THE UNIVERSITY OF DETROIT

A COMPARISON OF PERFORMANCE ON THE WECHSLER-BELLEVUE INTELLIGENCE SCALE AND SUCCESS IN THE ENGINEERING COLLEGE

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CHAPTER I

INTRODUCTION

Purpose of This Study

The purpose of this investigation is, first, to determine the average scores of freshman engineering students on the Full Scale, Verbal Scale, and Performance Scale of the Wechsler-Bellevue Intelligence Scale, Form II. Secondly, these scores will be correlated with the students' mean school grades for the first semester in the College of Engineering. The investigator hopes that the results can be of value in guiding prospective engineering students. In addition, a secondary objective of this research is to compare the relative efficacy of the Wechsler-Bellevue Intelligence Scale and the Pre-Engineering Inventory in predicting scholastic success in the field of engineering.

It seems self-evident that certain information about students can be obtained most advantageously by a systematic testing program and that testing data and the use of other diagnostic instruments should increase the understanding of college students. According to one writer,

> ... a systematic testing program can yield the core background of knowledge about the student which, in turn, may provide the foundation for more efficient counseling, for improved teaching and educational practices, and for institutional self-appraisal.[1]

1. D. E. Swanson, "The Role of Testing in Student Personnel Services at Hamline University," Educational and Psychological Measurement, VI (Spring, 1946), 25-36.

General Studies of Intelligence of Occupational Groups

The classical investigation of the relationship between intelligence (as measured by the Army Alpha tests) and different occupational groups was undertaken by Yerkes and others during World War I. The sample, numbering 18,423 men and 68 occupational groups, was the largest available up to that time, and, as a result, the investigation had a definite influence on vocational guidance and vocational selection. According to the Wadsworth study, the median score for all the men was 121, and the civil engineers (N=21) ranked highest with a median score of 274. However, Yerkes states that

> The number of cases representative of most of the occupational groups is too small to give a reliable distribution of intelligence scores... The median and quartile scores are also unreliable because they are based upon literate whites only... It is evident that such occupational classification is very loose (due to the general terms used).[2]

Naomi Stewart has published a detailed paper on the rank of various occupational groups on the Army General Classification Test. The investigation involved more than 250,000 Army inductees and included 227 different occupations.

> The Army General Classification Test, routinely administered to all inductees, was designed to measure their "aptness" for service. While the term "intelligence test" has never been officially applied

2. R. M. Yerkes, editor. "Psychological Examining in the United States Army," Memoirs of the National Academy of Sciences, Washington: Government Printing Office, XV (1921), 1-890.

> to the A.G.C.T., it has been found to correlate almost as high with various tests so designated as their own reliability coefficients.[3]

She feels that this study clearly demonstrated an occupational hierarchy, however unequally scaled. The ten highest-ranking occupations and their median scores are in this order: accountant (130), student of mechanical engineering (128), personnel clerk (128), student of medicine (127), chemist (127), student of electrical engineering (127), writer (126), student of civil engineering (126), statistical clerk (125), and student of chemical engineering (125). She concludes that "if properly interpreted the findings of the present study can be of considerable usefulness in counseling."[4]

Intelligence of College Students in Different Curricula

Gwendalen Schneidler and R. F. Berdie found that among the entering freshman students the range of mean scores on the American Council on Education Psychological Examination was from 63 for males in the College of Education to 87 for males in the Institute of Technology at the University of Minnesota. Their conclusions were that

> On the whole there is a definite tendency for the college aptitude of the average student in the colleges of Education, Agriculture, Denistry and Pharmacy to be lower than that of the average student in Science,

3. Naomi Stewart, "A.G.C.T. Scores of Army Personnel Grouped by Occupations," Occupations, XXVI (October, 1947), 5-41.

4. Naomi Stewart, op. cit., pp. 5-41.

> Literature and the arts, Law, Medicine, the Institute of Technology, and the School of Business Administration.[5]

Noble and Arps utilized the Army Alpha tests in a study on students from the various colleges of Ohio State University and reported medians of 136 for the entire university and 141 for the college of Engineering. They concluded that "all medians of the colleges of commerce, journalism and engineering are distinctly higher than the medians for the other colleges."[6]

The Wechsler-Bellevue

Wechsler feels that one of the most useful aspects of the Wechsler-Bellevue Intelligence Scale is the division into Verbal and Performance Sub-scales. According to him,

> Its a priori value is that it makes possible a comparison between a subject's facility in using words and symbols and his ability to manipulate objects, and to perceive visual patterns. In practice this division is substantiated by differences between occupational aptitudes. Clerical workers and teachers, in general, do much better on verbal tests, whereas manual workers and mechanics do better on performance. The correlations are sufficiently high to be of value in vocational guidance, particularly with adolescents of high school age.[7]

5. Gwendalen G. Schneidler and R. F. Berdie, "Educational Hierarchies and Scholastic Survival," Journal of Educational Psychology, XXXIII (March, 1942), 199-208.

