diagnosis of a case; but too much faith must not be placed in them as yet. The greatest use that they have shown is in choosing workers for particular jobs and only in a small way have they shown value in helping people choose a life career. Many of the experiments now being carried on may produce the needed supplements.

CHAPTER IV

MECHANICAL APTITUDE TESTS

As the scope of aptitude testing has widened within the past fifteen years, experimenters have concluded that there exists in some individuals a group of rather closely correlated abilities which are distinct from what has been termed "general abstract intelligence", and these are called traits of mechanical ability. In nearly all studies, their correlation with intelligence tests is very low. Some who have fallen in the lowest group in intelligence tests have been found to be among the highest in these determinants of mechanical aptitude.

Among the leaders who are outstanding in their development, Stenquist, MacQuarrie, MacFarlane, Rice, Toops, and O'Rourke may be listed.

MacQuarrie gives an opinion of the nature of mechanical ability and present attitude toward these tests in these statements: "The term mechanical ability has never been carefully defined, in fact a complete analysis would be very difficult. We assume that it takes mechanical ability to do the work of a mechanic, but we have a feeling that such ability is also used by a greater or less degree by the barber, typist, motorman, waiter, telephone operator, tailor, plasterer, dentist, draftsman, baseball pitcher and

pianist. These and many others in addition to mechanics, require manipulative skill, recognition of space relations, speed, muscular control, visual acuity and all those accomplishments which we usually associate with the mechanical trades.

No estimate of mechanical ability can be anything but rough. Nor is an accurate measurement necessary. There is no valid evidence at present to show that the carpenter requires more mechanical ability than the machinist, nor that the house-painter must develop greater skill than the plumber." (18)

There are some who believe that these tests depend chiefly upon "manipulative ability", but MacFarlane has made a thorough investigation of four mechanical tests and says that "mere motor dexterity is of comparatively small importance for success in the whole performance". (19)

Stenquist also holds that something more than manual dexterity is needed (19) and Landry concludes, after administering a battery of mechanical tests, that while they all have something in common, they do not all test the same abilities. (20)

In an attempt to get away from pure manipulation, many of the mechanical tests have been devised which are merely picture tests. Fryer makes a distinction between the types

of mechanical tests calling those of a manipulative nature, "mechanical ability"; and those of picture type, "mechanical interests tests". He also asserts that mechanical "interests" tests correlate only fair with mechanical ability tests. (21)

There is discussion as to the predictive value of both types. A few say that the only real mechanical tests are performance ones, and Clark believes that a mechanical test "should be manipulative, without the aid of pencil, paper or picture". The writer is inclined to favor this opinion also and that was one reason why he chose the Wiggly Block for use in this study. It will be explained fully in a later chapter.

Mechanical Tests Now in Use. Kelley listed but two mechanical tests in a recent book on Educational Measurements (23) which says that certain competent judges maintain that the Stenquist Mechanical Ability test is of value for group classification. The MacQuarrie test for Mechanical ability was mentioned but not rated highly enough to have it evaluated.

Bonner and Healey, however, list several tests, although some are not standardized.

The methods by which these tests strive to determine this aptitude include assembling small devices, naming tools, solving puzzle boxes, etc. Some are based upon native ability and some on acquired knowledge and skill.

Test 1. Rice's original mechanical test of interests, pictures of tools, etc. was the one from which the others were developed. The Army Mechanical Interest test was formed from this in 1920-1921. This was employed to assign men to Trade Schools.

Test 2. O'Rourke's Mechanical Aptitude test is a measure of mechanical and general trade interests. It has ninety pictures and consists of six tests. (21)

Test 3. Stenquist Mechanical Aptitude tests I and II

Test I. A series of ninety-five pictures of common mechanical objects, such as a screw driver, are outlined. In each problem the person is required to determine which one of five pictures belongs with each of five others.

Test II. Similar material with questions regarding a machine and its parts, and the mechanical processes in which they are used. While the test requires an ability to recognize mechanical relationships, it does not deal with concrete material constructively. The tests are mechanical only in a limited sense. Some prefer to state that the tests measure what might be called general mechanical intelligence. (24)

Test 4. The Detroit Mechanical Examination for boys is also a paper test which includes tracing direction of belts, naming tools, tracing, comparing geometrical figures.

Some of the pictures seemed a bit difficult. (25)

Opinion About These Picture Tests. Any one who has had experience with tools or mechanical devices will have a distinct advantage over others who have not. These tend to measure experience and training more than native capacity or perhaps interests. If one believes in a really close correlation of interests and abilities, one would say, "Well, if they show interest, they likewise predict ability"; but this conclusion is debatable.

Test 5. and 6. Puzzle Box Tests. Healy and Freeman each have a puzzle box test. The Freeman Puzzle Box has several levers which can be worked from outside the box and looked at through a glass cover. If the levers are manipulated properly, the box will open. The time limit is 5 minutes.

The Healy Puzzle Box encloses rings and strings that may be worked at through holes along the side by means of a buttonhook. Directions are: "You see that this box opens by the lid lifting up. The glass is put in so that you can see the way to open it. You can work through the holes and use the buttonhook. Study the box and if you do the things in the right order, it can be readily opened. Do not break the strings or glass. Open it as quickly as you can." Time limit for opening is 5 minutes. After the

box is opened, say, "Now close it." The time limit for closing is 10 minutes.

Wooley used the Freeman Puzzle Box as a test of Mechanical ability and found that the time limit was too short.

Healy says that the test "may bring out abilities or defects in manipulation powers in the ability to analyze a slightly complicated physical situation, in powers of attention and continuity of action." The time limit has proved much too short also. MacFarlane found this more discriminative of practical ability than any of the other tests she used.

Bronner and Healy say that the difficulty in keeping Puzzle Boxes in order no doubt has limited their use, but they believe these boxes are extremely valuable. (19)

Test 7. MacQuarrie Test of Mechanical Ability. This is divided into seven functions of Tracing, Tapping, Dotting, Copying, Location, Blocks, and Pursuit.

MacQuarrie explains: "In view of the fact that there is no standard piece of work requiring mechanical ability, this test has been developed in the hope that it might meet such a need. It is very simple. It requires for its material, paper, and for the single tool used, a lead pencil. It takes very little time to give and score. It has a high reliability and satisfactory validity. It has a very low

correlation with intelligence tests results, indicating that it measures something different. Those who take the test find it interesting and teachers of shop work have approved of it as a mechanical job." (18)

Assembly Tests Vary. Test 8. MacFarlane has a wheelbarrow and cradle test for boys and girls. Each consists of eight pieces which are made of one-half inch wood. The pieces are held together by wooden pegs. Both models are about eighteen inches long and stand about eleven inches high. The idea is to assemble as quickly as possible. It may be helpful in use for younger people, in the opinion of the present writer.

Test 9. An Automobile Construction Test similar to MacFarlane's has been used by Hayes and Dewey.

Test 10. Kelley has a rather clever test which attempts to measure creative and imaginative powers. A set of drilled blocks, boards, and pins is given to the person and he is given a definite time to construct whatever he will. The author provides thirty-nine photographs of products of various degrees of excellence in an endeavor to ensure objective grading of results, but the judgment of the examiner always plays a big part. Whereas these tests are not highly indicative of mechanical ability, Bronner and Healy feel that important features of a child's

temperamental and emotional make-up may be studied by his approach to the problem and his method of solution. (19)

Test 11. Stenquist Assembly Test. The test is made up of ten mechanical devices: a cap pistol, elbow catch, rope coupling, expansion nut, sash fastener, rubber stopper, inside calipers, four-piece paper clip, double acting hinge, and a lever lock.

Stenquist considers that the assembly tests "deal with the world of objects, real things as distinguished from words, and involve both mechanical skill and abstract mental ability. While their nature is essentially mechanical, they are in no sense trade tests, but should be considered tests of general mechanical intelligence and manual aptitude. Toops recommends this test, saying that he feels "reasonably certain that the Stenquist Assembly is to date the most important single test contribution to the measurement of general mechanical ability". (19)

Test 12. Whitman Manual Dexterity Series. This is supposed to be a test of manual dexterity alone. The material has pegboards, two hundred brass pins, adjusto tray, one hundred colored pegs, twenty bolts, twenty nuts, tray with one large and four small compartments. The pegs in certain holes with one hand one time the other another time and to assemble nuts and bolts.

Bronner and Healy feel that the test is rather cumbersome. Landry found that this test had the lowest correlation with abstract intelligence of all the tests he used. (20)

SUMMARY (of Mechanical Tests)

Some of these tests apparently are indicative of what is essential to many types of work called "mechanical".

They can be of value to the Vocational Counselor in sending boys to a Trade School, or in suggesting to them types of mechanical work to follow. However, in their present status, they should not be too strongly relied upon for a full indication, but rather as a helping medium.

Three or four authors suggest a use of several of these tests for prognostic purposes and the advisability of this suggestion is evident because it has been shown that while they have something in common, they measure different factors of "general mechanical intelligence". Then, if an individual rates high or low constantly in the tests, it should give the counselor some valuable material with which to make suggestions.

CHAPTER V

RELATION OF INTEREST TO APTITUDE

In a discussion of aptitudes and tests for them, it would be advisable for one to consider interests also because they seem to be closely allied.

The Nature of Interest. The exact psychological nature of an interest is rather difficult to explain, because many things are included--emotion, effort, concern, attention, meaning, and understanding. Interest, psychologically speaking, is the pleasure which accompanies attention to something. However, the point of consideration is the relation between interest and aptitude.

Cohen says that interest is a part of an aptitude. (1) Another author believes that an interest is an "integral part of special gifts. It is not the cause of it but is closely correlated with it."

Are Interests Predictive of Abilities? Woodworth states: "As a matter of fact human interests keep pace with human capacities. Almost always, where a child displays talent he also displays interest....Along with capacity for music goes the musical interest; along with the capacity for handling numerical relations goes an interest in numbers; along with the capacity for numerical devices goes the interest in mechanics; along with the capacity for language

goes the interest in learning to speak; and so on through the list of capacities, both those that are generally present in all men and those that are strong only in the exceptional individual." (26)

Thorndike, after many investigations, says, "The correlation between an individual's order of subjects for interest and his order for ability is one of the closest that is known (about .90).... A person's relative interests are an extraordinary accurate symptom of his relative capacities. Either because one likes what he can do well, or because one gives zeal and effort to what he likes, or because interest and ability are both symptoms of some fundamental feature of the individual's original nature, or because of the combined action of all three of these factors, interest and ability are bound closely together."

Bridges and Dollinger, however, (21) measured the relation between interest in college courses, evaluated subjectively by ranking of courses, and grades made in these courses by 500 students. The correlation was low (.22) and they concluded "that a person's relative interests are an extraordinarily inaccurate symptom of his abilities," but Thorndike said later that, with certain changes, the correlation could be raised to .70.

Prosser and Allen state that in their experience they "found in every case that the ability of pupils as measured,--

corresponded exactly with their interests in the subject taught." (27)

The relation between educational interests, estimated by children, and educational abilities, estimated by teachers from the work done, has been placed by Terman at about .40.

Fryer (21) says that Thorndike's higher correlation must be disregarded in the light of more refined methods. He places the correlation at .60.

Fryer claims also that "A correlation of about .30 would appear to represent the average relation between educational interests and educational abilities according to school grades."

The average correlation between the two factors obtained by different methods would be about .45. Results of research show them to be fairly unrelated, even more so than measures in two fields of abilities such as abstract and mechanical."

Summary. By the foregoing opinions, it may be seen that while some deny a relation, many others affirm a close relation between interests and abilities. From an everyday viewpoint, one is inclined to hold that people are generally interested in what they can do well and are willing to give time and energy to what they like to do. In the words of G. Stanley Hall, "If there is something you like to

do better than anything else, that way lies your calling." But if one looks at the matter from the vocational guidance standpoint, other elements enter the case. Knowledge of interests is indeed a help; and when aptitudes and interests are present together and opportunity given, then success will surely follow. Still, from a practical stand, just because a person has an interest in plumbing, it does not always mean he has ability to become a good one.

