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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

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Technical Report
S-373 R

Development of USTES

APTITUDE TEST BATTERY FOR

ENGINEERING AID

(profess. & kin.) II
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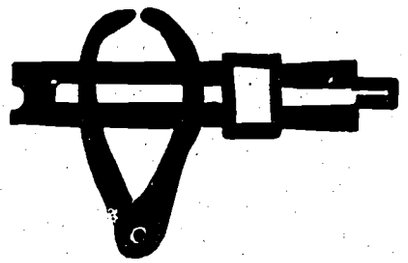
U S DEPARTMENT OF LABOR
Manpower Administration



Technical Report on Development of USTES Aptitude Test Battery

For .....

Engineering Aid (profess. & kin.) II 019.281

S-373R

(Developed in Cooperation with the
Washington State Employment Service)

U. S. Department of Labor
Manpower Administration

June 1970

FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measrues which, in combination predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

GATB Study #2592

DEVELOPMENT OF USTES APTITUDE TEST BATTERY

For

Engineering Aid (profess. & kin.) II 019.281-012

S-373R

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Engineering Aid (profess. & kin.) II 019.281-012. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB, B-1002 Scores
N - Numerical Aptitude	90
S - Spatial Aptitude	115
P - Form Perception	95

RESEARCH SUMMARY

Sample: Fifty-seven male students at technical schools in Tacoma and Pasco, Washington. This study was conducted prior to the requirement of providing minority group information. Therefore, minority group status is unknown.

Criterion: Grade-point averages

Design: Longitudinal (tests were administered during the first year of the two-year course, and the criterion data was collected after graduation). Minimum aptitude requirements were determined on the basis of job analysis and statistical analyses of aptitude mean scores, standard deviations, and selective efficiencies.

Predictive Validity: Phi coefficient = .35 ($P/2 < .005$)

Effectiveness of Norms: Only 65% of the nontest-selected students used for this study were good students; if the students had been test-selected with the above norms, 78% would have been good students. Thirty-five percent of the nontest-selected students were poor students; if the students had been test-selected with the above norms, only 22% would have been poor students. The effectiveness of the norms is shown graphically in Table 1:

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Students	65%	78%
Poor Students	35%	22%

SAMPLE DESCRIPTION

Size: N = 57

Occupational Status: Students

Training Setting: Students were enrolled at the following institutions: (1) Tacoma Vocational-Technical Institute, Tacoma, Washington; (2) Columbia Basin College, Pasco, Washington.

School Enrollment Requirements:

Age: Minimum acceptable age is 16 years.

Education: High school graduates with courses in Algebra, Geometry, and Physics preferred. Older applicants who are not high school graduates are considered for admission on the basis of an interview to determine interest and apparent potential to do the course work.

Previous Experience: None. For non-high school graduates, work as Stakeman or Rear Chairman in a survey party or other jobs related to engineering are considered favorably.

Tests: One institute, Tacoma Vocational-Technical Institute, administered a series of tests.

Principal Activities: The job duties of the occupation and the subjects contained in the course of study are shown in the Appendix.

Minimum Training: All students in the sample were graduates from the two-year training course which included classroom and field work.

TABLE 2

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age and Education.

	Means	SD	Range	r
Age (years)	21.7	5.0	17-42	-.010
Education (yrs.)	11.7	1.1	8-13	.157

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002A were administered during 1961 and 1962.

CRITERION

The criterion used was grade points for the first and second years' work. The grade points were given on each of four areas of school work: Quality of Production, Quantity of Production, Technical Knowledge, and Organization of Work. The schools placed equal emphasis on each area. The grade points for each year were totaled and converted to numerical scores. The numerical scores for the first and second years for each student were averaged for the final criterion score.

Criterion Reliability: The correlation between the first and second year numerical scores for the 49 graduates from Tacoma Vocational-Technical Institute was .67. Applying the Spearman-Brown prophecy formula to the scores obtained by averaging the first and second year scores to get an estimate of the reliability of the combined rating gave a correlation of .80. No measure of criterion reliability was obtained for the 8 graduates of Columbia Basin College because course grades were obtained at the completion of training.