6. E. L. Noble and G. F. Arps, "University Students' Intelligence Rating According to Army Alpha Tests," School and Society, XI (February, 1920), 233-237.

7. D. Wechsler, The Measurement of Adult Intelligence, 3rd edition. Baltimore: The Williams and Wilkins Company, 1944, p. 146.

This statement suggests that these tests should be of value in vocational guidance. However, Diamond states that

> The Wechsler-Bellevue Scales, which have been so thoroughly studied as instruments of clinical diagnosis, have received little attention, as far as the literature indicates, from the standpoint of their possible helpfulness in determining vocational aptitudes.[8]

Anderson and others are of the opinion that the Wechsler-Bellevue Intelligence Scale has provided a long needed individual intelligence test standardized upon adult subjects. Therefore, these tests should be of considerable value in student personnel work. However, they stress that

> As with any new test, it is essential to study the relation of the scale to other measures and criteria of intelligence and to determine the effectiveness of the test when used with groups of individuals which differ in some respects from the original standardization groups; only thus can the special merits and limitations of a new test become delimited. At the college level, intelligence tests are expected to show some correlation with scholastic success, regardless of the possible value of the Wechsler-Bellevue Scale with non-college populations, its usefulness with college students would be limited unless its relation to grade average compares favorably with that of other tests.[9]

These investigators made a study of the relationship between the scores on the Wechsler-Bellevue Intelligence Scale

8. S. Diamond, "The Wechsler-Bellevue Intelligence Scales and Certain Vocational Aptitude Tests," Journal of Psychology, XXIV (October, 1947), 279-282.

9. E. E. Anderson, et al., "College Studies in Psychology: A Comparison of the Wechsler-Bellevue, Revised Stanford-Binet, and the American Council on Education Tests at the College Level," Journal of Psychology, XIV (October, 1942), 317-326.

and grade point averages of 112 women students in various curricula and obtained correlations from .41 to .45. Their results suggest further research on more specified groups of students, particularly since research studies on this kind of sample of college students or corresponding vocational groups are scant.

Intelligence and Aptitude Tests with Engineering Students

There seem to be certain qualifications, although these apparently have not been clearly determined, required for those who are to succeed in the field of engineering. Holcomb and Laslett feel that "in order that vocational and educational guidance may be made more scientific ... (the) suitable characteristics should be determined and made measureable by means of differentiating tests."[10]

Berdie points out that correlation coefficients predicting scholastic success in engineering have ranged from about .50 to .70 and that these are fairly good. To him and others, the disturbing fact is the lack of research and improvement in this field.[11]

In order to get a picture of what work has been done during the last 25 years, the data have been presented in Table I. The device used to predict scholastic success in

10. G. W. Holcomb, and H. R. Laslett, "A Prognostic Study of Engineering Aptitude," Journal of Applied Psychology, XVI (1932), 107-116.

11. R. F. Berdie, "The Differential Aptitude Tests as Predictors in Engineering Training," Journal of Educational Psychology, XLII (February, 1951), 114-123.

engineering is given in the first column; the place where the research was undertaken, in the second column; and the correlation between the device and the grade point average, in the last column.

It should be noted that the correlations cluster around .50, a few are about .60, and batteries and combinations of tests are, in general, highest, with correlations of about .75. Of particular interest are the relatively high correlations obtained with the Pre-Engineering Inventory and various tests of mathematical ability.

The bulk of the material for Table I was obtained from an article written by J. E. Moore who makes some pertinent statements regarding this type of research.