A person's interest is also closely joined with his information on a subject especially in the case of a young person. If he does not know much about it, or if his knowledge is distorted, his interest is likewise affected or he may have a superficial interest which experience and greater knowledge may bring to an end. In addition to this, people do not always have a clear knowledge of their own interests. Subjective estimates of interest are not considered very reliable. Many a college student is graduated who has very little idea of what he wants or would like to do.

The wise move for the counselor is not to depend merely on interests as a prediction of abilities but to administer aptitude tests also and make his directing material a bit more reliable by combining the results of the two.

CHAPTER VI

SIGNIFICANCE OF KNOWLEDGE OF APTITUDES

In the previous chapters, the nature of aptitudes and ways of discovering them have been discussed. Now suppose a knowledge of these may be considered. When one is acquainted with the interests and abilities of a person, the next problem is the discovery of what vocation or type of work offers the best chances of success and happiness for such capacities. Bring together the qualified person and the suitable work and a happy combination will be effected which will enable the individual to make the best possible adjustments for a valuable life career. This action of intermediary is the function of Vocational Guidance.

Vocational Guidance. This movement dates back to about 1908 when Professor Parsons of Boston University opened his office to advise young men in their vocational choice. Since that time, the idea has spread rapidly and today many large cities have Departments of Vocational Guidance as well established units of the Public School program. Among the cities now maintaining activities of this nature are Los Angeles, New York, Chicago, Cincinnati, Boston, Atlanta, Providence, and Springfield.

What It Is. The National Vocational Guidance Association in 1924 defined the term "Vocational Guidance" as "The

giving of information, experience, and advice in regard to choosing an occupation, preparing for it, entering it and progressing in it." (28) It further explained the need of Vocational Guidance because of many faults in the general method of choosing a career.

Reasons for Guidance. Myers states that "Nearly 1,000,000 boys and young men and approximately 500,000 girls and young women in the United States each year face the problems involved in entering wage earning occupations. (29) It is a well known fact that many of these have very little idea of their abilities, interests, or what the world has to offer. They drift from one place to another and work wherever a dollar may be earned. While doing this, they waste many valuable years. Maladjustments result; real abilities lie hidden; and often the person is very unhappy at his work, which unhappiness affects his whole life in many other ways. But it is not only a loss to the shifter; industry also suffers because labor turnover causes losses of millions of dollars annually in the United States. In addition to these losses, the failure of the individual to find suitable outlet for his aptitudes produces a bad social effect, inasmuch as the discontented worker is not a satisfied member of a community. He becomes pessimistic and a real social liability. In view of these facts, it may be clearly seen that Vocational Guidance is needed. It is

valuable especially in this competitive age when all vocations appear to be overcrowded. If there is a correlation of capacities, interests, and opportunities, then efficiency and contentment will be realized.

Important Factor in Education. Employment managers are well aware of the problems stated above and they have been using some of the methods of Vocational Guidance over a number of years in their choice of those most suited for different positions in an attempt to better conditions. Personnel managers, trained for this choosing, have made use of the interview, rating charts, high school records, letters of recommendation, letters of application, and other specific means, suitable to the individual case. Some of this has been rather unscientific and unreliable, but within the past few years much improvement has been evident. Yet even with this increase of efficiency, educators realized that the problem was not one merely for industry to solve; it should be an important factor of education. Since the objects of education are concerned with the preparation of the individual to take a worthy and intelligent participation in the institutions of society, and since it has been shown that young people do not know enough about vocations or are inadequately informed about their own capacities, education must assume the duty of changing this condition.

Education must cooperate with industry on a broad scale; it must feel the need and revise its curriculum in accordance.

School Curriculum Needs Closer Correlation with Civic Life. Surveys reveal that, in general, school work is insufficiently connected with the life of the community. Not enough provisions are made for a broad understanding and practical participation in civic life.

It is unfortunate that economic dependence plays such an important part because it no doubt limits the scope of diversity. Today we hear, from several sides, complaints of overburdened tax-payers to the effect that the schools are crowding useless courses into the curriculum. Some even, unwisely and unintelligently, have reverted to sarcasm and ridicule in their condemnation of a wider curriculum. But a narrow view has prevented their seeing this vital need which will eventually fall back on their own shoulders, since society ultimately suffers from losses caused by the "misfits".

Charles W. Eliot, late President Emeritus of Harvard University, says, "We must reorganize the old fashioned curriculum, we must seek to introduce new means for the revelation of aptitudes, we must endeavor, more and more to put into the schools the activities of everyday life--the workshop, the laboratory, the studio, the kitchen, and the garden, and as far as practicable, link them up with

theoretical education." (30)

What Can the School do to Aid This Problem? What is being done? Many cities already have well organized and active units that are accomplishing satisfactory results, but it is only a beginning. Their plans are somewhat as follows. Both educational and vocational guidance are included.

The Elementary School. In the first six grades, the objects of education are to inculcate specific habits. At first the three R's were the essentials, but since then humanizing elements have been added such as literature, music, art, etc. Later, scientific studies found their way into the early years of school life. Now an industrial element has been introduced in some schools. A choice of information about the industries that supply the most common needs is made, and while no special teacher is needed for the work, the subjects may be worked into the curriculum and a part of the day devoted to it and other subjects correlated with it. No elective subjects are planned, but are all prescribed.

Proctor says that the important contribution of elementary education to this factor of guidance is to determine the rate of progress. McCracken is quoted as giving the opinion that "While it is not to be expected that anything in the

nature of specialized vocational training will be given in the elementary grades, opportunity should be given for information about many different vocations." (31)

Brewer believes that occupational information should also be given in the grades and Myers does not quite agree, feeling that the differentiating factors should be left for a later period of life. (32) The present writer is inclined to believe that while general information about the growing of vegetables, lumbering, mining, clothing, shelter, etc., may be given and thus serve as a basis for further knowledge about these fields, care must be taken not to become too specific and attempt to form opinions too early.

A cumulative record card may be kept to save teachers' and counselors' observations which may be used all through the school career.

The Junior High The Real Beginning of Differentiation. Since the Junior High School was established with opportunity for exploration as one of its aims, here guidance can really begin the discovery and preparation of life careers. Davis (33) states: "Of all the functions of the Junior High School, that which seeks to aid pupils in discovering their own capacities and limitations, interests and distastes, powers and weaknesses, is, in the judgment of the writer, most important."

In addition to a basic curriculum, tryout courses include agriculture, household arts, industrial arts, mechanical drawing, commercial work. The amount of time given to these and the kinds of courses varies with different localities. Eighty-eight percent of the Junior High Schools of North Central territory offer manual training and domestic arts and sciences. Sixteen percent offer commercial work. Only five percent offer distinct Vocational work and eight percent printing. (34)

Those who are in charge of these courses keep a close account of the interests and abilities of the students who have elected the various try outs. This can be given to the counselor and he can act in accordance.

Benefits from Junior High Guidance. By offering a wider opportunity to meet individual differences, many who might leave school early are urged to remain longer. This is valuable to industry because child labor is one of its biggest problems. By finding something that has interest and in which they have ability instead of developing a "failure complex", they acquire the feeling that there is something which they can do. Many thousands of children leave after Junior High School, and consequently this middle school can accomplish much in attacking the problem.

Extra Curricular Activities Help. Besides the curricular

studies, much emphasis is being placed upon extra-curricular work in Junior High and also in High Schools. Many urge that these are the best means of revealing interests and aptitudes. When the formal curricular studies turn to and freely choose what strongly appeals to him.

The Washington Junior High School at Rochester, N. Y., has about sixty different clubs: wireless, radio, camp lore, pottery, music, and many others. These clubs are really apart from school work, but offer exploratory experiences and are often the initial step in a life career. Many a talent or interest is revealed or enlivened by participation in one of these and the best part of it is that the student elects on his own ideas and selects what he likes best. (34)

Guidance in The High School. In the two lower schools, the guidance is primarily of an educational type, whereas in the Senior High, Educational Guidance, is included; but the actual helping in the making of a choice of life career is given. Opportunities for exploration should be given, but a more definite guidance program must be established.

Program. The High School should have a counselor skilled in the work and with whom all the faculty should cooperate to the full extent. In his office, complete records, that have been gathered from primary grades right through, should be kept on file. Some of the methods he would employ, as outlined by many authorities in addition

to tryout courses, are as follows:

A well ordered use of wisely chosen tests needed. The counselor may make a careful and discriminating choice of tests and administer them to groups in the school. The tests which have been mentioned previously for determining general intelligence, special aptitudes, and personality are an important cog in the machinery. When they have been given and scores accounted, the records may serve later as valuable information to the counselor in his suggesting.

If a sufficient number of these tests were proved positively indicative of what they try to measure, then the counselor's work would be lightened indeed. But a vast amount of improving must be performed to place the tests on such a solid foundation.

Presenting Occupational Information. Douglass explains that the life career course serves a three-fold purpose: (35)

1. To arouse in the pupil an interest in the matter of vocational choice so that information from any source in the next few years of his life will be utilized for the light it may throw upon his problem of choosing a life occupation;

2. To furnish the pupil with standards, criteria, and a method of approach to the study of a vocation as a possible occupation for him;

3. To furnish the pupil with information about the more important occupations, especially those in which he is interested.

A Test Should Be Used. A regular text should be used for such a course and a few cities have issued many bulletins and pamphlets which give vocational information. In advising about a text for such a class, Brewer says, "The text book should be supplied with exercises and should provide for the study of printed matter, visits, interviews, original investigations, reports, discussions and debates. It should candidly state the difficulties and problems in the occupations, and should touch on the social and economic questions necessary to be understood".

A special section should be set aside in the library for books pertaining to vocations. The pupils should be trained to use these and also other information available to a central library.

Notable studies of occupations have been made in Detroit, Philadelphia, and Chicago which have been published for use by those interested in the work of Vocational Guidance.

Visiting Industry Helps. As a supplementary and helpful adjunct, a visit to various industries can do much good. Tact must be exercised by the counselor in arranging and conducting these visits. The factory superintendent should be made to realize that these visits will help to advertise his products.

It is really amazing how very limited is the knowledge

of students about industries even in their own locality. The writer has asked pupils questions which one would imagine were common knowledge, but no answer was forthcoming. The writer also has visited different industries with groups, spending two or three hours. When all returned, a discussion of what was seen would be held and a wealth of splendid first hand information was revealed. Then the particular industry would be treated from various angles.

Special Assemblies Help. Men of the different vocations and professions may speak at assemblies outlining the advantages and disadvantages, chances for success, etc. If the school has a motion picture machine, it may be used with great benefit to show actual functions of life's jobs.

By an intelligent use of all these, the counselor can present a clear idea of what the world has to offer.

The Interview Should be Open to All. The Counselor must be a man who will inspire confidence, one who likes and understands young people. By use of an interview, he may acquire a knowledge of certain factors that might not be learned otherwise. Proctor would give this a central place in the guidance program. "No amount of information gathered, either in the form of general information blanks or self-analysis blanks, or as the result of mental, subject-matter, and vocational-aptitude tests can remove the

necessity for personal, first-hand knowledge by the counselor of the person to be counseled." (36)

These interviews may include talks to teachers and parents also. It is found better to have prepared blanks and the final choice must rest with the individual, because the counselor should never force a person into some line of work any more than a fond parent should force her son to become a doctor. Wise suggestion is the key-note.