Criterion Scores Distribution:

Possible range:	0-100
Actual range:	33-68
Mean:	50.4
Standard Deviation	9.0

Criterion Dichotomy: The criterion distribution was dichotomized into low and high groups by placing 35% of the sample in the low group to correspond with the percentage of students considered by the school to be doing marginal or unsatisfactory work. Students in the high criterion group were designated as "good students" and those in the low group as "poor students." Criterion critical score is 48.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitude S which did not have a significant correlation with the criterion was considered for inclusion in the norms because the qualitative analysis indicated that aptitude S was important for the job duties and it had the highest mean of any aptitude for the sample. A relatively high mean score indicates that some sample selection has occurred before or during the course and this may depress the correlation between the aptitude and the criterion. Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis
(Based on course description, the aptitudes indicated appear to be important for the course work)

Aptitude	Rationale
V - Verbal Aptitude	Receiving instructions, oral and written; reading reference materials; making reports, oral and written.
N - Numerical Aptitude	Applying arithmetic computations and mathematics through trigonometry to engineering problems; using the slide rule and logarithms.
S - Spatial Aptitude	Understanding two and three dimensional relationships needed for producing and using drawings, freehand and mechanical.
P - Form Perception	Making comparisons and recognizing differences in shapes and shadings of drawings, graphs, figures and pictorial material.
Q - Clerical Perception	Making and checking lists of material names and lists of numbers for costs and engineering data.
F - Finger Dexterity	Using instruments needed for drawing and surveying; operating machines, such as calculators.

TABLE 4

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB; N = 57

Aptitude	Mean	SD	Range	r
G - General Learning Ability	112.0	12.4	76-133	.395**
V - Verbal Aptitude	100.9	12.8	68-123	.292*
N - Numerical Aptitude	106.9	13.6	54-134	.400**
S - Spatial Aptitude	122.9	17.9	78-163	.171
P - Form Perception	112.9	15.8	76-144	.400**
Q - Clerical Perception	105.0	11.9	79-128	.354**
K - Motor Coordination	102.9	13.4	78-138	.069
F - Finger Dexterity	105.7	21.0	54-151	.132
M - Manual Dexterity	110.1	18.8	62-163	.138

*Significant at the .05 level
**Significant at the .01 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important		X	X	X	X	X		X	
Irrelevant									
Relatively High Mean	X			X	X				
Relatively Low Standard Dev.	X	X				X	X		
Significant Correlation with Criterion	X	X	X		X	X			
Aptitudes to be Considered for Trial Norms	G	V	N	S	P	Q			

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of aptitudes G, V, N, S, P, and Q at trial cutting scores were able to differentiate between the 65% of the sample considered good students and the 35% of the sample considered poor students. Trial cutting scores at five point intervals approximately one standard deviation below the mean were tried because this will eliminate about 1/3 of the sample with three-aptitude norms. For four-aptitude trial norms, cutting scores of slightly less than one standard deviation below the mean will eliminate about 1/3 of the sample; for two-aptitude trial norms, cutting scores of slightly more than one standard deviation below the mean will eliminate about 1/3 of the sample. The phi coefficient was used as a basis for comparing trial norms. Norms of N-90, S-115, and P-95 provided the optimum degree of differentiation of trainees for the occupation of Engineering Aid (profess. & kin.) II 019.281-012. The validity of these norms is shown in Table 6 and is indicated by a phi coefficient of .35 (statistically significant at the .005 level).

Table 6

Predictive Validity of Test Norms, N-90, S-115, and P-95

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Students	8	29	37
Poor Students	12	8	20
Total	20	37	57

Phi coefficient (ϕ) = .35 Chi square (X^2_y) = 6.80
Significance level = $P/2 < .005$

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP-34 which is shown in the 1970 edition of Section II of the Manual for the General Aptitude Test Battery. A phi coefficient of .25 is obtained with the OAP-34 norms of N-90, S-95, and P-90.

A-P-P-E-N-D-I-X

ENGINEERING TECHNICIANS COURSE OUTLINE

Engineering Technicians program is a six-unit course of two years' duration consisting of four regular semesters and two summer sessions. Classes are in operation five days each week, six hours per day. Class hours for the course total 2,580. The objective is to educate and develop talents in drafting and the related mathematics, sciences and general technical practices. The time schedule given with the following outline is based on average ability.