> The reader would do well to keep in mind that the coefficients of correlation were computed on groups of students which varied in number from fewer than a hundred to over a thousand. Certain caution is also needed in thinking of the scholastic success criterion. The correlation which is obtained by one school with college grades may be heavily influenced by such factors as entrance requirements, screening tests employed prior to initiation of the study, consistency of grading by the college faculty, and the time chosen for making the study. This latter point may make for a great deal of difference...
>
> The reader should also be cautious in interpreting the significance of correlations between tests and various kinds of grade point averages. Such means of prediction are seldom likely to reach or extend beyond the 0.90 level because of the variability of students' performance and the variation in a

> teacher's ability to evaluate or report scholastic success in a consistent manner...
>
> One final word of caution is offered... Could it be that the forecaster or predictor has been a little presumptuous in restricting himself to administering a few tests to an individual and from the test scores attempt to forecast a student's eventual success or failure?[12]

The State of the Problem

To summarize the main points of this short literary review of the present problem, it is indicated (1) that there is a need for testing the efficacy of the Wechsler-Bellevue Intelligence Scale as a predictor of scholastic success; (2) that there is a lack of research on the problem whether the various occupational and college groups manifest different measurable characteristics and capacities and, if this be the case, whether these can be utilized in counseling; and (3) that the solution of these two problems would be of particular interest to those who attempt to predict scholastic success in the field of engineering.

The main objective of this study is to determine the mean scores of freshman engineering students on the Full Scale, Verbal Scale, and Performance Scale of the Wechsler-

12. J. E. Moore, "A Decade of Attempts to Predict Scholastic Success in Engineering Schools," Occupations, XXVIII (November, 1949), 92-96.

TABLE I

CORRELATIONS OF HIGH SCHOOL GRADES, PERCENTILE RANKS, AND VARIOUS TESTS WITH MEAN SCHOOL GRADES IN ENGINEERING COLLEGES*

Predictive Item	College	Correlation: Predictive Item and Mean School Grade First Term
High School Grades:		
Average in Science	U. of Washington	.46
Average in Math.	U. of Washington	.49
Average in Nat. Sc.	U. of Washington	.54
Total Credits in Math., Science, and Manual Train.	U. of Minnesota	.19
Average in Grade 12	U. of Saskatchewan	.61
All Grades	Worcester Polytechnic	.41
Average in Math. and Science	Worcester Polytechnic	.51
Average in Math. and Science	U. of California	.35
High School Data other than School Grades:		
Class Percentile Rank	U. of Wisconsin	.56
High School Rank	Colorado Ag. and Mech.	.36
Aptitude and Achievement Tests:		
Cooperative English Test	Eight Engineering Colleges	.45
Cooperative Math. Test	Eight Engineering Colleges	.57
College Entrance Board Math. Test	Newark College of Engineering	.69
Engineering and Physical Aptitude Test	Penn. St. College	.79

TABLE I (CONT'D)

Predictive Item	College	Correlation: Predictive Item and Mean School Grade First Term
Iowa Math. Apt.	State U. of Iowa	.72
	Ill. Inst. of Tech.	.61
	U. of Washington	.58
Iowa Chem. Apt. Test	N. C. State Coll.	.82
Iowa Physics Apt. Test	U. of Washington	.55
Pre-Engineering Inventory:		
General Verbal Ability	Ten Engineering Colleges	.16-.50
Technical Verbal Abil.		.25-.55
Comp. Scientific Material		.41-.65
General Math. Ability		.51-.71
Comp. Mech. Principles		.30-.55
Spatial Visualization		.22-.42
Understanding Modern Soc.		.25-.53
Composite Score		.44-.68
Composite Score (1945)	Ga. Institute of Tech.	.63
Composite Score (1945)		.49
Composite Score (1947)		.65
Yale Scholastic Aptitude Test:	Newark Coll. of Eng.	
	Northwestern U.	
	U. of Texas	.50-.66
	U. of Tennessee	
	U. of Florida	
	Worcester Polytech.	

TABLE I (CONT'D)

Predictive Item	College	Correlation: Predictive Item and Mean School Grade First Term
Psychological Tests:		
A.C.E.	U. of Saskatchewan	.34
A.C.E.	Ga. Inst. of Tech.	.46
Ohio State Psych. Exam.	Ohio State U.	.61
Otis (S.A.)	N.C. State College	.49
Otis (Q.S.)	Ga. Inst. of Tech.	.50
Interests:		
Strong Engineering Key	U. of Wisconsin	.13
College Marks:**		
1st Quarter Grades	U. of Utah	.67
1st Semester Grades	U. of California	.87
Four Year Math. Average	Cornell U.	.84
1st Semester Grades	Ga. Inst. of Tech.	.78
Combination of Tests:		
Cooperative Math. Cooperative Physics Cooperative Chem. Yale Personnel Test II High School Grades	Worcester Polytech.	.64
Iowa Math. Training Cooperative Int. Alg. Thurstone V Factor Decile of High School Grad. Class	Purdue U.	.79

TABLE I (CONT'D)