Placement Bureaus Help to Complete a Well Rounded Program. In some schools, a close contact is kept with industry. The counselor and employer collaborate to fill positions with those who are capable. This service is valuable, because it enables the student, even though he may be skilled, to make the proper connections and all the previous work of guidance is likely to prove of little worth. To the writer, this is one of the truly important functions of guidance and one which at present offers the greatest barrier. Many thousands are leaving school each year and the jobs they might obtain are rather scarce. The writer recalls a certain business school which five years ago guaranteed to place its students and which now finds itself able to do this only on a very minor scale. The whole program of Vocational Guidance is going to be retarded by economic conditions, but without a doubt when business improves, it

will progress rapidly.

Closely allied with placement is the follow-up process. In this way, a checkup can be made to determine the success of the individual to see if he is contented or if a change is needed, and, consequently, how beneficial the guidance program has proved. The Springfield Trade School follows up its graduates closely and this practice appears to be customary in other Trade Schools.

A report of follow-up work done in New York with children who have received guidance is given by Dr. Clark: (37) "This report describes the results of educational and vocational guidance given to 556 students of graduating classes of six elementary schools of New York. This group was guided by the school counselors in the fall of 1920, and the follow up of each student has been carried on for a year and a half.

"The following results have been found: sixty-seven percent were advised to go to High School, twenty-six percent to Trade School, eleven percent to special schools, and five percent to work. Forty percent of the pupils already had places that were O.K.'d by the counselor."

Records of visits by the counselor to the industry where placements are made must be kept and the visitor must remember to maintain a spirit of friendliness with all who are kind enough to allow this privilege.

Other Ways of Helping Industry Solve the Problem. In addition to the methods outlined, education has established Trade and Continuation schools where specific training is given. In these departments of education, many of the children who could not find interest or success in a comprehensive or academic school prove to be highly efficient in the courses offered. The writer remembers the case of one boy in such a school who went merely to the sixth grade. The boy was labeled very incapable in the academic school, but his knowledge and explanation of how an involved geometrical figure could be applied in an actual piece of work once put the writer to shame.

The work that these special schools is accomplishing has tremendous weight in assisting industry to get the right men.

Clark, of the Springfield Trade School, which is a fine example of such a type of school, explains the organization as follows: (22) "It is organized on a deportmental basis and includes the following trades; printing, electricity, machine work, pattern making, cabinet making, sheet metal work, automobile repairing, and drafting. A boy spends one week in the shop, the next in class where the work is equally divided between strictly academic studies and what are called "related" subjects of trade science, mathematics and drawing".

Cooperative Trade Schools. In some of these schools, the cooperation with industry is even more close and they are called Cooperative Schools.

Prosser and Allen mention the cooperative school at Beverly, Massachusetts, as one of the best. (38) It cooperates with the United Shoe Machinery Company. Another is operated at Southbridge, Massachusetts, in union with the American Optical Company. Many of these schools are operating with real satisfaction to the industries with which they are allied and these authors believe that this type of Trade School obtains better results than the non-cooperative type of Trade School.

Plans were mentioned in Enfield, Connecticut, to have courses given to High School students interested in the rug industry by capable men from the Bigelow Sanford Carpet Company. This could develop into one of the units of the proposed Trade School and perhaps doubly pay the Mill Associates for any assistance given.

Summary. The foregoing subjects have been treated briefly, but they portray to some extent what is believed by authorities in the work and what is actually being done. Progress has certainly been made, but this particular phase of education offers a wide field of investigation and broad opportunities of proving practically beneficial to the taxpayers, if they will but see it clearly.

CHAPTER VII

PRELIMINARIES TO MY RESEARCH

1. Town of Enfield

An explanation of the field in which the thesis is concerned is as follows:

The Town of Enfield, which is situated on the East bank of the Connecticut River, below Springfield, has a population of 13,403 people. It dates back 253 years, and includes three townships, Thompsonville, Hazardville, and Scitico. Its industries are agriculture, rugs, carpets, coffin hardware, builder's supplies, papers and textiles.

Thompsonville, where the High School is located, is called the Carpet City, because here is located the largest unit of the Bigelow Sanford Carpet Company. This Company has 31 buildings and employs over 3000 people when in full operation.

Enfield High School. The High School, which is a modern brick building with a capacity for five hundred, is located in Thompsonville. It is about eight years old and was erected at a cost of approximately two hundred and seventy-seven thousand dollars.

In order to relieve crowded conditions, a two-session plan was adopted this year. The Seniors, Juniors, and Sophomores attend what is called the Senior High from eight un-

til twelve-thirty in the morning and the Freshmen go from one until five in the afternoon.

The School offers a variety of curricula including full academic, partial academic, commercial, and vocational courses. (The greater number electing Commercial or Vocational.) There are over eight hundred students, many of whom are Polish and Italian. About one hundred tuition students attend from three surrounding towns. The faculty numbers twenty-six.

2. Selection of Wiggly Block Test

In selecting a suitable test for determining mechanical ability, the following factors were considered. A test was sought which had proved to be highly significant mechanically; one which would appeal to those tested and which had been administered to large numbers, the results of which might serve as a helpful comparison in this research.

The Wiggly Block was chosen because it has proved to be highly indicative of the amount of mechanical ability present in an individual. Dr. Johnson O'Connor, at present on the faculty of Stevens Institute, through five years of administering this test to over four thousand people in the General Electric Company has rather conclusively proved that "the assembly of the Block necessitates a peculiar type of analysis, characteristic of engineers and mechanics. The

ability measured by the block is strictly mechanical analysis, distinct from analysis in general, and is a requirement for success in every class of work calling for the solution of mechanical problems, in tool and die making, all-around machining, machine setting-up and repairing, structural iron and sheet metal work, designing, drafting, scientific research work, laboratory experimenting and technical designing and construction engineering." (39)

The block is a puzzle and appeals to all. It is particularly of interest to those tested now because of the puzzle craze. Several of the boys remarked, "This is just like a jig-saw puzzle." It was chosen because it was calculated to be of interest, and it proved to be such, for the majority enjoyed doing it and after their scores were recorded, many returned to try it again.

In addition, the Block had been used in testing about six hundred students at the Springfield Trade School and some interesting and helpful results were recorded. Inasmuch as the prime purpose of this bit of research centered in the establishment of a Trade School, it was decided that the fact that it had been given in a Trade School so near would serve as a splendid comparison. How would the boys in Enfield High compare with those in a Trade School?

The test had also been tried on 200 boys at West Springfield High School and the information gathered there was a

still further incentive for comparison.

3. Description of the "Wiggly Block" Test

The Wiggly Block or Work sample #5, (39) as it is called, consists of nine irregular pieces which when fitted together form a solid block. The time required for assembly being the measure of mechanical ability.

Dr. O'Connor tested over four thousand people and their scores were carefully recorded. Norms were established for each age and age factors were worked out for ages from sixteen to nineteen. He found that the most rapid thousand complete the assembly in two minutes and three-quarters or less. The slowest thousand take more than six. Four groups have been established A, B, C and D.

SCORE		GRADE
Men	Women	
0.25-2.75	0.25-4.00	A
2.76-4.00	4.01-6.50	B
4.01-6.00	6.51-10.00	C
6.01-up	10.01-up	D

By following those hired, those in industry, and those who quit, Dr. O'Connor would say that the chances for mechanical success for the four classes as rated by the Wiggly Block are as follows:

A	80	out	of	100
B	66	"	"	100
C	29	"	"	100
D	6	"	"	100

In his book "Born That Way", Johnson O'Connor says:

"A mechanical genius subconsciously recognizes the nine pieces as of 3 types, corners, sides and center. One less gifted in this line, but with nevertheless, a trace of structural instinct, consciously and often actually assorts the 9 blocks into three separate piles on the table, and then selects as he needs the pieces. One without this natural aptitude picks aimlessly any block, without recognizing the 3 types. This man almost invariably consumes six minutes or longer, as compared with two or three minutes of the gifted mechanic. The distinguishing mark of a good mechanic or successful engineer is ability to visualize structure so clearly that analysis is made easy."

Directions. The following is an exact copy of the directions for administering the Wiggly Block. This wording and procedure were carefully followed.

ADMINISTRATION OF WORKSAMPLE

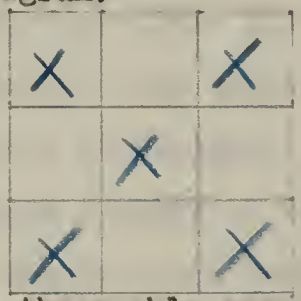
NO. 5

Place the assembled block before the examinee with one end facing him. (40) "This is made of nine wiggley pieces like this." Take one of the top corner blocks in the hand.

"I am going to mix them up and have you put them together again." Return the top corner block to its original position. "Notice carefully how it is made. It is sawed through into three piles, with three blocks in each." Separate the blocks into three vertical piles, of three blocks each, amplifying the description freely with gestures, so that a person who has difficulty in following the language will understand from the motions. Move the hand through twice, as if cutting the formation into the three piles. Touch each pile as it is mentioned,also the separate blocks. Next push the three piles together, making the block as originally assembled. "It is also sawed through into three layers, with three blocks in each." Remove the top two layers of three each, and place them on the table beside the bottom layer, a few inches from it. Then lift the top layer of three from the middle layer and place it so that the three layers are arranged before the examinee in the order, bottom, middle, and top. Separate the three blocks for a moment in the middle layer and then in the top. Reassemble again by placing the middle layer on the bottom, and then the top layer above these. "Remember that it is three blocks high and three blocks wide. Now I shall mix them up." Do not hurry the explanation; allow time for each step to be followed and understood.

Disassemble the block in full view of the examinee.

Turn the two upper corner blocks end for end, and put them on the table. Place the center block from the top, and the two side blocks from the center layer with the first two, without turning end for end. In the same way, turn end for end and place in the pile, the middle block in the center layer and two corner blocks in the bottom layer. The center block in the bottom layer put in the pile without turning end for end. The blocks to be turned are marked with crosses (X) on the following diagram.



Now mix the blocks thoroughly enough so that the examinee cannot follow individual pieces, taking care to turn none end for end, and then spread them out once more, so that the blocks are arranged in a neat row, parallel to one another, an inch or so apart, and with one end of each toward the examinee. They should not be piled on top of one another or left in an irregular order. Leave a free space of approximately a foot in front of the blocks for the assembling operation. Arrange the test to indicate as nearly as possible mechanical ingenuity and to be affected as little as possible by dexterity, or any other complicating character-

istic. Piling the blocks in a heterogeneous pile, without working room, requires more dexterity in reassembling then arranging the blocks neatly and providing free working space.

Take care not to say a word of any kind during reassembling. Refraining from giving help through a word or motion of guidance presents one of the most difficult parts in administering the test.

Time the reassembling in minutes and hundredths. Tell the examinee whether he has been fast or slow, using judgment in doing so, not to discourage him unduly if he has done poorly. Having answered any questions which the examinee has to ask, proceed as follows: "We take the average of three trials simply because it is a little fairer than giving only one. Try it again in just the same way." Mix the blocks as before with no more explanation than the above three lines. Repeat a third time with the words, "Try it once more. This is the last time."

SCORING OF WORKSAMPLE NO. 5

Enter separately, in minutes and hundredths, the times of the three trials. Multiply the time of the first by 1.0, the second by 1.4, and the third by 1.7. Add the results and divide by 3.

First .... X 1.0 = ...
Second.... X 1.4 = ...
Third .... X 1.7 = ...
Sum ....
Final Score (Average) ....

"In evaluating the second trials, O'Connor uses what he terms, 'Improvement Factors' before obtaining the average of the three. These factors were obtained by dividing the sum of the first trials of a great many cases by the sum of the second; and the sum of the first trials by the sum of the third trials. Thus multiplying the second trial by 1.4 and the third trial by 1.7 gives scores that are comparable with the first. It also helps to give an examinee a fair score in case, for some reason or other, only one or two trials could be scored. On the surface, this method of scoring the trials would seem very fair to the individual, since it penalizes the boy who by 'trial and error' reasoning might hit upon a quick solution for the first trial, and without actual mechanical reasoning, would not do so well the second and third. On the other hand the boy, who, for his first trial, took the time to analyze properly his problem and mastering it completes the second and third trials in short order, finds that the improvement factors have worked to his advantage." Mr. Hermon Clark at the Springfield Trade, whose explanation of the "Improvement Factors" has just been quoted, found that 1.5 and 2.00 were his improvement factors and after consulting Dr. O'Connor was advised to use these. (Mr. Herbert Landry at West Springfield used these and they are used in scoring those tested in this research.)

