THE PROGNOSTIC VALUE OF THE STENQUIST MECHANICAL ABILITY TEST

by

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THE PROGNOSTIC VALUE OF THE STENQUIST MECHANICAL ABILITY TEST, SINGLE SERIES 1

INTRODUCTION

The objection on the part of shop teachers to the common educational practice of directing students of relatively low general intelligence* into shop courses is becoming more and more insistent. From articles in current literature the general impression is gained that shop teachers of long and succesful experience believe that those students possessing mechanical ability should be directed into shop courses, rather than those students who are "misfits" in other courses or who possess relatively low general intelligence. Practical experience has convinced the majority of shop teachers that the students who fail the more abstract courses will probably fail the manual courses, also.

S. D. Horning and Ruth S. Leonard, in a study involving twenty-five in mechanics classes of the Pasedena Junior High School, have shown the correlation between scores in the McQuarrie Test of Mechanical Ability and ranks in class pro-

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* Throughout this study the term "general intelligence" must be used to signify that ability of which current "intelligence tests" are purported to yield a definite measure. Whether "general intelligence" is an entity, a composite of entities, or a "What not" does not fall within the premise of this study. This study is merely an effort to determine the practicability of using the Stenquist Test in educational guidance.

jects to be .66 .(3,349)*. The writers interpret this correlation to be significant of the possibility of using scores in mechanical ability or aptitude tests as prognostic measures in an educational guidance program in the field of manual education. In this same study a correlation of only .02 was reported to exist between scores in the Terman Group Test of Mental Ability and scores in the McQuarrie Test. This low correlation is interpreted by the authors to mean that a dull student in the more abstract courses has an equal chance to be dull in courses of a mechancial nature.

In support of this latter correlation and the tentative conclusion derived from it, is a more pretentious study by Edna Board and others of five hundred 7th and 8th grade students selected at random from the five junior high schools of Fresno, California. In this study a correlation of .05 is secured between general intelligence, measured by the Terman Group Test, and mechanical ability, measured by the Stenquist Mechanical Aptitude Test**. A higher correlation, .23, is

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*The first number in the parenthesis refers to the reference in the bibliography bearing this number. The second number in the parenthesis is the page number of the reference.

**It should here be noted that the Stenquist Mechanical Aptitude Test is the familiar "picture test" whereas the Stenquist Mechanical Ability Test used in the present study is the less familiar "assembling test", Single Series 1.

established by Board and others between general intelligence and scores in the McQuarrie Test of Mechanical Aptitude. In concluding their article these writers assert that if mechanical ability is measured by the mechanical aptitude tests then the students of low and of high intelligence have an almost equal chance to succeed in courses in manual arts (1,331).

S. S. Sutherland of the Iowa State College, Ames, Iowa, has made a study bearing directly upon the question of the relation of general intelligence to success in shop courses (8,256). Scores in the revised Army Alpha Test were used as measures of general intelligence and the grades received in shop courses were considered as varying degrees of success in the shop courses. From the study of two hundred ten freshmen of the Iowa State College he draws the following general conclusions:

a. "The chance of a student of inferior intelligence doing superior shop work is one in ten."

b. "Chances are eight to one against a student of superior intelligence receiving a low shop grade."

c. "Nine out of ten students of below average intelligence receive grades of average or below."

These conclusions are based upon a study involving a sufficient number of cases to establish certain validity.

The above studies are cited as typical examples of those appearing in current literature devoted to manual arts and the problems in connection with manual arts teaching. All of these studies point to two general conclusions; first, that shop teachers are sustained in their objection to the use of low intelligence test scores as criteria of probable success in shop courses; and secondly, that there is a possibility of using scores in certain mechanical ability tests as prognostic measures which would be of value in educational guidance in the field of manual education.

With these facts in mind the writer undertook a study of the prognostic value of the Stenquist Assembling Test of General Mechanical Ability, Single Series 1. The study had as its major objectives:

a. The value of the Stenquist Mechanical Ability Test as a prognostic instrument in educational guidance.

b. The relation of general intelligence, as measured by standard intelligence tests, to general mechanical ability, measured by the Stenquist Test of Mechanical Ability.

c. The relation of general intelligence to success in school courses of a mechanical nature.

