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Validation Study of Armed Services Vocational Aptitude Battery (ASVAB) Selector Composites: Basic Electricity and Electronics (BE&E) Schools and Their Class "A" Schools for the Electronics Occupational Group

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Validation of the Armed Services Vocational Aptitude Battery (ASVAB) for the Basic Electricity and Electronics (BE&E) Schools and their Follow-on Class "A" Schools for the Electronics Occupational Group

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The purpose of this study was to validate ASVAB composites for the 11 ratings of the Electronics (OG) Occupational Group. The ASVAB consists of the following 10 tests: General Science (GS), Arithmetic Reasoning (AR), Word Knowledge (WK), Paragraph Comprehension (PC), Numerical Operations (NO), Coding Speed (CS), Auto and Shop Information (AS), Mathematics Knowledge (MK), Mechanical Comprehension (MC), and Electronics Information (EI). Verbal (VE) is composed of WK and PC.

This study was requested because of high attrition rates in the follow-on class "A" schools and the merging of the BE&E prerequisite schools into the follow-on Class "A" schools. The study recommends (1) retaining the operational selector composite and minimum qualifying score, AR + MK + EI + GS = 218, and (2) conducting expectancy analyses after the BE&E and follow-on Class "A" schools are merged to determine if the 218 minimum qualifying score is adequate.

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Foreword

This study was conducted in response to a request from the Chief of Naval Personnel (PERS-23) to validate the Armed Services Vocational Aptitude Battery (ASVAB) Selection criteria for the Electronics Occupational Group in CLASP (Classification and Assignment within PRIDE--Personalized Recruiting for Immediate and Delayed Enlistment).

The investigation was sponsored by PERS-23 and funded by reimbursable Work Unit WRE5102. Results, which are published at this time for archival purposes, are intended for use by the Bureau of Naval Personnel, Navy school officials, and the research community.

KATHLEEN E. MORENO
Director, Personnel and Organizational Assessment

Summary

Problem

This study was conducted in response to a request from the Chief of Naval Personnel (PERS-23) to validate the Armed Services Vocational Aptitude Battery (ASVAB) selection criteria for the Electronics (OG) Occupational Group in CLASP (Classification and Assignment within PRIDE--Personalized Recruiting for Immediate and Delayed Enlistment). The ASVAB consists of the following 10 tests: General Science (GS), Arithmetic Reasoning (AR), Word Knowledge (WK), Paragraph Comprehension (PC), Numerical Operations (NO), Coding Speed (CS), Auto and Shop Information (AS), Mathematics Knowledge (MK), Mechanical Comprehension (MC), and Electronics Information (EI). Verbal (VE) is comprised of WK and PC.

The Basic Electricity and Electronics (BE&E) prerequisite schools for the follow-on Class "A" schools traditionally have high attrition rates. Therefore, periodic validation of the ASVAB selection criteria is required. Further, since the BE&E schools are in the process of being incorporated into the follow-on "A" schools, validation of the ASVAB in these schools was also performed.

Objective

The objectives of this research were to (1) validate the operational ASVAB selector composite against BE&E school performance measures for the OG occupation group ratings, (2) identify and evaluate alternative ASVAB composites that would be more effective for determining qualification for school assignment, and (3) determine minimum qualifying scores for the recommended selector composites that would reduce attrition in the follow-on "A" schools without significantly reducing the percentage of Navy recruits available for school assignment.

Approach

Each BE&E school sample was randomly divided into a test selection sample and a hold-out sample. A multiple regression procedure was used for two methods where the most valid composite identified in the test selection sample and the operational selector composite were cross-validated in the holdout sample. Method I did not correct for restriction in range of test scores resulting from ASVAB selection, while Method II did. Experimental composites and the operational composite were compared from validities obtained in the holdout sample. Minimum qualifying scores were evaluated from expectancy analyses.

Results and Conclusions

For each BE&E school, the operational composite, AR+MK+EI+GS, generally had equal or higher validity than the experimental composites. This was also the case for the follow-on "A" schools. Expectancy analyses for the three BE&E schools with the highest attrition showed no appreciable gains in graduation rates by raising the current minimum qualifying score (218).

Recommendations

The following recommendations are addressed to PERS-23:

1. The ratings of the OG occupational group should retain their operational selector composite, AR+MK+EI+GS, and minimum qualifying score, 218, for school selection.

2. Expectancy analyses should be conducted for the OG occupational group ratings after the BE&E schools are incorporated into the Class "A" schools to determine if the 218 minimum qualifying score is adequate.

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Introduction

Background and Problem

This study was conducted in response to a request from the Chief of Naval Personnel (PERS-23) to validate the Armed Services Vocational Aptitude Battery (ASVAB) selection criteria for the Electronics (OG) Occupational Group. The OG group was selected for study because (1) the Class "A" schools comprising this group have prerequisite Basic Electricity and Electronics (BE&E) schools that traditionally have high attrition rates, and (2) the BE&E schools are in the process of being merged with their respective follow-on Class "A" schools and thus, can possibly affect the attrition rates at the Class "A" school level.