CHAPTER VIII

COLLECTION OF DATA

The first source of information was the Wiggly Block Test. Before giving it to others, the writer practised assembling it several times so that the same fate would not befall him which happened to a professor of psychology at a university in one of our large cities who was bringing a Wiggly Block into class one morning and dropped it. Unable to reassemble it, he left it on the desk disassembled, much to the amusement of all present.

Testing Procedure. The testing was begun early in September and continued for several weeks because each boy had to be tested individually and some required a rather long time to assemble the block. The boys were asked to return after classes were completed to take the test but at first this plan was hindered because a number traveled home in school busses and found it necessary to leave immediately after school closed. However, they kindly agreed to remain certain days.

A regular classroom was used as a laboratory and the person worked at the front of the room. Sometimes a few other students would be present, but they were advised to stay in the back and not interfere. The room did not offer

the full psychological setting which Dr. O'Connor suggests, but Mr. Clark at Springfield Trade School in his thesis on the Wiggly Block worked under conditions similar to those in this research and found that the scores did not appear to be affected. Nor do the scores in this testing show effects. In fact, they are better. A stop watch was used for all timing and close account was kept. A short explanation of the block was given to each one, telling how it had been taken by about 4000 at the General Electric Company and also by many at the Trade School. Then the directions as outlined in another chapter were followed verbatim.

It was interesting for the writer to watch the various methods of attack. Some would immediately set to work and without apparent delay reassemble the Block quickly. Many would say after a few minutes, "I'll never get this", but with a little encouragement succeeded and improved their second and third trials. Others would fumble, twist, and turn the pieces without the slightest idea of the connection between parts. And a few had to give up even after twenty minutes was allowed for their first attempt. Two boys who are academically superior were compelled to give up in this way and it seemed strange that they were not able to assemble at least some of the pieces.

Questionnaire. As each student presented himself for

the Wiggly Block Test, he was asked the following questions to ascertain if he really desired to attend a Trade School, some idea of his vocational aim, and if at present he possessed mechanical interests.

1. Name?
2. Age?
3. Course taken in the High School?
4. Would you like to attend a Trade School?
5. If so, what trade would you want to prepare for?
6. What do you think you will do after High School, College, Business, Trade?
7. Do you ever work on automobiles, radios, or other devices?

The responses to these inquiries were varied and a summary of their answers is given later.

The Terman Test of Intelligence. After the Mechanical Aptitude test had been taken by the 200 boys, the Terman test was administered to determine their intelligence rating. This device for testing intelligence seemed easy to give and the writer was aided by two others. It was necessary to extend it over six successive school periods without any time in between to allow for collaboration. The direc-

tions as outlined in the Manual of Directions were followed verbatim, covering the exact time limits and other requirements. While the test was not hard to give, the scoring was rather prolonged. It was possible to score only about eight tests an hour and approximately thirty hours in all were taken to complete the scoring.

The special features of the test and the procedure are outlined as follows in the Manual of Directions published by the World Book Company of New York.

Special Features of this Test. This test embodies many of the general features of other well-known scales for group testing. It differs from others in the following respects:

1. It is designed primarily for use in Grades 7 to 12, although it may be used also in Grade 6 and with first-year college students. Such restriction of the scope makes possible simplification of procedure, reduces the time required for securing a measure, and favors accuracy.

2. The test as it stands is composed of questions and problems which were selected from a much larger number by correlating each separate item with a dependable measure of mental ability. The criterion used for this purpose was a composite which included grade location, age, total score on a two-hour mental test, and ratings of the pupils by from

two to five teachers on intelligence and quality of school work. The trial series was composed of thirteen tests with a total of 886 items. Try-outs of these resulted in the elimination of three of the thirteen tests, and in the reduction of the 610 items in the remaining tests to 370. All items which failed to differentiate pupils of known brightness from pupils of known dullness were eliminated. Since only the cream of the original material was retained, it has been possible to reduce the length of the examination considerably below the limits which otherwise would have been necessary.

3. The time allowances for the separate tests are more than ordinarily liberal, in view of the reduced number of items. Power, rather than speed, determines the pupil's score. Yet, because of economy of time in the procedure, the examination easily falls within a school period of thirty-five minutes.

4. Special attention has been given to simplicity and convenience. The directions can be mastered by any teacher in a few minutes. The personal equation of the examiner is reduced to a minimum. Each test is given two, three, or four minutes, half minutes being avoided. The typographical arrangement of the tests favors ready interpretation and promotes ease of scoring. The pupil does no writing. The size of the examination booklet makes it

possible to test pupils in an auditorium or other room not equipped with desks. The scoring keys are especially convenient to use. On the back of each key are all the rules for scoring the test to which the key corresponds. A Manual of Directions and a set of scoring keys are included in each test package, doing away with the necessity of ordering these separately.

THE TEST PROCEDURE

(To be followed verbatim)

"Here is a test to see what pupils can do. I will give each of you a test book. Do not open it until I tell you to." (Examiner sees that this is obeyed.)

After all are provided with blanks and pencils: "Now fill the blanks in the first seven lines at the top of the first page. Do it as quickly as you can, but write plainly." (Time for filling blanks should ordinarily not exceed 2 or 3 minutes.)

After blanks have been filled: "Attention. Listen carefully to what you are told to do. Ask no questions. Do not look at your neighbor to see what he does. Do not begin till I say 'Go.' When I say 'Stop,' you must stop instantly and hold your pencils up. Both speed and accuracy will count toward your score. Try each question, but do not spend too much time on one you do not understand.

"Now turn over the page to Test 1, and fold your books back, this way." (Examiner illustrates, holding his book up and folding the backs together.)

TEST 1. INFORMATION

"Read the directions at the top of the page: 'Draw a line under the ONE word that makes the sentence true, as shown in the sample.' Ready--GO!"

After 2 minutes, say "STOP! Turn over the book to Test 2."

TEST 2. BEST ANSWER

"Read the directions at the top of the page: 'Read each question or statement and make a cross before the BEST answer, as shown in the sample.' Ready--GO!"

After 2 minutes, say "STOP! Turn over the page to Test 3. Fold your books back."

TEST 3. WORD MEANING

"Read the directions at the top of the page: 'When two words mean the SAME, draw a line under "SAME." When they mean the OPPOSITE, draw a line under "OPPOSITE."' Ready--GO!"

After 2 minutes, say "STOP! Turn over the book to Test 4."

TEST 4. LOGICAL SELECTION

"Read the directions at the top of the page. 'In each sentence draw a line under the TWO words that tell

what the thing ALWAYS has. Underline TWO, and ONLY TWO, in each line.' Ready--GO!"

After 3 minutes, say "STOP! Turn over the page to Test 5. Fold your books back."

TEST 5. ARITHMETIC

"Read the directions at the top of the page: 'Find the answers as quickly as you can. Write the answers on the dotted lines. Use the bottom of the page to figure on.' Ready--GO!"

After 4 minutes, say "STOP! Turn over the book to Test 6."

TEST 6. SENTENCE MEANING

"Read the directions at the top of the page: "Draw a line under the right answer, as shown in the samples.' Ready--GO!"

After 2 minutes, say "STOP! Turn over the page to Test 7. Fold your books back."

TEST 7. ANALOGIES

"Read the first sample at the top of the page: 'EAR is to HEAR as EYE is to'--what?" (Wait for correct response.)

"Yes. Read the second sample: 'HAT is to HEAD as SHOE is to '--what?" (Wait for correct response.)

"Do them all like the samples. Ready--GO!"

After 2 minutes, say "STOP! Turn over the book to Test 8."

TEST 8. MIXED SENTENCES

"Read the directions at the top of the page: 'The words in each sentence below are mixed up. If what a sentence means is TRUE, draw a line under "TRUE." If what it means is FALSE, draw a line under "FALSE." Ready--GO!"

After 3 minutes, say "STOP! Turn over the page to Test 9. Fold your books back."

TEST 9. CLASSIFICATION

"Read the first sample at the top of the page: 'bullet, cannon, gun, sword, pencil.' These are all names of things to fight with except 'pencil,' so 'pencil' is crossed out.

"Read the second sample: 'Canada, Chicago, China, India, France.' These are all names of countries except 'Chicago,' so "Chicago' is crossed out.

"In each line cross out the word that does not belong there. Cross out JUST ONE WORD in each line. Ready--GO!"

After 3 minutes, say "STOP! Turn over the book to Test 10."

TEST 10. NUMBER SERIES

"Read the first sample at the top of the page: '5, 10, 15, 20, 25,'--the next two numbers would of course be 30, 35.

"Now read the second sample: '20, 18, 16, 14, 12,'--the next numbers would of course be 10, 8.

"In each row try to find out how the numbers are made up, then on the two dotted lines write the two numbers that should come next. Ready--GO!"

After 4 minutes, say "STOP! Close your books." (Examiner collects books immediately.)

School Marks. The final source of information was the records of school marks which are kept in the principal's office. Each student has a card on file with space for his record in every subject covering all marking periods extending over his whole High School career. These were consulted and a scholastic classification of each student was made by taking an average mark. For example, if the person had three marks of B rating and two of A rating, he was classed B+. Some, being only Freshmen, did not have many marks by which to be judged, and perhaps their present record is not a true indication of what their whole career in High School will be, but at least it is their present standing, in which this study is chiefly interested.

CHAPTER IX

STATISTICAL INTERPRETATIONS

In this chapter, different statistical methods will be used. First an explanation of these methods and how to interpret them will be given and then they will be applied to the data gathered in this research.

Statistical methods make collected data more easily understood. They add to the accuracy and validity of interpretation. That is, they increase the validity of interpretation and not of the data themselves. They help to analyze, summarize, and interpret data.

In the following pages, graphs and charts will be used to show the median, coefficient of correlation, partial correlation, multiple correlation, probable error, and explanation of these terms will now be given. (41)

a. Median. This is a measure of central tendency. It is the middle score when all the scores have been arranged in order of size. It gives an idea of the representative measure of a group.

b. Meaning of Correlation. By this we mean the comparison of standing of individuals in different forms of endeavor. For example, is there a tendency for pupils who do well in class work to do well also in their tests and do those who are failures in one, also show the same re-

sults in the other? Or to bring the illustration to this work, if those who get high ratings in their class work also scored high in the intelligence test, then one would conclude that the test and marks correlated. If there were a marked correspondence then one might say that the correlation is high; but if this relation were only slight, one would say that the correlation is low. Often correlation is used as a measure of degree to which one measure can be predicted from another, but one must be very careful in one's interpretations and not go beyond what is actually shown by the figures.

c. Coefficient of Correlation. This is a number which expresses the relation between, or degree of correspondence between, two sets of variables. It ranges from a (+1) to a (-1). Plus one means full correlation and minus one means no correlation. Two things determine the value of a coefficient of correlation and they are both necessary. The first one is magnitude. No coefficient below (.30) is good. The second is the relation to the probable error. No coefficient is good unless 4 times the probable error. (41)

d. Partial Coefficient. It is sometimes desirable when three or more variables are involved in determining a factor to eliminate one of these and see what correlation exists between the two variables when the third one is

"partialed out."

e. Multiple Correlation. This is a correlation between a combined score and a criterion. It gives a little higher correlation.

f. Probable Error. This is a measure of reliability. It is used with the coefficient of correlation and means that it is very likely that the true coefficient of correlation has: 1 to 1 chance of falling within $\pm$ 1. P.E.
4.5 to 1 chance of falling within $\pm$ 2 P.E.