I. PRACTICAL INSTRUCTION

Hours

1. Drafting Fundamentals.....150
   a. Selection and use of instruments
   b. Lettering
   c. Applied geometry
   d. Orthographic projection
   e. Auxiliary projection, revolution, and descriptive geometry
   f. Section view
      (1) Conventions (2) Symbols

2. General Drafting Detailing.....200
   a. Make-up of a complete drawing--borders, titles, placing of views
   b. Dimensions and notes
   c. Thread forms, bolts, screws, nuts, washers, springs
   d. Rivets and welding
   e. Piping and electrical symbols and standards
   f. Sheet metal, wood, and fabricated steel symbols and standards
   g. Map drawing

3. Specialization in one of the following.....630
   a. Architectural working drawings
      (1) Standard details
         (a) Wall sections and framing
         (b) Doors
         (c) Windows
         (d) Kitchens
         (e) Stairs
         (f) Porches
         (g) Fireplaces
         (h) Millwork
      (2) Garage
      (3) One-story house
      (4) One and one-half-story house
      (5) Residential planning and design
      (6) Plot plans
      (7) Plumbing, heating and electrical
      (8) Industrial details and materials
      (9) Presentation work
      (10) Material lists, schedules, costs and specifications

b. Mechanical working drawings
   (1) Shop practices
   (2) Gears and cams
   (3) Jigs and fixtures
   (4) Motions and mechanisms
   (5) Bearings
   (6) Materials and costs
   (7) Heat treatment
   (8) Original design
c. Structural working drawings
   (1) Shop practices
   (2) Structural riveting and welding
   (3) AISC Handbook, Wood Handbook, Smoley's Tables, etc
   (4) Pc marking and standard structural drawing practices
   (5) Truss layout
   (6) Miscellaneous detailing
   (7) Reinforced concrete detailing
d. Electrical working drawings
   (1) Shop practices
   (2) Electrical diagrams
   (3) Electrical equipment and fixtures
   (4) Commercial and industrial wiring
   (5) Residential wiring

4. Sketching and Pictorial Representation.....100
   a. Orthographic sketching
   b. Isometric, oblique and cabinet drawing
   c. Perspective drawing
   d. Pictorial sketching
   e. Shading

5. Office Work.....150
   a. Bills of material
   b. Weight and stress calculations
   c. Field notes, charts and specifications
   d. Cost estimates
   e. Machine calculations
   f. Report writing and communications

Total Practical Hours..... 1230

II. RELATED INSTRUCTION

1. Simplified Engineering.....390
   a. Principles of mechanics
   b. Timber construction
   c. Steel construction
   d. Reinforced concrete
   e. Roof trusses

2. Applied Mathematics.....340
   a. Arithmetic review
   b. Algebra
   c. Geometry
   d. Trigonometry
   e. Logarithms
   f. Graphs, charts, and diagrams
   g. Use of the slide rule

3. Orientation in Ethics, Responsibilities, etc.....100
   a. Safety
   b. General office practices and procedures
   c. Fields of drafting application
   d. Securing employment
   e. Observational field trips

4. Applied Physical Science.....360
   a. Fundamental units
   b. Thermo-dynamics
   c. Properties of solids, liquids, and gases
   d. Forces, motions, power, and mechanisms
   e. Electricity
   f. Sound
   g. Hydraulics
   h. Chemistry

5. Surveying.....160
   a. General consideration--history, etc.
   b. Chaining procedures
   c. Leveling
   d. Transit work
   e. Field problems

Total Related Hours..... 1350

TOTAL PRACTICAL AND RELATED INSTRUCTION HOURS.....2580

NOTE:

Related instruction runs concurrent with the practical instruction throughout the course.

Practical instruction does not necessarily have tc be presented in the same order as listed in the outline.

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FACT SHEET

Job Title: Engineering Aid (profess. & kin.) II 019.281-012

Job Summary: Assists an Engineer in any and all fields of engineering including mechanical, structural, civil, electrical, and architectural, utilizing technical knowledge of fundamental engineering and draft design principles.

Work Performed: Performs such duties as detailing, tracing, lettering, simple design, preparation and cost information, statistical materials, material charts, and list, and production of blueprints and other types of reproductions of engineering material and drawings.

Holds level or stadia rod at designated points and moves rod or target on rod following hand or verbal signals to assist in determining elevations and laying out construction stakes for map making, construction, mining, land, and other surveys.

Obtains data pertaining to angles, elevations, points, and contours used for construction, map making, mining, or other purpose using alidade, level, transit, and other surveying instruments. Compiles notes, sketches, and records data obtained.

Computes and tabulates design data.

Maintains engineering office records, plans and maps. Performs clerical duties in engineering or architectural offices when such duties require familiarity with engineering practices and terms and the use of engineering media.

Effectiveness of Norms: Only 65% of the nontest-selected students used for this study were good students; if the students had been test-selected with the S-373R norms, 78% would have been good students. Thirty-five percent of the nontest-selected students used for this study were poor students; if these students had been test-selected with the S-373R norms, only 22% would have been poor students.

Applicability of S-373R Norms: The aptitude test battery is applicable to jobs which include a majority of duties described above.

GPO 898.815