The chief contribution hoped for was the presentation of sufficient data to establish the predictive value of the scores received in the Stenquist Mechanical Ability Test.

THE TESTS USED IN THE STUDY

Three tests were used in this study; (1) Stenquist Assembling Test of General Mechanical Ability, Single Series 1; (2) Otis Self-Administering Test of Mental Ability, Intermediate and Higher Examinations, Form A; and (3) Peterson Uniform Test of Mental Performance*. The intelligence test scores were, for the most part, secured from the office files of the schools involved.

The Stenquist Assembling Test of Mechanical Ability, Single Series 1, was prepared by John L. Stenquist while at Teachers College, Columbia University, and may be secured from the Charles Stoelting Co., Chicago. The test consists of ten common mechanical devices placed in separate compartments of a box, $2\frac{1}{2}$ x 5 x 25 inches in size. The compartments of this box are labeled A, B, C, etc. Compartment A contains a cupboard catch, B contains a clothes pin, C a paper clip, D a chain, E a bicycle bell, F a rubber hose shut-off, G a wire bottle stopper, H a push button, I a door lock, and J a mouse trap. The mechanical devices are placed in the proper compartment unassembled. The test consists of assembling

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*This test was first published under the title "A Uniform Test of Intelligence" but the term intelligence has since been replaced by the less presumptive term, mental performance.

each of these devices under standard conditions in a standard length of time. In the photograph of the test, shown in Plate 1, the nature and arrangement of the test elements are shown. It will be seen that, as the students are directed to open the box with the hook fasteners away from them, the lid of the box makes a convenient tray in which to place the loose parts of the device being assembled. The time allowed for the completion of the test is thirty minutes and a time bonus of one-half point per minute is given those students who complete the test in less than the regular allotted time. Thus if a student finishes at the end of twenty-four minutes three points will be added to his raw score.

In the standard score sheet, supplied with the test, there are described two methods of scoring the completed test. The "Partial Score Method" and the "Short Form Method." Descriptions of these methods are included in order to make subsequent terminology understood.

The "Partial Score Method" involves the assigning of a partial score to the various degrees of perfection in assembling each of the ten test devices. A score of ten is assigned to a correctly assembled device, while any score from zero to ten is assigned a dvice which is only partially assembled. The exact partial score assigned a device depends upon the degree of perfection achieved in assembling it. In the score sheet are listed the partial score values to be

Plate I.

given to each possible degree of perfection which may be achieved in assembling each of the ten devices. After each of the ten devices has been assigned a partial score the "raw score" is computed by obtaining the sum of the ten partial scores and any time bonus which may have been given.

The "Short Form Method" of scoring consists of counting only those devices which have been completely assembled. Partial scores are disregarded entirely and the correctly assembled devices are assigned a score of ten. In utilizing this method of scoring the examiner is instructed to count as complete all devices which would receive a partial score of eight or nine if the "Partial Score Method" was being used. The "raw score" is equal to the sum of the separate scores and any time bonus which may be due.

After having determined the raw score by either of the scoring methods described the final step in scoring consists of converting this raw score into the corresponding "T" Score. The "T" Scale scores are the mean square deviation equivalents for the distribution of twelve year old boys. A table furnished with the test contains a list of the possible raw scores and opposite each is placed the corresponding "T" Scale Score. Scores thus derived are designated as "T" Scores. Throughout this study "T" Scores derived from raw scores have been used. The Partial Score Method was employed to secure the raw scores since this method is recommended by

the author of the test as being the more accurate.

The Otis Self-Administering Test of Mental Ability was used as the measure of general intelligence of the junior and senior high school students included in this study. The Higher Examination and Intermediate Examination being used in the senior and junior high schools, respectively. This test is one of the standard intelligence tests whose validity is generally recognized and needs no detailed description here.

The Peterson Uniform Test of Mental Performance is a test of general intelligence. It was devised by Dr. J. C. Peterson, of the Education Department, Kansas State College. This test is used regularly by the Department of Education in determining the percentile rank in intelligence of all students at that college. The intelligence ratings of the college students included in this study were taken from the files in the offices of the Education Department.