Inasmuch as all possible cases are not used but a sample taken, the P. E. is used to give the probable magnitude of the true coefficient.

Application to Data Collected

1. Figure 1 shows the school median in the distribution of Wiggly Block scores. These scores ranged from .81 of a minute to impossibility of assembly and the middle score of each age is also shown in Figures 2 and 3. Whereas the school median is 3.27, three age groups are below this and two above. The lack of gradual decrease according to increase of age is not apparent here as found in other studies.

2. The norms that have been found in this research may be added to the information already found on the Block test.

3. The improvement factors of 1.4 and 1.7, which are the standard figures, were used for the first scores, but Landry and Clark found that 1.5 and 2.0 were more applicable

Figure 1 shows the Distribution of Weekly Block Scores which were obtained by using the improvement factors of (1.4) and (1.7). The Median Score for the whole group is 3.27 minutes.

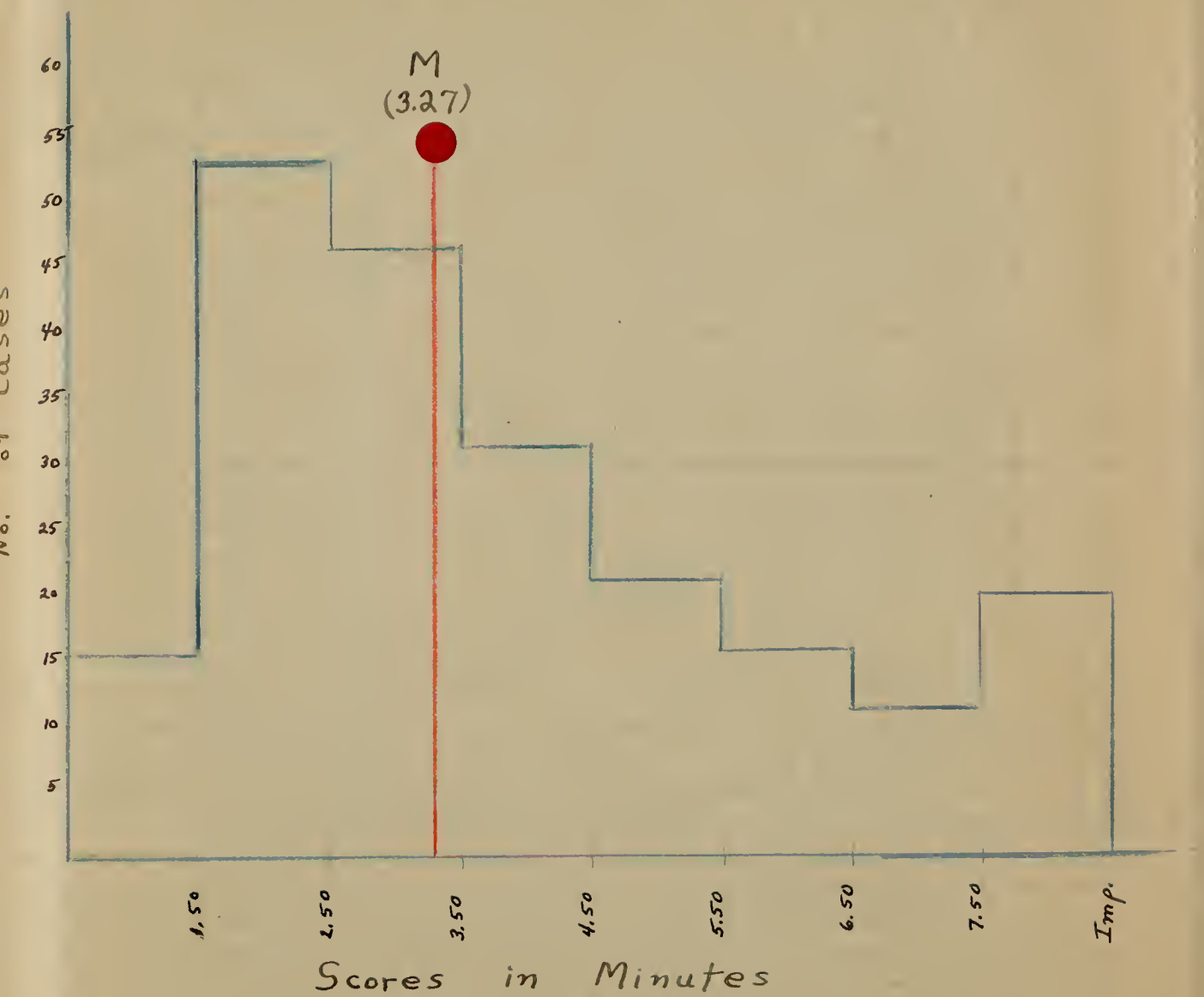


Figure 2 shows the Distribution of Wiggly Block Scores and the Median Score for the ages 14, 15, and 16.

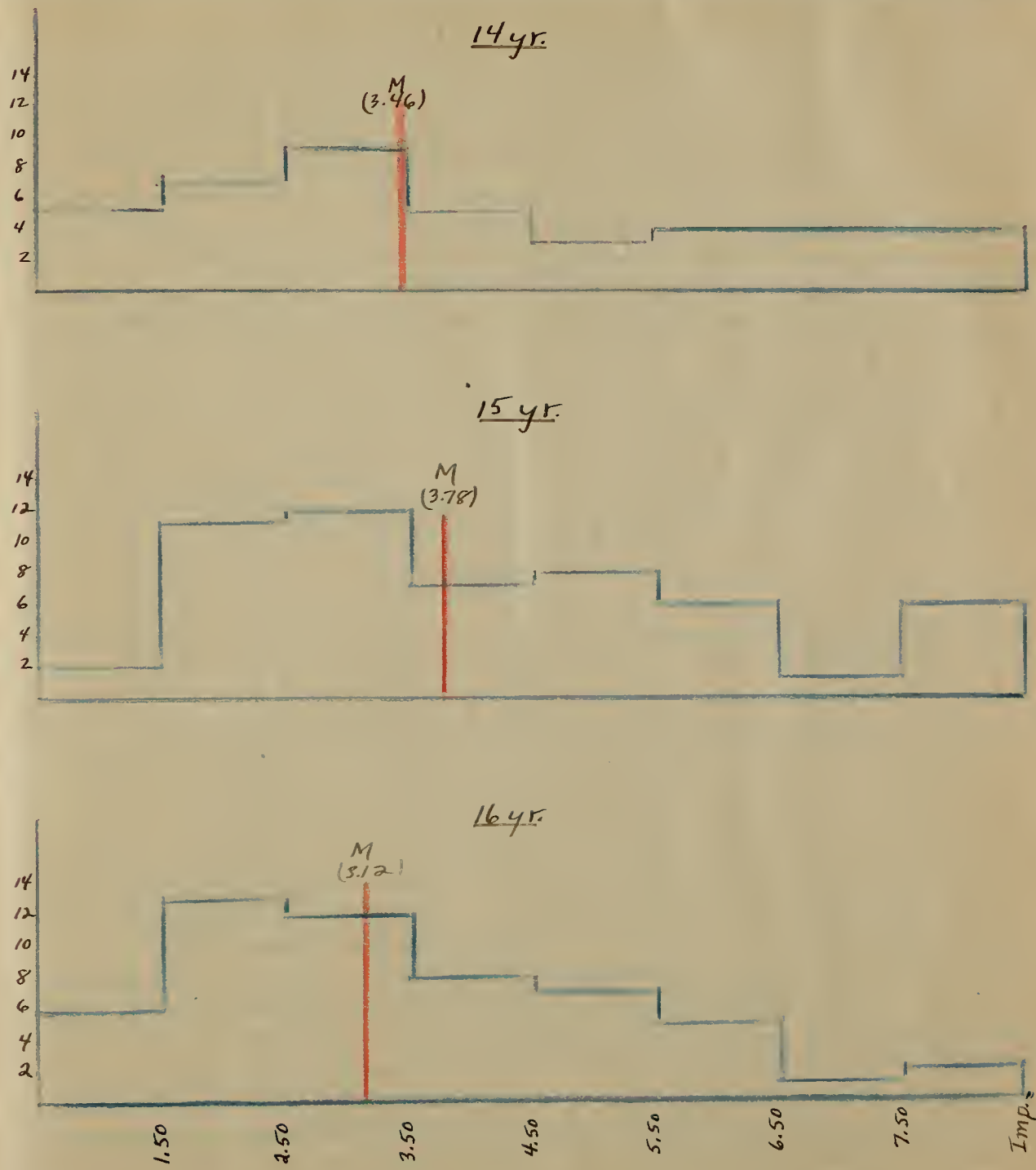
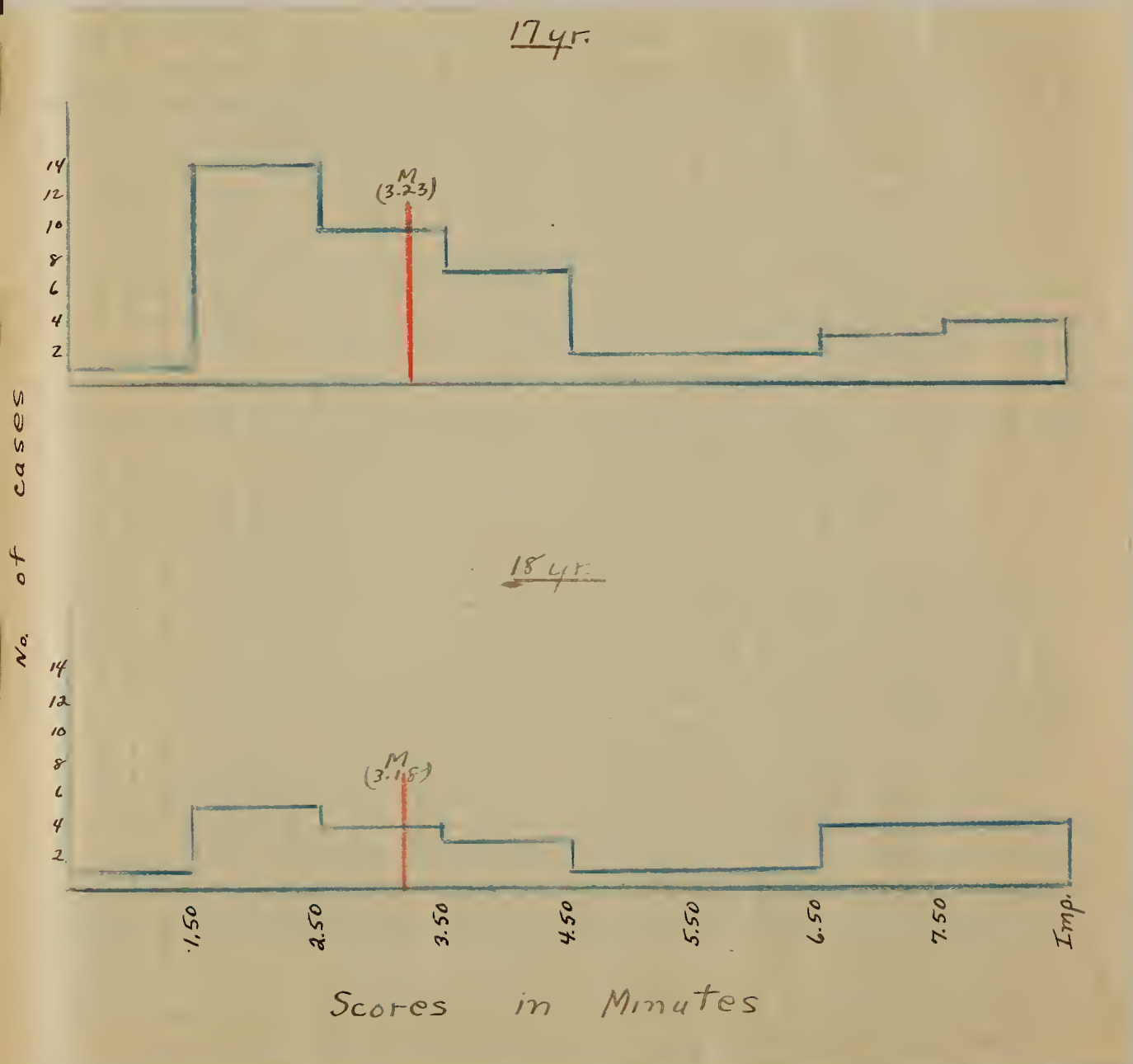


Figure 3 shows the Distribution of Wiggly Block Scores and the Median Score for the ages 17 and 18.



in their case. The writer also used these to determine the difference they would make over 1.4 and 1.7. (Table 2 - Page 81). It was found that they bring up the median of the school and of the various ages somewhat. The School median as shown in the graph is 3.88 (Figure 4 - Page 83). Two age medians are below and two above. But since the test is a standard one, the factors 1.4 and 1.7 and the scores from them will be reported in this research as the scores of the school.