Predictive Item	College	Correlations: Predictive Item and Mean School Grade First Term
A.C.E. Iowa Place. Exam. Chem. Cooperative Engl. Nelson-Denny Reading	Colorado Ag. & Mech.	.85
Iowa A.S. Content Iowa Silent Reading Iowa Math. Iowa English	State of Iowa U.	.74
Battery-College Entr. Examination Board	Cooper Union	.62
Scholastic & Math. Aptitude College Board Subject Math. Tests Adjusted High School Rank	Yale U.	.75

*Table modified from J. E. Moore, "A Decade of Attempts to Predict Scholastic Success in Engineering," Occupations, XXVIII (November, 1949), 92-96, and D. Harris, "Factors Affecting College Grades: A Review of the Literature, 1930-1937," Psychological Bulletin, XXXVII (1940), 125-166.

**An apparent mistake in J. E. Moore's table. The predictive items for the first quarter grades and first semester grades are apparently correlated with themselves.

Bellevue Intelligence Scale, Form II. These scores will be correlated with the students' mean school grades in the first semester.

It is the intention of this writer, therefore, to make a systematic investigation with the Wechsler-Bellevue Intelligence Scale on a rather specialized group of college students. The principal parts of this thesis will consist of (1) a tabular presentation of the mean IQ scores of 50 freshman engineering students on the Full Scale, Verbal Scale, and Performance Scale of this test and (2) expectancy tables showing the number and per cent of these subjects of various Wechsler-Bellevue Full Scale, Verbal Scale, and Performance Scale IQs in relation to specified mean grades in the first semester in the engineering college. A similar table, based on the results obtained on the same subjects with the Pre-Engineering Inventory will be presented.

The Instruments

The Wechsler-Bellevue Intelligence Scale consists of 11 sub-tests divided in two sub-scales, namely, a Verbal Scale and a Performance Scale. The Verbal Scale includes the information, comprehension, arithmetic, similarities, and vocabulary sub-tests. The picture arrangement, picture completion, block design, object assembly, and digit symbol tests constitute the Performance Scale. According to Wechsler, the following procedure was utilized in constructing the tests. (1) A thorough analysis was made of various other intelligence tests with particular reference to the functions measured, the samples on which they were standardized, their reliability in

terms of their correlations with one another, and their validity in terms of correlations with subjective judgments by teachers, army officers, etc. (2) The sub-tests were evaluated on the basis of clinical experience. (3) The author and his collaborators used the tests experimentally for about two years with some 5,000 cases before it was published.

The tests were standardized on a white, adult population which was selected by occupational status according to the proportions found in the 1930 census. It was determined that a 20 point scale for each sub-test with a mean of 10 and a standard deviation of 3 would be most adequate. The raw scores for each sub-test were converted into weighted scores by means of Hull's formula.[13]

Form II was developed to meet the need of a parallel instrument. Its norms are based on a sample of over 1,000 cases of male adults and studies of special groups. Wechsler reports correlations between the two scales and a mean difference of less than two points.[14]

Rabin and Cuertin have published the most recent review of the research and literature on these scales.[15] The writer chose to use Form II in his investigation mainly because less work has been done on it.

13. D. Wechsler, The Measurement of Adult Intelligence, pp. 73-77, 116-135.

14. D. Wechsler, The Wechsler-Bellevue Intelligence Scale, Form II. (Manual.) New York: The Psychological Corporation, 1946.

For administration, scoring and interpretation consult the two preceding references (13, 14).

15. A. I. Rabin and W. H. Cuertin, "Research with the Wechsler-Bellevue Test: 1945-1950," Psychological Bulletin, XLVIII (May, 1951), 211-248.

The Pre-Engineering Inventory is a series of tests intended to measure certain abilities conducive to the successful study of engineering. The test materials are kept strictly confidential in order to safeguard the integrity of the instrument. The tests are presented in two booklets, each of which is used in one of the two sessions required for the completion of the inventory. Booklet I includes tests of general verbal ability, technical verbal ability, and ability to comprehend mathematical materials. Booklet II consists of tests in general mathematical ability, ability to comprehend mechanical principles, spatial visualizing ability, and understanding of society. Each test has a specific time limit. The inventory, which is machine-scored, is corrected for guessing by subtracting a certain fraction of the wrong answers from the number of correct answers. Eight raw scores are derived, namely, one for each of the tests plus a Composite Score. These are converted to percentile ranks. The norms are based on a selected sample of 9,994 engineering freshman students in 33 colleges of engineering.[16]

The Subjects

The group investigated consisted of 50 engineering freshmen who volunteered to act as subjects. In this study a freshman engineering student was one who had had no previous college training and was enrolled in the Engineering School of the University of Detroit in the fall semester of 1951.