METHOD

The study involved five hundred six students. Three hundred twelve were students in shop courses at the Kansas State College, Manhattan, Kansas. The majority were of freshman or sophomore standing but some were junior, senior and graduate students. The remaining one hundred ninety-four cases were taken from the junior and senior high schools of Butler and Greenwood Counites, Kansas. Of this latter group the majority were taken from the junior and senior high schools of Eureka and El Dorado, Kansas.

Both of the college and junior-senior high school groups were given the Stenquist Mechanical Ability Test, Single Series 1, at or near the beginning of their shop course during the school year 1928-1929. The test was given to groups of thirteen students, this being the number of tests at the writer's disposal. All of the tests were given under the direct supervision of the writer according to the following directions, which are those included in the manual of directions accompanying the test.

Directions for giving test:

Use regular class room, and single desks if possible. With pupils seated, and 40-50 boxes, and also score sheets, near the examiner's desk, proceed as follows:

1. Distribute score sheets, one for each pupil (be sure to have the right ones). Each pupil fills out the score sheet blanks; name, age, etc. - and leaves blank on his desk to be enclosed in the box when he finishes (if he fails to enclose it there is no way of identifying his box).

2. Appoint one boy for each row to distribute the boxes to each row. Do not permit the boxes to be opened until all begin.

3. When each pupil has his box instruct as follows: "We will now read the directions; you read them silently while I read them aloud." (Examiner now takes a box and reads the directions on the box aloud, while the pupils read silently). As soon as the examiner has finished, and all understand, he says, "You have thirty minutes; already? begin." Note that boxes open backward. See that all get started right, beginning with model A, B, etc. After about three minutes say again, "Do not spend more than about three minutes on any one model." Examiner should be sure to allow exactly thirty minutes.

4. When time is up, each pupil hands in his box (with score sheet inside). Stack the boxes immediately beside the scorer's desk if they are to be scored at once.

All the tests were scored by the writer immediately following their completion. Thus it would seem that absolute uniformity had been achieved in administering and scoring the

tests. The "T" Scores resulting from these tests are, according to Stenquist (7,87), an objective measure of these qualities in pupils that are considered by shop teachers in judging pupils relative abilities in shop courses. Hence we should expect that these "T" Scores would correlate highly with the pupils' subsequent success in shop courses. Since the major objective of this study was to determine the reliability of the Stenquist test as a prognostic instrument, the next step was to compute the actual correlation whichexisted between "T" scores made by students and the students' subsequent success in shop courses.

The percentile ranks in intelligence of the college cases included in this study were secured from the files of the psychology offices of the Department of Education. In some cases this data was incomplete and as a result the correlations involving intelligence ratings include a fewer number of cases than the correlation of "T" Scores and shop grades. Since there were two hundred forty-eight complete cases, however, it was not considered necessary to administer any of the Peterson Ability Tests.

In the case of the high school groups the intelligence ratings were so often lacking on the office cards that it was necessary to administer the Otis Intelligence Tests to approximately eighty-five students. The Otis tests were given in

regular class rooms according to the directions accompanying the test.

Shop grades in the college group were secured from the office files of the Department of Shop Practice. In the high school group the shop grades were taken from the shop teacher's grade book and were those grades subsequently reported as the student's final grade in the shop course. In this study I have considered these shop grades as the measure of relative success or failure in the shop courses.

RESULTS AND DISCUSSION

Analysis of College Data

For statistical treatment the data were divided into two parts, in part one was placed the data pertaining to college students and in part two the data pertaining to junior and senior high school students. In each division of the data three correlations were then computed to yield specific measures of any relation which might exist between the three variables, "T" Scores, shop grades, and percentile rank in intelligence. The correlations computed from the data relating to the college students are shown in Table 1.