4. The next figures (5 and 6) and table (3) picture the number of A, B, C and D scores (Pages 84 and 85). It will be seen that 60.4% of those tested in the school rated with the better half of all those tested by the Wiggly Block. This might indicate that a fair degree of mechanical ability was present.

5. Results of Terman Test. In this intelligence test, the boys ranged from 41 to 201. The highest possible score is 220. The graph (Figure 7), Page 86 shows the school median to be 122, which is also the median of Sophomores in High School as indicated by the chart on the following page.

It will be seen that the median of the Freshman group is seven less than the listed median for all scores. The Sophomore median is about four below. The Junior median is about eight below and the Senior median is only one lower than that for all cases. (Consult Tables 4 and 5, Pages 87 and 89.

TABLE 1

Distribution of All Wiggly Block Scores According to Ages

Age	Medians for Wiggly Block				
(6)	(41)	(52)	(54)	(43)	(19)
13	14	15	16	17	18
1.40	Imp.	Imp.	Imp.	16.94	18.17
2.31	10.07	Imp.	10.04	14.17	9.65
2.45	9.05	Imp.	7.22	11.95	9.64
3.54	7.83	10.52	6.10	8.96	8.66
3.85	7.23	9.50	5.93	7.12	7.20
7.10	7.12	7.58	5.91	7.08	5.42
	6.60	7.29	5.90	6.53	4.22
	6.55	6.43	5.85	6.14	3.87
	6.44	6.42	5.28	5.68	3.83
	6.24	6.07	5.13	4.72	M3.18
	6.10	5.86	4.89	4.54	3.10
	6.00	5.66	4.78	4.49	3.09
	5.39	5.56	4.63	4.45	2.55
	5.11	5.37	4.62	4.36	2.46
	4.53	5.28	4.62	4.16	2.37
	4.08	5.17	4.20	4.14	2.06
	4.04	5.15	4.12	4.06	1.81
	3.78	5.03	4.06	3.87	1.70
	3.61	4.78	3.81	3.47	1.11
	3.59	4.63	3.70	3.36	
	M3.46	4.54	3.66	3.30	
	3.12	4.39	3.61	M3.23	
	3.11	4.26	3.51	3.15	
	3.08	4.23	3.40	3.13	
	3.05	3.98	3.35	2.92	
	2.96	3.83	3.29	2.77	
	2.93	M3.78	3.26	2.71	
	2.89	3.72	M3.12	2.63	
	2.68	3.27	2.98	2.47	
	2.37	3.24	2.93	2.33	
	2.36	3.21	2.77	2.20	
	2.06	3.11	2.76	2.19	
	1.89	2.76	2.73	2.19	
	1.62	2.74	2.70	2.19	
	1.56	2.73	2.53	2.15	
	1.54	2.73	2.41	2.08	
	1.48	2.72	2.34	2.01	

These Scores were found by using (1.4) and (1.7) as improvement factors.

TABLE 1 (Cont.)

(6)	(41)	(52)	(54)	(43)	(19)
13	14	15	16	17	18
	1.34	2.68	2.33	2.00	
	1.32	2.59	2.31	1.90	
	1.18	2.54	2.24	1.68	
	.81	2.48	2.18	1.56	
		2.39	2.08	1.51	
		2.28	2.00	1.07	
		2.25	1.97		
		2.01	1.96		
		2.01	1.64		
		1.98	1.62		
		1.86	1.55		
		1.80	1.38		
		1.70	1.37		
		1.62	1.36		
		1.46	1.31		
		.93	1.23		
			1.08		

TABLE 2

Wiggly Block

Scores According to Age

13	14	15	16	17	18
7.90	Imp.	Imp.	Imp.	17.60	20.63
4.31	11.51	Imp.	12.47	15.52	11.24
3.97	10.09	Imp.	10.06	14.72	10.10
2.81	7.67	11.03	8.52	10.05	9.45
2.69	7.18	10.25	8.11	8.22	7.68
1.72	6.94	8.92	8.05	7.02	6.24
	6.90	7.92	8.04	6.89	4.82
	6.76	7.28	7.36	6.78	4.42
	6.62	6.96	7.29	6.53	4.34
	6.47	6.44	7.05	5.53	3.68
	5.68	6.42	6.67	5.27	3.48
	5.60	6.10	6.64	5.17	3.26
	4.93	6.01	6.28	5.11	2.99
	4.36	5.84	5.91	5.00	2.88
	4.31	5.75	5.84	4.82	2.75
	4.30	5.74	5.84	4.64	2.20
	4.13	5.64	5.52	4.62	2.03
	3.93	5.64	5.10	4.56	2.00
	3.85	5.44	5.09	4.30	1.50
	3.76	5.37	5.08	4.20	
	3.59	5.03	5.04	4.06	
	3.52	4.91	4.98	3.82	
	3.43	4.84	4.86	3.75	Using Improve-
	3.38	4.61	4.53	3.69	
	3.33	4.54	4.52	3.69	Factors of
	3.20	4.39	4.24	3.59	
	3.19	4.38	4.14	3.41	1.5 and 2.0.
	2.94	4.37	3.91	3.38	
	2.86	4.05	3.88	3.36	
	2.66	3.78	3.81	3.33	
	2.64	3.65	3.70	3.20	
	2.46	3.59	3.67	2.97	
	1.90	3.44	3.62	2.91	
	1.89	3.28	3.49	2.77	
	1.86	3.17	3.49	2.71	
	1.81	3.15	3.40	2.67	
	1.70	3.02	3.20	2.66	
	1.69	3.00	3.16	2.51	
	1.41	2.81	3.16	2.50	

TABLE 2 (Cont.)

13	14	15	16	17	18
	1.31	2.78	3.08	2.26	
	1.12	2.76	3.01	2.17	
		2.75	2.99	2.09	
		2.72	2.91	1.94	
		2.67	2.63	1.85	
		2.58	2.48	1.18	
		2.50	2.44		
		2.48	2.31		
		2.32	2.14		
		2.10	1.97		
		2.05	1.86		
		1.99	1.74		
		1.92	1.67		
		1.31	1.67		

Figure 4 shows the Distribution of Wiggly Block Scores which were obtained by using the improvement factors (1.5) and (2.0). The Median Score for the whole group is 3.88 minutes.

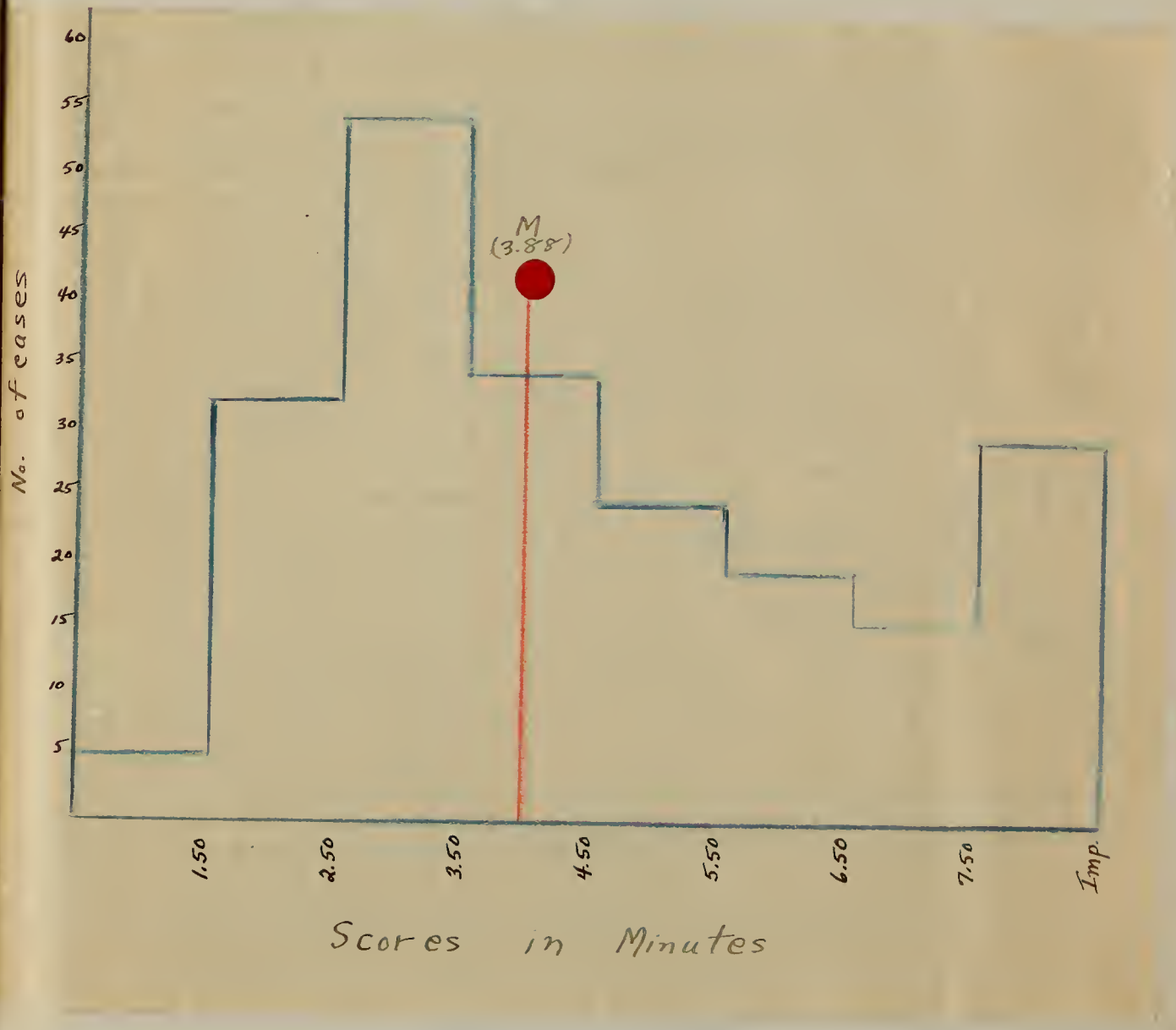


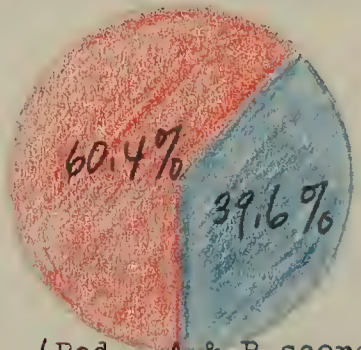
Table 3 shows the number of cases falling within the four scoring classes of the Wiggly Block Test.