16. The Carnegie Foundation for the Advancement of Teaching. The Pre-Engineering Inventory. (Norms Bulletin.) New York: The Project Office, 1946.

The distribution of the ages is presented in Table II.

TABLE II

AGE DISTRIBUTION OF SUBJECTS

Age Group	Subjects
17	5
18	28
19	13
20	2
23	1
24	1

None of the subjects had taken an intelligence test previously.

The Procedure

The Wechsler-Bellevue Intelligence Scale, Form II was administered to the subjects during the fall semester beginning October 10, 1951. The testing conditions were kept as constant as possible in regard to the physical conditions, rapport, praise, and encouragement. It should be noted, however, that the time of the day the test was administered, which might have had some influence on the physical condition of the subjects, was not easy to control. Nevertheless, the examiner attempted to follow as closely as possible Wechsler's instructions.

The subjects' final grades for the first (Fall) semester and their composite scores on the Pre-Engineering Inventory, which was administered by the College of Engineering at the beginning of the semester, were obtained from the files in the Dean's office. Finally, all the pertinent data for each subject, i.e., name, age, date of examination, birthdate, test scores, and the final grades were transcribed to individual records.

17. D. Wechsler, The Measurement of Adult Intelligence, pp. 171-191.

CHAPTER II

PRESENTATION AND ANALYSIS OF DATA

As mentioned previously, this study is based on the performance of 50 freshman engineering students on the Wechsler-Bellevue Intelligence Scale, Form II. It became evident at the end of the semester, however, that in one case there was no record of the grades and that three of these subjects had not taken the Pre-Engineering Inventory. Consequently, the means and standard deviations on the Wechsler Full Scale, Verbal Scale, and Performance Scale are based on 50 subjects, whereas the correlations between the scores on these scales and the mean school grades are computed on the basis of 49 subjects, and, finally, only 46 records were available for the calculation of the correlation between the scores on the Pre-Engineering Inventory and the mean school grades.

Means of the Wechsler Scales and the Pre-Engineering Inventory

The means and the standard deviations were computed by the short method in which $M = M' + C$ AND $\sigma = i\sqrt{\frac{\Sigma x'^2}{N} - C'^2}$, according to Guilford.[18] The results obtained by these formulae are presented in Table III. The instrument utilized

18. J. P. Guilford, Fundamental Statistics in Psychology and Education, 2nd edition. New York: McGraw-Hill Book Company, 1950, pp. 61, 102.

TABLE III

MEANS AND STANDARD DEVIATIONS OF THE WECHSLER FULL SCALE, VERBAL SCALE, AND PERFORMANCE SCALE AND THE PRE-ENGINEERING INVENTORY

Instrument	M	SD	N
Wechsler Full Scale	124.10	6.98	50
Wechsler Verbal Scale	120.14	7.73	50
Wechsler Performance Scale	120.98	8.00	50
Pre-Engineering Inventory (Composite Score)	47.32	14.05	47

is placed in the first column and the mean, standard deviation, and number of subjects used in the following columns. The IQ scores on the Wechsler Full Scale ranged from 110 to 139.2 with a mean IQ of 124.1. On the basis of statistical theory, Wechsler classified subjects according to intelligence as: defective, borderline, dull normal, average, bright normal, superior, and very superior; and indicated the percentage in each of these classes. According to his calculation, 6.72 per cent of the American population are of superior intelligence and obtain an IQ score between 120 and 127 on the Wechsler-Bellevue Intelligence Scale. In view of this, the average freshman engineer in this sample is of superior intelligence and ranks higher on this capacity than about 91 per cent of the population. The mean scores on the Verbal Scale and the Performance Scale, 120.14 and 120.98 respectively,

would also give the average subject in this sample a higher ranking than about 91 per cent of the population, according to Wechsler's standardization, although both of these means are slightly lower than the mean IQ score on the Full Scale. (The scores on the Verbal Scale and Performance Scale ranged from 105 to 137 and 101 to 137 respectively.)[19]

One should, however, be cautious in applying these data to groups other than the freshman engineering students at the University of Detroit for two reasons. First, the sample is not large enough to be adequate for any other group of freshman engineers. Secondly, using volunteers as subjects does not guarantee random sampling.

These subjects obtained percentile composite scores on the Pre-Engineering Inventory ranging from 17 to 76 with a mean of 47.32. The mean score for all the freshman engineers who entered the University in the fall semester of 1951 was 41.68. Nevertheless, the mean percentile score of 47.32 approximates more closely the mean for the standardization group, namely, 50. As far as this test is concerned, then, our sample is fairly representative of the entire freshman class.