TABLE 1

Correlations Computed From College Data

Variables	Number of cases	r	P. E.
"T" Scores and Shop Grades	295	-.056	.0391
"T" Scores and Percentile Rank in Intelligence	256	-.096	.0420
Shop Grades and Percentile Rank in Intelligence	248	.242	.0403

Since this phase of the study involves over three hundred cases the results are significant, but disappointing. The correlation of -.056 $\pm$.0391 shown in Figure 1, between

Correlation STENQUIST "T" SCORES and GRADES IN SHOP COURSES

	Y	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	F_y	F_yY	F_yY^2	$\Sigma F_{xy}X$	$Y\Sigma F_{xy}X$	$(\Sigma F_{xy}X)^2$	$\frac{(\Sigma F_{xy}X)^2}{F_y}$
	" X =																												
20																													
19																													
18																													
17																													
16																													
15																													
14		40-42	43-45	46-48	49-51	52-54	55-57	58-60	61-63	64-66	67-69	70-72	73-75	76-78	79-81	82-84	85-87												
13	E+																						0	0	0	0	0		
12	E					1	1	1		2	1		1		1	9							17	204	2448	207	2484		
11	E-					1					1	1											3	33	363	26	286		
10	G+							1	1	1	3		1										7	70	700	66	660		
9	G					1	2		7	6	8	10	13		29	36							112	1008	9072	1419	12771		
8	G-			1	1		2	5	1		2	1	3		2	3							21	168	1344	202	1616		
7	M+						1	2		3			3										9	63	441	83	581		
6	M	1			2	1	2	3	2	1	5	7	19		30	32	1						106	636	3816	1343	8058		
5	M-						1						1		1	1							4	20	100	47	235		
4	P+																						0	0	0	0	0		
3	P							1		1	2	1	3		6	1							15	45	135	182	546		
2	P-																						0	0	0	0	0		
1	F															1							1	1	1	15	15		
	F_x	1	0	1	3	4	9	13	11	14	22	20	44	0	69	83	1						295	2248	18420	3590	27252		
	F_xX	1	0	3	12	20	54	91	88	126	220	220	528	0	966	1245	16						3590						
	F_xX^2	1	0	9	48	100	324	637	704	1134	2200	2420	6336	0	13524	18675	256						46368						
	$X\Sigma'F_{xy}Y$																												
	$(\Sigma'F_{xy}Y)^2$																												
	$\frac{(\Sigma F_{xy}Y)^2}{F_x}$																												

ΣF_yY^2 $\Sigma F_{xy}X$ $\Sigma F_{xy}XY$ $\Sigma(\frac{(\Sigma F_{xy}X)^2}{F_y})$

ΣF_yX^2

$\Sigma F_{xy}XY$

$\Sigma(\frac{(\Sigma F_{xy}Y)^2}{F_x})$

$$r = \frac{\Sigma F_{xy}XY - \frac{(\Sigma F_xX)(\Sigma F_yY)}{N}}{\sqrt{(\Sigma F_xX^2 - \frac{(\Sigma F_xX)^2}{N})(\Sigma F_yY^2 - \frac{(\Sigma F_yY)^2}{N})}}$$

$$r = \frac{27252 - \frac{3590 \times 2248}{295}}{\sqrt{(46368 - \frac{(3590)^2}{295})(18420 - \frac{(2248)^2}{295})}}$$

$$r = \frac{27252 - 27357.016}{\sqrt{345\,5200 \cdot 3444}}$$

$$r = -.056$$

Figure 1

Stenquist test scores and shop grades is too low, of course, to possess positive or negative significance. There is apparently no definite relation between "T" Scores and grades received by students in college shop courses. Either the Stenquist Test of Mechanical Ability does not yield objective measures of mechanical ability, or mechanical ability is not essential to success in college shop courses. It is here assumed that when assigning grades shop teachers are attempting to measure a student's relative success in the shop course. To the extent that mechanical ability functions in achieving this success the shop teacher is in reality therefore estimating the amount of mechanical ability possessed by the student. It seems only reasonable to assume that if such a trait as general mechanical intelligence and ability exists that the amount of such trait possessed by a student would have a definite relation to the student's success or failure in the shop course. The results of any instrument yielding actual objective measures of mechanical intelligence or ability should, therefore, correlate highly with grades received in shop courses. The Stenquist Mechanical Ability Test is claimed by its author to be an instrument "for obtaining a definite measure of a trait which is generally estimated with great inaccuracy by school authorities as well as by parents and pupils themselves." (7,61) Whatever may be the trait measured by this test we are forced to conclude that it can

have no relation to success or failure in school courses of a mechanical nature.