The ASVAB has been the personnel selection and classification instrument for all the military services since 1976. The paper-and-pencil battery, which measures cognitive abilities, skills, and technical information, consists of the following 10 tests: General Science (GS), Arithmetic Reasoning (AR), Word Knowledge (WK), Paragraph Comprehension (PC), Numerical Operations (NO), Coding Speed (CS), Auto and Shop Information (AS), Mathematics Knowledge (MK), Mechanical Comprehension (MC), and Electronics Information (EI). Verbal (VE) is composed of WK and PC. Table 1 briefly describes these tests. Each military service uses various combinations of these tests as composites to classify recruits into military occupations. Table 2 lists the Navy's 11 operational ASVAB selector composites. The operational selector composite for the OG occupational group ratings is AR+MK+EI+GS (Basic Electricity and Electronics).

The ASVAB is an integral part of the Navy's automated classification system called CLASP (Classification and Assignment within PRIDE--Personalized Recruiting for Immediate and delayed Enlistment). The CLASP system assigns Navy recruits to various ratings based on factors such as their ASVAB composite scores, training availability, quota requirements. Navy ratings within CLASP have been organized into 14 occupational groups, with individuals being allowed to express personal preference for a group at the time of assignment. The ASVAB selection standards are validated periodically for each "A" school to ensure that the most effective (valid) selector composite is in use. When possible, all ratings of an occupational groups are included for study.

This study of the OG occupational group used data collected before the merging of the BE&E schools with their respective follow-on Class "A" schools. This was necessary because (1) complete integration of the curriculum could take several years, postponing any ASVAB validation, and (2) analyses conducted during the transition period would reflect continuous curriculum revisions.

Table 1

Content of ASVAB Tests

Test	Abbreviation	Description
General Science	GS	A 25-item test of knowledge of the physical (13 items) and biological (12 items) sciences--11 minutes.
Arithmetic Reasoning	AR	A 30-item test of ability to solve arithmetic word problems--36 minutes.
Word Knowledge[a]	WK	A 35-item test of knowledge of vocabulary, using words embedded in sentences (11 items) and synonyms (24 items)--11 minutes.
Paragraph Comprehension[a]	PC	A 35-item test of knowledge of vocabulary, using words embedded in sentences (11 items) and synonyms (24 items)--11 minutes.
Numerical Operations	NO	A 50-item speed test of ability to add, subtract, multiply, and divide one- and two-digit numbers--3 minutes.
Coding Speed	CS	An 84-item speeded test of ability to recognize numbers associated with words from a table--7 minutes.
Auto & Shop Information	AS	A 25-item test of knowledge of automobiles, shop practices, and use of tools--11 minutes.
Mathematics Knowledge	MK	A 25-item test of knowledge of algebra, geometry, fractions, decimals, and exponents--24 minutes.
Mechanical Comprehension	MC	A 25-item test of knowledge of mechanical and physical principles--19 minutes.
Electronics Information	EI	A 20-item test of knowledge of electronics, radio and electrical principles and information--9 minutes.

[a]Verbal score: VE = WK + PC (raw scores).

Table 2

Navy Operational ASVAB Selector Composites

Composite	Components
General Technical	VE + AR
Mechanical	VE + MC + AS
Electronics	AR + MK + EI + GS
Clerical	VE + NO + CS
Basic Electricity & Electronics	AR + 2MK + GS
Engineering	MK + AS
Cryptologic Technician	VE + AR + NO + CS
Hospitalman	VE + MK + CS
Machinery Repairman	AR + MC + AS
Submarine	VE + AR + MC
Business/Clerical[a]	VE+MK+CS

Note. See Table 1 for full test names.
[a]Student Testing Program composite implemented July 1987.

Objectives

The objectives of this research were to (1) validate the operational ASVAB selector composite against BE&E school performance measures for the OG occupation group ratings, (2) identify and evaluate alternative ASVAB composites that would be more effective for determining qualification for school assignment, and (3) determine minimum qualifying scores for the recommended selector composites that would reduce attrition in the follow-on "A" schools without significantly reducing the percentage of Navy recruits available for school assignment.