	No. of cases	and percentage
A	82	38.1%
B	48	22.3%
C	49	22.8%
D	36	16.8%

60.4% of all those tested scored A or B in the Block Test

	Time Limits
A	.25 --- 2.75 minutes
B	2.76 --- 4.00 "
C	4.01 --- 6.00 "
D	6.01 up

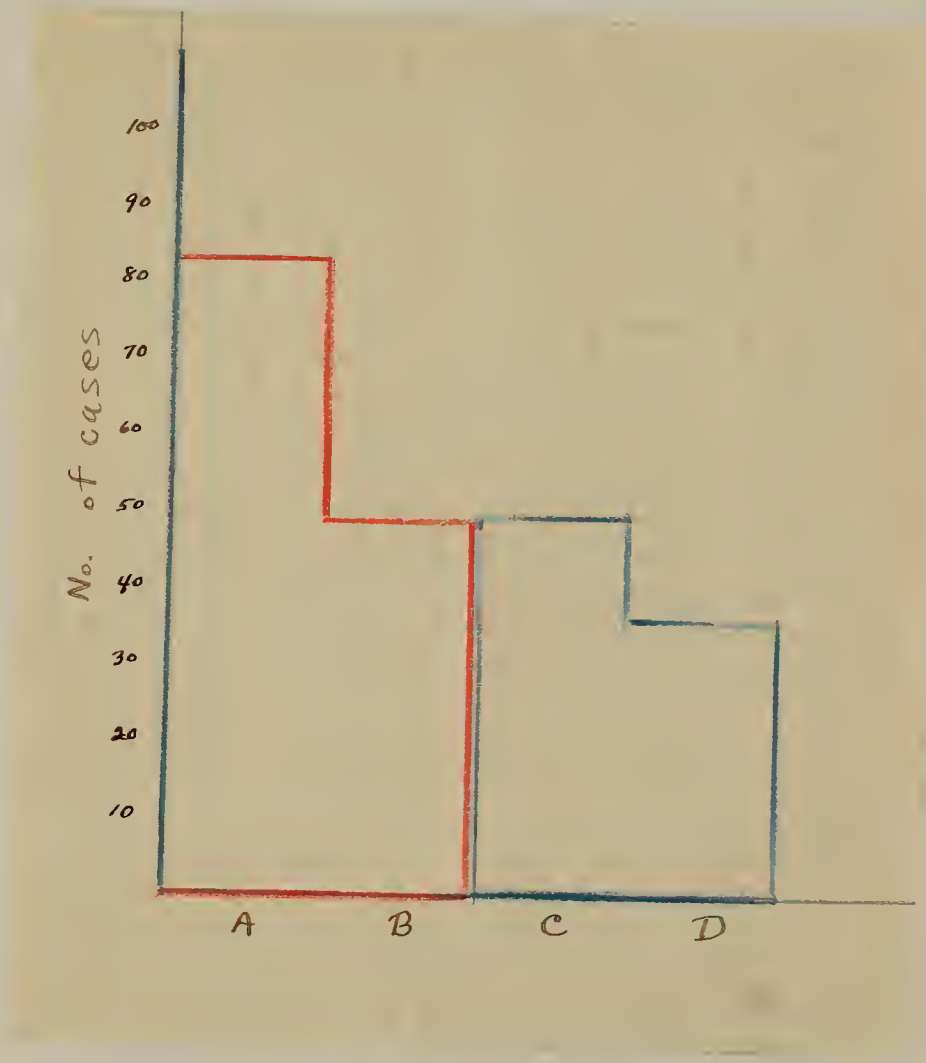
Figure 5 shows the relation of the number of better scores (A & B) and the number of poorer scores (C & D) in sectogram form.



(Red - A & B scores)

(Blue - C & D scores)

Figure 6 shows the relation of the number of better scores (A & B) and the number of poorer scores (C & D), which were obtained in the Wiggly Block Test.



(Red = A & B scores)

(Blue = C & D scores)

Figure 7 shows the Distribution of Terman Test Scores and the Median Score of the 200 boys tested at the Enfield High School.

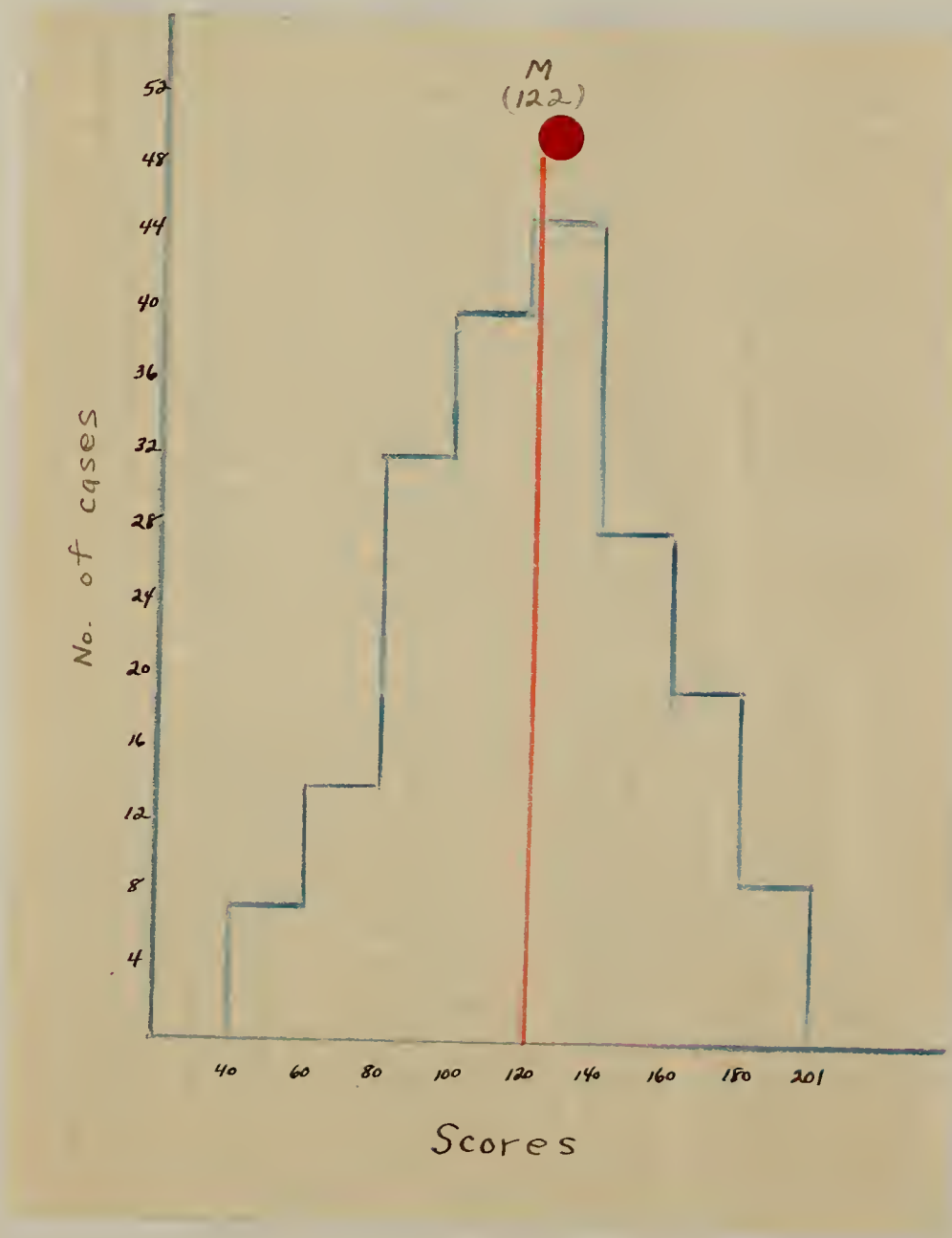


TABLE 4

Shows the Distribution of all Scores in the Terman Intelligence Test.

Terman Scores--According to Grade

(52) Fresh.	(50) Sophs.	(60) Juniors	(33) Seniors
188	172	201	188
163	160	199	184
161	160	189	182
157	159	182	174
148	158	176	173
147	158	172	171
140	155	170	171
129	148	169	164
128	147	168	163
127	142	166	161
126	140	166	151
124	137	163	150
124	137	161	149
123	137	160	148
122	135	152	148
121	132	152	147
120	132	152	146
114	131	152	139
112	129	148	137
107	128	147	135
106	128	147	133
104	124	144	131
103	122	142	127
102	121	141	123
98	119	141	122
97	118.5	139	121
97	118	137	119
97	118	136	115
97	117	133	112
97	117	132	110
92	112	130.5	102
91	111	129	81
89	110	129	60
88	108	126	
87	107	124	
85	106	123	

Median Scores

9	Freshman------ 97
10	Sophomores----118.5
11	Juniors-------130.5
12	Seniors-------146

TABLE 4 (Cont.)

(52) Fresh.	(50) Sophs.	(60) Juniors	(33) Seniors
84	104	122	
83	103	121	
80	100	119	
80	98	117	
80	98	116	
78	96	115	
78	92	115	
67	91	115	
67	88	114	
67	83	113	
66	82	110	
64	72	110	

TABLE 5

Percentile Scores by Grade

This table shows the medians of High School Grades and is given as a source of comparison.

	GRADE	7	8	Fresh.	Soph.	Jr.	Sr.
	1 per cent equal or exceed..	147	170	181	194	203	207
	2½ " " " " " ..	134	159	172	185	196	200
	5 " " " " " ..	122	148	164	177	189	194
	10 " " " " " ..	109	135	151	166	180	185
	15 " " " " " ..	100	126	142	159	174	179
Upper	20 " " " " " ..	93	118	135	152	168	174
Quartile	25 " " " " " ..	88	112	128	147	165	169
	30 " " " " " ..	83	107	123	141	158	165
	40 " " " " " ..	75	97	113	131	147	156
Median	50 " " " " " ..	68	89	104	122	138	147
	60 " " " " " ..	61	81	95	113	128	138
Lower	70 " " " " " ..	54	73	86	103	118	128
Quartile	75 " " " " " ..	51	69	81	98	112	122
	80 " " " " " ..	47	64	76	92	105	115
	85 " " " " " ..	43	58	71	86	99	109
	90 " " " " " ..	38	52	63	79	90	100
	95 " " " " " ..	31	43	53	67	77	86
	97½ " " " " " ..	25	36	44	58	66	74
	99 " " " " " ..	20	30	35	48	55	63
Number of cases for each grade.....		5582	9087	10881	6730	4206	4886

Total number of cases, 41, 241. The norms apply to February

CHAPTER X

COMPARISONS

Table 6, Page 91, shows clearly that all age medians on the O'Connor Wiggly Block in this research were considerably lower than those found in any of the other studies. The graph, Figure 8, Page 92, shows even more readily that the median scores of this research are lower. This study has all its age medians in the lower register, while the other three are much higher and rather closely coincide except for a few places. The sixteen year median, for example, is 3.26 minutes faster than Clark's Trade School Group, where one would surmise they would even be lower than those at Enfield High School; and 2.08 minutes more rapid than Landry's which was found in a High School similar in nature to that in which this research was carried on.

At first sight, one might conclude that the boys of Enfield High School possessed considerably more mechanical ability in comparison to the boys in the other studies, but may be other factors must be considered.