There are certain well known characteristics of shop courses which in themselves might account for a low correlation between shop grades and other criteria of mechanical ability. Chief among these characteristics is the stereotyped form of the courses and of the elements composing these courses. There is little chance for the student of superior mental or mechanical ability to demonstrate his superiority. As a result of this there is the tendency for fixed levels of achievement which are too few in number and too closely grouped to permit a normal distribution of grades in a shop course. That this condition prevails in the shop courses included in the present study is clearly shown in Table II.

The question of the reliability of shop teachers' grades might well be raised at this point but the author of the test states that "while shop teachers grades are no more accurate than those of the regular teachers, they are equally as good" (7,87).

In Table III is given the distribution of the "T" Scores received by the college students.

The distribution of "T" Scores does not appear to be a normal one. There is a marked tendency toward high scores. It will be observed that 66.76% of the scores fall within the approximate limits of the upper fourth of the "T" score range.

The nature of this distribution indicates that the value of the Stenquist Test, as a measure of mechanical ability of college students, is doubtful; since a definite mental trait would appear in amore normal distribution than here indicated.

Table II

Distribution of 295 College Shop Grades

Shop Grade	Distribution of Grades	Per Cent
E+	0	0.0
E	17	5.76
E-	3	1.02
G+	7	2.37
G	112	37.96
G-	21	7.12
M+	9	3.05
M	106	35.93
M-	4	1.35
P+	0	0.0
P	15	5.08
P-	0	0.0
F	1	.34
Total	295	99.98

Mean G- +.59 of the interval S. D. = 2.09

Table III

Distribution of "T" Scores Received
by 295 College Cases

"T" Score	Distribution of "T" Score	Per Cent
85-87	1	.339
82-84	83	28.13
79-81	69	23.39
76-78	0	00.00
73-75	44	14.91
70-72	20	6.77
67-69	22	7.46
64-66	14	4.74
61-63	11	3.72
58-60	13	4.40
55-57	9	3.05
52-54	4	1.35
49-51	3	1.02
46-48	1	0.339
43-45	0	0.00
40-42	1	0.339
Total	295	99.957

Mean 79.238 S. D. 3.01

Considering next the relation existing between "T" Scores and percentile rank in general intelligence, we are again confronted by a correlation which is too low to possess any significance of agreement or disagreement. It appears that general intelligence as measured by the Peterson Test of Mental Performance, has no effect upon achievement in the Stenquist Test. In support of this conclusion is the study by

Edna Board and others in which a correlation of .05 is reported between general intelligence and mechanical ability (1,331). Horning and Leonard also report a correlation of .02 between general intelligence and mechanical ability as measured by the McQuarrie Test (3,350). Since the test is devised to test a particular trait or ability it is to be expected that the correlation between measures of this ability and general intelligence measures would be low.

The relation between general intelligence (percentile rank in intelligence) and shop grades is more definite. The correlation of $.242 \pm .0403$ is, according to Rugg, indicative of at least a low agreement (6,256). With this low agreement, measures of general intelligence would be of little value from the standpoint of prediction. This same conclusion is reached by Gordon from a study including seven hundred boys when he states that the I. Q. has not materially aided shop teachers to foresee success of shop students (2,250).

Dr. Peterson, in an unpublished report to the President of Kansas State College, has established certain correlations between mental ratings and academic achievement. His findings are based upon the records of two hundred sixteen students enrolled in the engineering courses at that college. These correlations appear in Table IV.

Table IV

Variables	Value of r
Percentile Rank in Intelligence and Chemistry Grades	.67
Percentile Rank in Intelligence and Trigonometry Grades	.60
Percentile Rank in Intelligence and College Rhetoric Grades	.42
Percentile Rank in Intelligence and Wood Work	.17
Percentile Rank in Intelligence and Forging Grades	.21

These data furnish further evidence that there is only low agreement between general intelligence and achievement in shop courses. That a higher and a significant agreement exists between intelligence and achievement in the more abstract courses, Chemistry and Trigonometry, raises again the question of faulty distribution of shop grades.