Correlations Between Wechsler Scale Scores, Pre-Engineering Percentiles and Mean School Grades

The analysis of the mean IQs obtained provided some

19. D. Wechsler, The Measurement of Adult Intelligence, pp. 36-48.

information about the group of students tested. The next step is to determine the coefficient of validity of the Wechsler scales in order to procure evidence of their predictive usefulness at the college level. A comparison of the agreement of the determined IQs and scholastic success will yield an index of their practical validity. The correlations between the Wechsler scales and the mean school grades for the first semester in the engineering college are rendered in Table IV. These correlations can be compared with the one obtained with the Composite Score of the Pre-Engineering Inventory, which presumedly measures abilities required for scholastic success in this field. The first column in the table indicates the instrument utilized, the second the correlation between it and the mean school grades, the third the standard error, and the fourth column gives the level at which the correlations are significant. The correlations were computed by the formula for Pearson r from the scatter diagram and corrected for coarse grouping according to a table furnished by Guilford.[20] The standard error was estimated by the formula $\frac{1}{\sqrt{N-1}}$, and the level of significance was determined by a table offered by Lindquist.[21]

20. J. P. Guilford, op. cit., p. 162.

21. E. F. Lindquist, Statistical Analysis in Educational Research. New York: Houghton Mifflin Company, 1940, p. 212.

TABLE IV

CORRELATIONS BETWEEN THE WECHSLER FULL SCALE, VERBAL SCALE, PERFORMANCE SCALE, THE PRE-ENGINEERING INVENTORY AND THE MEAN GRADES FIRST SEMESTER

Instrument	r	SE	Significance
Wechsler Full Scale	.556	.144	1% level
Wechsler Verbal Scale	.594	.144	1% level
Wechsler Performance Scale	.417	.144	1% level
Pre-Engineering Inventory (Composite Score)	.719	.149	1% level

The correlation of .556 (SE: .144) of the Full Scale is sufficient to suggest a substantial relationship between the two variables. Hence, this scale seems of practical usefulness, particularly when one considers that this correlation is significant at the 1% level. It is interesting to note the relatively great difference between the correlations for the Verbal Scale and the Performance Scale, .594 (SE: .144) and .417 (SE: .144), respectively. Both correlations are positive and significant at the 1% level; nevertheless, it is indicated that the Verbal Scale has a decidedly better practical validity, because its correlation seems to be the more dependable one. Still more substantial is the high correlation of .719 (SE: .149) obtained by the Composite Score of the Pre-Engineering Inventory, although

the reason for the higher correlation may be the greater range (cf. pp. 18-19). Nevertheless, it suggests a marked relationship between this score and success in the engineering college. Again, the correlation is significant at the 1% level. One can assume, therefore, that the practical validity is distinctly higher for the Pre-Engineering Inventory than for the Wechsler-Bellevue Intelligence Scale, Form II. This is intelligible, because the Inventory is a test of specific aptitude for engineering. However, the reader should take cognizance of the fact that these correlations are relative to the particular circumstances under which they were obtained and can only be interpreted in this light.[22] In regard to measurement of achievement, he should take into consideration that grades determined by teachers might be poor metric material as was pointed out by J. E. Moore (cf. p. 10).

Grade Expectancy

In order to demonstrate more adequately what these correlations mean and how they can be interpreted the results have been presented in expectancy tables.[23] Table V gives the relationships between the Wechsler Full Scale test scores, placed in the middle column, and the mean school grades, which are recorded in the top row.

22. J. P. Guilford, p. 167.

23. A. G. Wesman, "Expectancy Tables--A Way of Interpreting Test Validity," Test Service Bulletin, No. 38 (December, 1949), 1-5.

TABLE V*

NUMBER AND PER CENT OF FRESHMAN ENGINEERS OF VARIOUS WECHSLER FULL SCALE IQs IN RELATION TO SPECIFIED MEAN GRADES FIRST SEMESTER

N	No. of Subjects for Each Grade F D C B A	Wechsler Full Scale Scores	Per Cent of the Sub-Group for Each Grade F D C B A	Per Cent
7	2 5	130-139	29 71	100
28	3 8 11 6	120-129	11 29 39 21	100
14	2 6 6	110-119	14 43 43	100
49	5 14 19 11 0			

*A=4; B=3.0-3.9; C=2.0-2.9; D=1.0-1.9; F=below 1.0. The mean school grade for each student was determined by adding up the total number of quality points earned and dividing this sum by the total number of credit hours carried in the first semester.