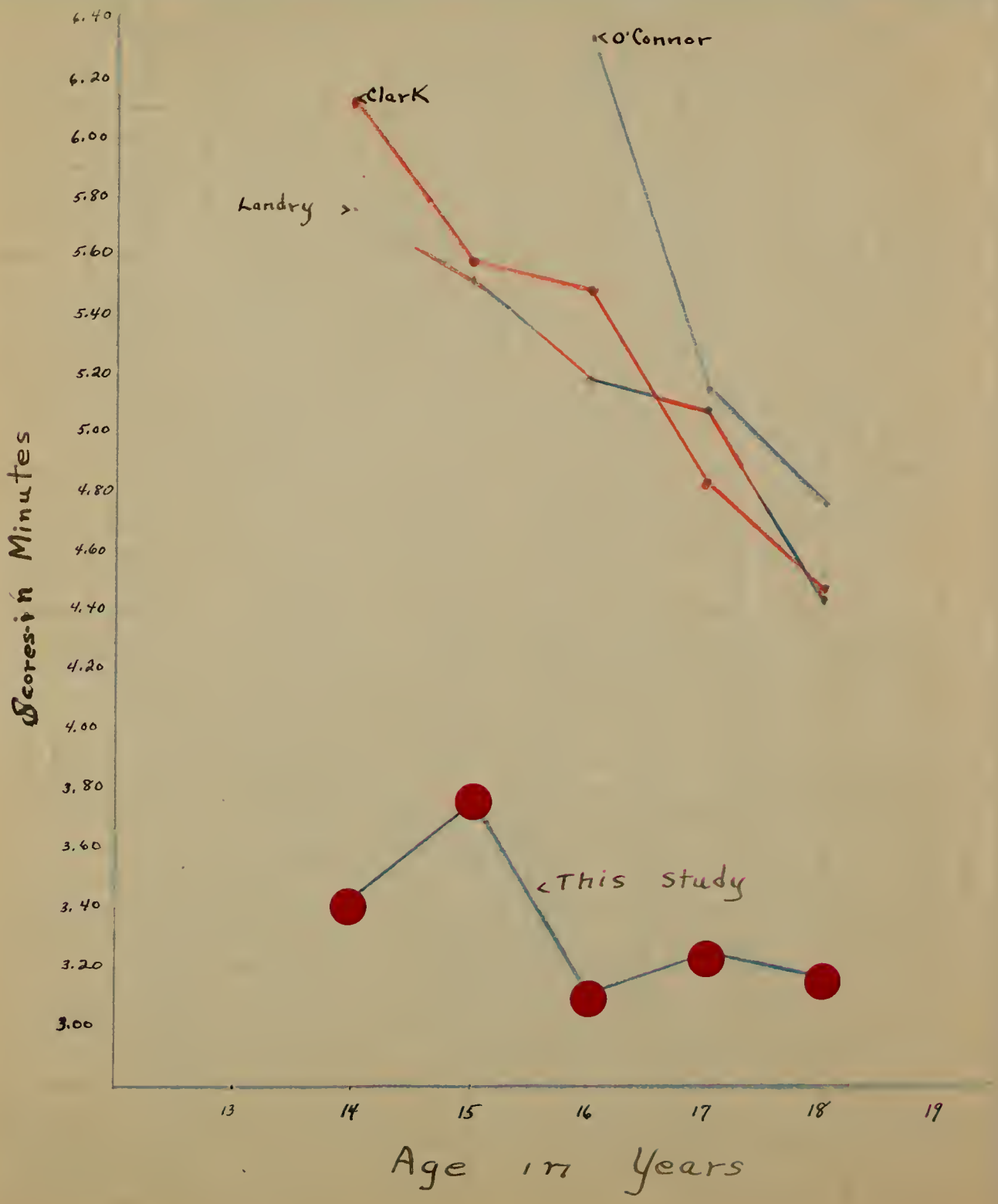
The fact that there were not as many taking the test as O'Connor's or Clark's might perhaps account for the difference in scores, but Landry tested about the same number as this study did and his scores are higher.

TABLE 6

Summary of Scores on The Wiggly Block for Each Age and Comparison with Results of O'Connor, Clark and Landry, who have used the Wiggly Block in other Research Work.

AGE	Scores in Minutes			
	This Study	O'Connor	Clark	Landry
14	3.46		6.13	5.77
15	3.78		5.60	5.53
16	3.12	6.38	5.50	5.20
17	3.23	5.17	4.85	5.10
18	3.18	4.78	4.50	4.47
19		4.57	4.00	
20		3.98		

Figure 8 shows a comparison of medians of the Wiggly Block Scores found in this study and other studies. It will be seen that the Medians found at the Enfield High School are considerably lower than those found in other places.



Another possibility might be that the perfect, quiet psychological setting was not present which should help the person being tested. Even if it had been present, the scores might have been lower, however, rather than higher.

It cannot be that the Block was practised because no opportunity was given for this, since it was locked away when not in use.

The writer did not coach the individuals nor did others.

6. Correlations. First a correlation was made between the Block and Intelligence. The correlation found was (.10) ±.04 which would rather clearly indicate that the relationship is very low. Abstract ability or general intelligence and mechanical ability, as shown by the Block, do not run together. This conclusion was anticipated by the author, because the relationship between the two has always been found to be low. Table 7, Page 95, shows the results of other studies. Landry found a correlation of .24 between the block and intelligence and Clark's correlation between teachers' marks and #5 was also low.

7. A correlation was found between an average of school marks and the Block test which was only .01 higher than that between the Block and Intelligence. It was .11 ± .05. School marks are generally considered to manifest abstract ability, and so again this correlation would show a very low relationship between mechanical aptitude and abstract ability.

Coefficient of Correlation Between
Mechanical Ability and Intelligence

$$R = \frac{\frac{\Sigma xy}{N} - c_x \quad c_y}{\sigma_{\bar{x}} \quad \sigma_{\bar{y}}} \qquad (43)$$

$c_x = \frac{\Sigma fd}{N} = \frac{50}{197} = 2.53$ $\qquad$ $c_y = \frac{\Sigma fd}{N} = \frac{-186}{197} = -.944$

$c_x^2 = .063$ $\qquad$ $c_y^2 = .891$

$\sigma_{\bar{x}} = \sqrt{\frac{fd^2}{N} - c_x^2}$ $\qquad$ $\sigma_{\bar{y}} = \sqrt{\frac{fd^2}{N} - c_y^2}$

$\sigma_x = \sqrt{\frac{934}{197} - .063}$ $\qquad$ $\sigma_{\bar{y}} = \sqrt{\frac{1288}{197} - .891}$

$\sigma_x = 2.162$ $\qquad$ $\sigma_{\bar{y}} = 2.376$

$$R = \frac{\frac{60}{197} - (-.2388)}{5.137} = \frac{.543}{5.137}$$

$$P.E. = \pm .6745 \frac{\frac{R}{\frac{.105}{1-r^2}}}{N} = \pm .6745 \frac{1-.011}{14.03}$$

$$P.E. = \pm .047$$

$\therefore R = .105 \pm .047$

TABLE 7

Correlations Between Mechanical Ability and Intelligence in Other Studies

Study	Test	Int. Test	Cases	Coeff. of Corr.
Brown	Assembly	Haggerty Detta	436 boys 10-13 yrs.	.24
Gaw	Assembly	Stan. Rev. Binet		.29
Stein	Assembly	Army Alpha	15 College Students	.10
Toops	Assembly	Read. & Arith. Scores	433 boys 12-15 yrs.	.10 to .26
Toops & O'Rourke	Assembly	Army Alpha	145 boys High School	.14
Stenquist	Assembly	Scores of 5 tests pooled	367 boys Grades 7 & 8	.23 to .34
McFarlane	Puzzle Box		238 English cases	.28
Board, and Others	MacQuarrie	Terman Group	500 boys Grades 6 & 7	.23
Whitman	Manual Dexterity	Myers. Ment. Measurement	434 boys & girls 7 to 15 years	.37
Landry	5 Tests	?	Junior High & High School boys	.07 to .24

(20)

8. Marks and Intelligence showed a correlation of .64 ±.03 which would cause one to conclude logically that the correlation was high. The coefficient is well above thirty and satisfies the condition that a coefficient should be 4 x P. E. because the P. E. was ± .04. Other studies have usually shown a close correspondence between high school success and mental tests.

9. A partial correlation between the Block and Intelligence, with the effect of marks eliminated, was (.04) and between the Block and marks, with intelligence eliminated, was (.06).

A combination of marks and Intelligence with the block as criterion gave a multiple correlation of .116, which shows a slight increase over either one alone, still not enough to make the relationship between mechanical aptitude and abstract ability anymore pronounced.

	Coeff.	P.E.
Wiggly Block vs. Intelligence	.10	± .04
Wiggly Block vs. Marks	.11	± .05
Marks vs. Intelligence	.64	± .03

CHAPTER XI

SUMMARY AND CONCLUSIONS

1. Vocational Guidance has many possibilities that may open up several new avenues for education. It is a factor that must be given due consideration and enthusiastic support. Present conditions may retard its development, but when the economic status is strengthened, it should advance rapidly.

2. In the comprehensive High School investigated, there is apparently a considerable amount of mechanical ability and interest present, which might be directed into proper channels where the best results will follow.

3. More information on the Wiggly Block has been recorded. This may be added to that already obtained. The scores were considerably lower than those gathered before and will help in further comparisons.

4. The scores in the Terman Test deviated only slightly from the established Medians, showing that the group tested was about the same in general intelligence as other High School Groups.

5. Correlations showed that the two capacities "Mechanical Ability" and "General Intelligence" are quite distinct, which may go to strengthen this fairly well established belief.

Concerning a Trade School. Of the two hundred fifteen boys examined, fifty-four said they would like to attend a Trade School; one hundred and twenty-two had no desire for this form of education and the remaining number were undecided. Fifty-three percent of those who would care to attend a Trade School were in the better divisions of Block ratings, or, as called, the A and B divisions. O'Connor says that those in the A division have 80 chances out of 100 of being successful mechanics and those in B class have 66 chances out of 100 of being successful mechanics.

Clark says, "Whatever a boy's previous record, a high score in the Wiggly Block should gain for him admission to the machine, automobile, cabinet, pattern, sheet metal or drafting departments of the Trade School." (22) So this would mean that about twenty-nine of the boys tested, who had signified interest in a Trade School, might enter any of these departments and stand a fair chance of success.

In addition to this number, there were about one hundred others who scored A or B but did not express a desire for Trade School. Perhaps they may change their mind. Many of these also would stand a good chance of success in this kind of vocational training, if they so desired it. No doubt if a Trade School were established in Enfield many of these would avail themselves of the opportunity of at-

tending it.

Seventy-two boys said that they have mechanical interests at present, working on model airplanes, cars, radios, model coaches, etc., and of those 29 who scored high and wanted to attend a Trade School, twenty-four perform various mechanical tasks at present, showing a rather close relationship between their interests and abilities.

This group of 29 might serve as a nucleus for the beginning of a Trade School. Then there are no doubt others in the surrounding villages who have mechanical aptitude and desire to go to a Trade School. After the best of these have been chosen, then the next group who wished to attend but who obtained only C and D scores might be admitted.

Academic Standing of Those Who Want to Attend Trade.

Sometimes one is inclined to believe that certain students who are failing academically, might be more successful in a Vocational or Trade School where they may exercise their "handmindedness." This study shows that of these twenty-nine boys who are mechanically superior as indicated by the Wiggly Block, ten are academic failures. This finding might lend support to the idea stated above.

Of the whole 54 who would like to attend a Trade School, 15 are failing in the comprehensive High School work. While this ratio is not as large as the previous one, it may indicate

that a Trade School would be more beneficial to them.

Eight of the ten who are failing academically and are superior mechanically also received a mark in the Terman test below their age median which again shows the difference between mechanical ability and general intelligence.

The names of these twenty-nine boys who scored A and B and desire a Trade School training will be kept on file for use by the Superintendent if a Trade School should be established before long. This group would enable him to make a start in his selection of candidates if the number entering is limited.

Other Factors. At present, there are thirty-one boys who commute from Enfield to the Hartford Trade School. If a school were established in Enfield, naturally they would attend there. Add this number to the other twenty-nine and there would be sixty.

As previously stated, the Carpet Mill could include a course in carpet making which would train boys in preparation for work that required skill. No doubt several would avail themselves of this course, because many of the boys said that after High School they would endeavor to procure work in some department at the Mill.

It would appear from this study that in Enfield there are many boys who might profit by Trade School training.

They seem to possess what many trades require for success. Further research in the Town may strengthen this belief.

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