Analysis of the High School Data

The correlations computed from the data relating to the junior and senior high school students are shown in Table V.

Table V

Correlations Computed From High School Data

Variables	Number Of Cases	r	P. E.
"T" Scores and Shop Grades	188	.224	.0467
"T" Scores and I. Q.	175	-.0801	.0507
Shop Grades and I. Q.	175	.1432	.0494

In this group the correlation between "T" Scores and shop grades is somewhat more definite than was true in the college group. An examination of this correlation, shown in Figure 2, reveals the two probable causes of this higher agreement. First, there is the more normal distribution of high school shop grades; and secondly, there appears a more normal distribution of "T" Scores. The distributions of shop grades and of "T" Scores are shown in Tables VI and VII, respectively.

This distribution of grades is quite superior to that found to exist in the college grades. The very nature of this distribution makes a high correlation between these grades and other criteria of mechanical ability more probable than in the college data, where a less normal distribution of grades was found. The data below indicates that high school

Correlation — STENQUIST "T" SCORES and GRADES IN SHOP COURSES

Y	" X =	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	F_y	F_yY	F_yY^2	$\Sigma' F_{xy}X$	$Y\Sigma' F_{xy}X$	$(\Sigma' F_{xy}X)^2$	$\frac{(\Sigma F_{xy}X)^2}{F_y}$
		40-42	43-45	46-48	49-51	52-54	55-57	58-60	61-63	64-66	67-69	70-72	73-75	76-78	79-81	82-84	85-87												
13	E+																						0	0	0	0	0		
12	E										1	2	1		2								6	72	864	72	864		
11	E-										1	1			1								3	33	363	35	385		
10	G+																						0	0	0	0	0		
9	G		1	2		3		1	3	10	11	8	12		12	3							66	594	5346	699	6291		
8	G-						2	3	1	1	5		1		3								16	128	1024	154	1232		
7	M+	1					1	1		3	2		1										9	63	441	73	511		
6	M			1		1	1	2	2	8	13	2	8		6	3							47	282	1692	493	2958		
5	M-						2	3	2			1	1			1							10	50	250	87	435		
4	P+			1					1		1		1										4	16	64	33	132		
3	P		1		2			1	1	7	5	1	2		1	1							22	66	198	202	606		
2	P-								1														1	2	4	8	16		
1	F	1							1	1					1								4	4	4	32	32		
F_x		2	2	4	2	4	6	11	12	30	39	15	27	0	26	8	0						187	1310	10250	1888	13462		
F_xX		2	4	12	8	20	36	77	96	270	390	165	324	0	364	120	0						1888		ΣF_yY^2	$\Sigma F_{xy}X$	$\Sigma F_{xy}XY$	$\Sigma\left(\frac{\Sigma F_{xy}X}{F_y}\right)^2$	
F_xX^2		2	8	36	32	100	216	539	768	2430	3900	1815	3888	0	5096	1800	0						20630	ΣF_yX^2					
$X\Sigma' F_{xy}Y$																								$\Sigma F_{xy}XY$					
$(\Sigma' F_{xy}Y)^2$																								$\Sigma\left(\frac{\Sigma' F_{xy}Y)^2}{F_x}\right.$					
$\frac{(\Sigma F_{xy}Y)^2}{F_x}$																													

Figure 2

$$r = \frac{\Sigma F_{xy}XY - \frac{(\Sigma F_xX)(\Sigma F_yY)}{N}}{\sqrt{\left(\Sigma F_xX^2 - \frac{(\Sigma F_xX)^2}{N}\right)\left(\Sigma F_yY^2 - \frac{(\Sigma F_yY)^2}{N}\right)}}$$

$$r = \frac{13462 - \frac{1888 \times 1310}{188}}{\sqrt{\left(20630 - \frac{(1888)^2}{188}\right)\left(10250 - \frac{(1310)^2}{188}\right)}}$$

$$r = \frac{13462 - 13155.7446}{1368.593}$$

$$r = .2237$$

shop courses are better administered than are college courses of like nature. It is probable that under the urge of supervision high school shop teachers have diversified the elements composing their shop courses and have refined somewhat their technique of grading.