By this table one can determine roughly the probability whether a student with a given Wechsler Full Scale score will succeed in the first semester of engineering college and what average grade he can expect to receive. The frequencies on the left half side of the table have been converted to per cent on the basis of the total number of scores placed in each row. Thus, the table reads that of the students who obtained Full Scale scores between 130 and 139, seventy-one per cent (5 students) earned a mean grade of B and twenty-nine per cent (2 students) earned a mean grade of C. Not one student whose score was in this group received a lower grade than C. Of the twenty-eight students

who scored a Full Scale IQ between 20 and 29, twenty-one per cent obtained a mean grade of B; thirty-nine per cent, a C; twenty-nine per cent, a D; and eleven per cent, an F. Finally, of fourteen students who had scores between 110 and 119 on the Full Scale, forty-three per cent obtained a C; forty-three per cent, a D; and fourteen per cent, an F. In other words, none of these earned an average better than C. On the basis of this table, then, one might predict the probable grades received in the first semester of prospective engineering freshmen.

Table VI, VII, and VIII show the number and per cent of students of various Wechsler Verbal Scale, Performance Scale, and Pre-Engineering Inventory scores in relationship to these specified mean school grades. These expectancy tables can also be interpreted in terms of simple probability. For example, Table VI reads that the probability for a student with a Verbal Scale score between 100 and 119 of earning a mean grade less than C is 13/23, whereas the probability of earning a mean grade of C or B is 10/23. Likewise, Table VIII states that the probability that a student with a score below 40 on the Pre-Engineering Inventory will earn a mean grade less than C is 2/3 and that his chance for a C is 1/3. The basic data are the same as those utilized in computing the correlations, but there is a difference in the way these data have been handled. In the tables the data are arranged for analysis of the probability of the individual's scholastic success in

TABLE VI

NUMBER AND PER CENT OF FRESHMAN ENGINEERS OF VARIOUS WECHSLER VERBAL SCALE IQs IN RELATION TO SPECIFIED MEAN GRADES FIRST SEMESTER

N	No. of Subjects for Each Grade					Wechsler Verbal Scale Scores	Per Cent of the Sub-Group for Each Grade					Per Cent
	F	D	C	B	A		F	D	C	B	A	
7			3	4		130-139			43	57		100
19	2	4	7	6		120-129	10	21	37	32		100
20	2	8	9	1		110-119	10	40	45	5		100
3	1	2				100-109	33	67				100
49	5	14	19	11	0							

TABLE VII

NUMBER AND PER CENT OF FRESHMAN ENGINEERS OF VARIOUS WECHSLER PERFORMANCE SCALE IQs IN RELATION TO SPECIFIED MEAN GRADES FIRST SEMESTER

N	No. of Subjects for Each Grade					Wechsler Perf. Scale Scores	Per Cent of the Sub-Group for Each Grade					Per Cent
	F	D	C	B	A		F	D	C	B	A	
8		2	2	4		130-139		25	25	50		100
22	3	4	9	6		120-129	14	18	41	27		100
13	1	6	5	1		110-119	8	46	38	8		100
6	1	2	3			110-109	17	33	50			100
49	5	14	19	11	0							

TABLE VIII

NUMBER AND PER CENT OF FRESHMAN ENGINEERS OF VARIOUS COMPOSITE SCORES ON THE PRE-ENGINEERING INVENTORY IN RELATION TO SPECIFIED MEAN SCHOOL GRADES FIRST SEMESTER

N	No. of Subjects for Each Grade F	D	C	B	A	PEI Composite Scores	Per Cent of the Sub-Group for Each Grade F	D	C	B	A	Per Cent
9			5	4		60-79			56	44		100
25	1	7	10	7		40-59	4	28	40	28		100
11	3	4	4			20-39	27	36	36			99*
1		1				0-19		100				100
46	4	12	19	11	0							

*Discrepancy is due to rounding.

the field of engineering, whereas the validity coefficients summarize these data. In other words, the expectancy tables show the details of the distributions rather than the averages. Nevertheless, the validity coefficients are more stable. One should be aware of this fact in interpreting the tables.[24] However, it is evident that the higher the correlation the more useful becomes the expectancy table. For example, Table VII, based on the results from the Performance Scale which showed the lowest correlation (.417) of the instruments used in this study, does not lend itself as well for prediction as Table VIII which is made from the composite scores of the Pre-Engineering Inventory which had the highest correlation.

24. A. G. Wesman, op. cit., p. 4.

With these qualifications, it may be stated that, in general, these results indicate a substantial relationship between the Wechsler Bellevue Intelligence Scale, Form II, and the mean school grades for the first semester in the College of Engineering at the University of Detroit and that it might prove useful in forecasting scholastic success in this field.

CHAPTER III

SUMMARY

1. The objectives of this investigation were (1) to determine the average scores of freshman engineering students on the Full Scale, Verbal Scale, and Performance Scale of the Wechsler-Bellevue Intelligence Scale, Form II, (2) to correlate these with the students' mean school grades for the first semester in order to determine the practical validity of this test on the college level, and (3) to organize the data in expectancy tables by which it would be possible to predict an individual's probable success or failure in terms of his results on this intelligence test. An additional objective was to correlate the composite scores these students obtained on the Pre-Engineering Inventory with the mean school grades for the first semester in order to compare this instrument, which supposedly measures abilities conducive to success in the engineering colleges, with the Wechsler scales.

2. The Wechsler test was administered during the first semester to 50 freshman engineering students who had no previous college training. With only four exceptions, the students were from 17 to 19 years of age. The school grades and the composite scores on the Pre-Engineering Inventory,

which was administered by the University, were obtained at the end of the first (Fall) semester from the Dean's office in the College of Engineering.

3. The data were statistically analyzed. The mean scores on the Wechsler Full Scale, Verbal Scale, and Performance Scale were 124.10 (SD: 6.98), 120.14 (SD: 7.73) and 120.98 (SD: 8.00), respectively. According to Wechsler's classification, this means that the average student in this sample ranks higher than about 91 per cent of the population. The mean percentile composite score on the Pre-Engineering Inventory was 47.32, a little lower than the mean for the standardization group (50).

4. The coefficients of validity for these scales were determined in order to achieve an index of their practical validity at the college level. The composite scores of the Pre-Engineering Inventory showed the highest correlation with .719 (SE: .149), which suggests a marked relationship between these scores and the grades earned by these students during the fall semester. However, the correlation of .556 (SE: .144) for the Wechsler Full Scale is also rather high for a single test. Furthermore, it was determined that the Verbal Scale had the higher correlation of the two Wechsler sub-scales, namely, .594 (SE: .144) as compared with .417 (SE: .144) for the Performance Scale. All correlations were significant at the 1% level.

5. Finally, four expectancy tables were arranged in order to present the details of the relationships between the scores on the three Wechsler scales and the composite scores on the Pre-Engineering Inventory and the mean school grades. Whereas the coefficient of correlation summarizes the group data, these tables indicate the chances an individual has for success or failure in terms of his scores on these various items. It was indicated that the higher the correlation the more useful becomes the expectancy table.

CHAPTER IV

CONCLUSIONS

1. The high intelligence ratings of engineers indicated by the World War I studies with the Army Alpha test and other investigations referred to in the Introduction are substantiated. There is evidence that student engineers are, on the average, of superior intelligence and that they, according to Wechsler's standardization, rate in the upper nine or ten per cent of the population.

2. There is a dependable relationship between the scores on the Wechsler-Bellevue Intelligence Scale, Form II, and grades earned the first semester by freshman students in the College of Engineering at the University of Detroit. The validity coefficients are relatively high for this type of study, and hence this scale seems to be of practical usefulness for this purpose. However, the correlation between the Wechsler Performance Scale IQs and the mean school grades seems to be less reliable than is the case with the Verbal Scale IQs.

3. On the basis of expectancy tables one might forecast roughly an individual's probable success or failure in the engineering college. Again, the Performance Scale seems less useful for this purpose.

4. Compared with the composite scores of the Pre-Engineering Inventory the coefficient of validity of the Wechsler Bellevue Intelligence Scale, Form II, is less, and, consequently, it is not of equal practical usefulness for this purpose. Since the Inventory presumedly measures more directly abilities required for scholastic success in the field of engineering, this result could be expected.

5. One should, however, be cautious in applying these results to other groups of freshman engineers for the following reasons:

a. The sample is not large enough to be universally adequate.

b. Using volunteers as subjects does not guarantee a representative sample, although it seems to fulfill this requirement fairly well as far as the Pre-Engineering Inventory indicates.

c. Grades determined by teachers might be poor metric material.

6. Further studies along these lines are necessary before these conclusions can be accepted. Research along the following lines is suggested:

a. Similar studies with students in the other colleges at the University.

b. Investigation of the validity of each Wechsler sub-test in connection with every subject studied by these students.

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