Table VI

Distribution of 188 High School Shop Grades

Shop Grades	Distribution of Grades	Per Cent
E+	0	0.0
E	6	3.19
E-	3	1.59
G+	0	0.0
G	66	35.11
G-	16	8.51
M+	9	4.73
M	47	25.00
M-	10	5.32
P+	4	2.13
P	22	11.70
P-	1	.53
F	4	2.13
Total	188	99.94

Mean M - 2/3 of the interval S. D. = 2.443

Table VII

Distribution of "T" Scores Received by 188 High School Students

"T" Scores	Distribution of "T" Scores	Per Cent
85-87	0	0.0
82-84	8	4.25
79-81	26	13.83
76-78	0	0.0
73-75	27	14.36
70-72	15	7.97
67-69	39	20.74
64-66	30	15.95
61-63	12	6.38
58-60	11	5.85
55-57	6	3.19
52-54	4	2.12
49-51	2	1.06
46-48	4	2.12
43-45	2	1.06
40-42	2	1.06
Total	188	99.94

Mean 68.61 S. D. 2.94

While the distribution of the "T" Scores received by the high school students is more normal than that of the college students there is still evidence of "bunching" and a general tendency toward high scores. It would seem that if a true ability were being measured a more normal distribution would appear.

Even though there is apparently a better distribution of shop grades and "T" Scores in the high school group the

correlation between these two variables, .22 $\pm$ .0467, possesses little significance (6,256).

It is interesting to note that the correlation between "T" scores and I.Q. is almost identical to that existing between percentile rank in intelligence and "T" Scores in the college group. This points very definitely to the conclusion that there is no relation between general intelligence and the trait or ability that is measured by the Stenquist Test.

The relation between general intelligence and shop grades is less apparent here than in the college group. That a student possess a high degree of general ability does not alone insure a high degree of success in shop courses.

ANALYSIS AND RELIABILITY OF THE STENQUIST TEST

In administering the tests many other questions of interest in regard to the nature and validity of the test itself suggested themselves. While the ten elements of the test possess varying degrees of difficulty, it is evident that the order of difficulty is not the same for the college and high school groups. In order to determine the rank in difficulty of the ten test elements, average partial scores of each element were computed. Only those cases were included which had received a partial score of 1 or greater in J, the last element of the test. It was believed that, since these cases had apparently attempted all of the test elements, the average partial score of each element would be a measure of its relative difficulty. The results appear in Table VIII.

The last four elements of the test apparently present somewhat the same order of difficulty for both groups. Practically no further agreement is present. For the group tested the arrangement of elements has a different order of relative difficulty than that believed to exist by the author of the test (7,40).

Table VIII

Relative Difficulty of Test Element

Test Elements	A	B	C	D	E	F	G	H	I	J
Average P Score	9.15	9.39	9.17	8.95	8.93	8.72	8.69	8.09	7.45	8.12
College Rank in Difficulty	3	1	2	4	5	6	7	9	10	8
Average P Score for High School	8.74	8.72	8.73	9.00	8.85	8.77	7.94	7.06	6.10	6.16
Rank in Difficulty	4	6	5	1	2	3	7	8	10	9

One criterion of the reliability of a testing device such as the one under consideration is the correlation which exists between alternate elements of the test. It is evident that, if the test is measuring a specific ability, a subject who gets a high score on one-half of the test's elements will tend to get high score in the remaining elements. Likewise, a subject of low ability should secure low scores in both parts of the test.

In order to study the reliability of the test by this method a correlation between alternate elements of the test was computed. The sum of the partial scores received by students in elements A, C, E,G, and I was obtained. Also

the sum of the partial scores received in elements B, D, F, H, and J was computed. The value of "r" for these two variables was derived in the usual manner (Pearson's Product Moment). Next a reliability coefficient was computed in the manner recommended by Kelly (4,41) by means of the Spearman-Brown Formula:

$$r_{1\ I} = \frac{2\, r_{(\frac{1}{2}\ \frac{I}{II})}}{1 - r_{(\frac{1}{2}\ \frac{I}{II})}}$$

Where $r_{(\frac{1}{2}\ \frac{I}{II})}$ is the correlation between "half scores" and $r_{1\ I}$ is the reliability coefficient. The results are shown in Table IX.

Table IX

Reliability Coeeficients

Variables	r	P. E.	r(1 I)
Part (ACEGI) and Part (BDFHJ) 311 College Cases	.6968	.0196	.81
Part (ACEGI) and Part (BDFHJ) 192 H.S. Cases	.6102	.031	.76

According to Monroe (5,105) the value of the correlation between alternate parts falls between .60 and .90 for most

educational tests. This would place the Stenquist intercorrelation rather near the lower boundary and would indicate that the test elements were not measuring uniformily the trait, for which the test is a measure.

Kelley states that the value of "r" is an excellent estimate of the true measuring value of any test (4,41). He further asserts that the value of $r_{(1\ I)}$ should exceed .94 if the test has sufficient reliability to be used in individual diagnosis (4,211). With these facts in mind we have still further reason to doubt the reliability of the test. It seems certain that the Stenquist Test falls far short of possessing any value as an individual diagnostic test.

Considerable experience with the Stenquist Test has gradually caused the writer to not only doubt the validity and the reliability of the test but to question also the nature of the trait or quality which it measures. Whatever may be the nature of this quality or trait, it has been shown that it has no definite relation to other measures of mechanical ability. It has also been shown that there is a tendency toward high scores in the test. Evidently it is measuring some trait or quality which is possessed in a high degree by the majority of students who have taken the test. The writer can think of no trait or quality that so well fits this description as does that gained by experience with common mechanical devices. It would seem that experience with

the multitude of common mechanical devices present in the environment of the average individual would in itself have a definite effect upon the individual's ability to perform this type of test. Since such experience is possessed by practically all students there follows as a natural result the tendency toward high scores. In the study by Board and others (1,332) the concluding remarks contain the pertinent question "Do mechanical ability tests measure mechanical ability or mechanical experience?" There is a need for controlled experiments to determine the effect of experience with mechanical devices upon scores received in current mechanical ability tests.

CONCLUSIONS

1. There is no definite relation between the "T" Scores received by a student in the Stenquist Mechanical Ability Test and the student's subsequent success or failure in shop courses.

2. Since "T" Scores possess no relation to success or failure in shop courses, they possess no prognostic value and consequently are valueless in educational guidance.

3. There is no definite relation between general intelligence and ability to perform the Stenquist Test.

4. The student of high general intelligence has little if any better chance to excel in shop work than does the student of low general intelligence.

5. Low intercorrelations of alternate test parts indicate that the Stenquist Test is of doubtful value as a true ability test.

6. Low reliability coefficients show the Stenquist Test to have no value as an individual prognostic test.

7. From the above findings the writer reaches the final tentative conclusion that the Stenquist Test is a measure of experience rather than of any ability.

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BIBLIOGRAPHY

1. Board, Edna; Marsh, Wilda and Stockwell, Lynn E.
1927. The Relation of General Intelligence to Mechanical Ability. Ind. Arts M. 16:330-332

2. Gordon, George, Jr.
1929. The Relation of Pupils' Intelligence Quotients to Their Grades in the High School Shop. Ind. Educ. M. 250 Jan. 1929.

3. Horning, D. S. and Leonard, Ruth S.
1926. Testing Mechanical Ability by the McQuarrie Test. Ind. Arts M. 15:348-350. O '26

4. Kelley, Truman Lee.
1927. Interpretation of Educational Measurements. World Book Co., N. Y.

5. Monroe, Walter Scott.
1923. An Introduction to the Theory of Educational Measurements. Houghton Mifflin Co., N. Y.

6. Rugg, Harold O.
1917. Statistical Methods Applied to Education. Houghton Mifflin Co., N. Y.

7. Stenquist, John L.
1923. Measurements of Mechanical Ability. Contributions to Education, No. 130. Teachers College N. Y.

8. Sutherland, S. S.
1928. Correlations of Intelligence and Skill in Shop Work. Ind. Arts M. June 1928.