The following 11 ratings make up the OG occupational group:

1. Aviation Antisubmarine Warfare Technician (AX)
2. Aviation Electronics Technician (AT)
3. Aviation Fire Control Technician (AQ)
4. Electronics Technician-Advanced Electronics Field (ET-AEF)
5. Electronics Technician-Nuclear Field (ET-NF)
6. Electronics Warfare Technician (EW)
7. Fire Control Technician-Gun (FTG)
8. Fire Control Technician-Missile (FTM)
9. Ocean Systems Technician-Maintenance (OTM)
10. Sonar Technician-Submarine (STS)
11. Sonar Technician-Surface (STG)

Approach

Predictors

The predictors used in this study were the 10 tests of the ASVAB Forms 8, 9, and 10 and parallel Forms 11, 12, and 13, introduced in October 1984 to replace Forms 8, 9, and 10. The raw scores for the six forms were converted to standard scores using tables developed from the 1980 American Youth Population (U.S. Department of Defense, 1982). A technical description of the development of the ASVAB Forms 11, 12, and 13 can be found in Prestwood, Vale, Massey, and Welsh (1985).

Criteria

Two types of performance criteria were used, one for self-paced schools and one for group-paced schools. The measure of school performance for the self-paced schools was "contact time." Contact time is the total time a student spends to complete a course of instruction and includes any special study time. All 11 BE&E schools and 3 of the 11 follow-on Class "A" schools (AX, AT, and AQ) were self-paced.

The criterion for the seven "A" schools that were not self-paced was final school grade (FSG). FSG was the average of all test scores (usually weekly) including a final comprehensive exam. Although FSG is on a scale of 0 to 100, passing scores are usually between 70 and 100. The criterion for the Ocean Systems Technician Maintenance (OTM) school was a dichotomous pass/fail grade as indicated by the binary code 1 or 0.

Attrites were retained in the analyses to provide representative samples. FSGs for attrites were estimated for both the BE&E and follow-on Class "A" school samples using mathematical procedures developed by Abrahams and Alf (1992) and described in Appendix A. This was done because an attrite's criterion score is usually zero or in some cases, the student's score at the time of disenrollment.

Samples

The BE&E school samples were obtained from the Computerized Managed Instruction (CMI) system provided by the Management Information and Instructional Systems Activity (MIISA). BE&E school performance data were extracted from these tapes for students attending courses from October 1980 to September 1986. Performance data for the follow-on Class "A" school samples were collected within this same time-frame, but, because each follow-on Class "A" school provided its own performance data, the actual collection dates for these schools varied.

Once student performance data were collected for both the BE&E and "A" schools, this information was matched with Student Action Codes contained in the Navy Integrated Training Resources and Administration System (NITRAS) data tapes. This procedure verified which students were graduates and which were attrites. The samples were further matched with Defense Data Center (DMDC) tapes to obtain raw ASVAB test scores and ASVAB form number.

Table 3 lists the ratings in the OG occupational group and the Course Data Processing (CDP) codes, validation sample size, and attrition rate for each school in this study.

Table 3

School Samples

	Course Code		Number of Cases		Attrition (%)	
School	BE&E	Class "A"	BE&E	Class "A"	BE&E	Class "A"
AX	6,232/609Y	6,241/610H	1,440	1,391	8	10
AT	6,230/610A	6,239/610J	5,772	5,824	8	9
AQ	6,231/609Z	6,240/610G	2,078	2,086	13	14
ET-AEF	6,414	603V	2,878	2,346	18	2
ET-NF	6,256	604E	3,653	2,069	6	9
EW	6,306	602B	1,334	341	11	5
FTG	6,248	609W	959	127	17	2
FTM	6,249	609X	901	171	15	8
OTM	610B	610X	141	119	6	27
STS	606N	6,172	1,619	977	13	1
STG	6276	6,015	1,326	1,916	10	3

Data Analyses

This section contains two parts: The first describes the procedures used to analyze the BE&E school validation samples, while the second describes procedures used to analyze the follow-on Class "A" school validation samples.

BE&E School Samples

Subjects for each of the BE&E school samples were sorted into graduates, academic attrites, and nonacademic attrites. Academic and nonacademic attrites were assigned separate or the same criterion score based upon a t-test performed to test the significance of the difference between their operational selector composite scores (see Table B-1).

For each BE&E school, subjects were randomly divided into a test selection sample (60% of the students) and a hold-out sample (40% of the students). Prior to this assignment, subjects were sorted to ensure that both samples had equal percentages of graduates and attrites. Academic and nonacademic attrites were combined when they were not statistically differentiated on the ASVAB (See Table B-1). Table 4 lists the BE&E school sample compositions.

Table 4

Number of Graduates, Nonacademic, and Academic Attrites in the Test Selection and Holdout Samples for the BE&E Schools

School	Test-Selection Sample			Holdout Sample			Total
	Graduates	Non-academic Attrites	Academic Attrites	Graduates	Non-academic Attrites	Academic Attrites	
AX[a]	796	27	41	531	24	21	1,440
AT	3,190	121	152	2,126	81	102	5,772
AQ	1,091	58	98	727	39	65	2,078
ET-AEF	1,410	140	176	940	94	118	2,878
ET-NF	2,051	86	55	1,368	57	36	3,653
EW	709	42	50	472	28	33	1,334
FTG[a]	480	48	47	320	41	23	959
FTM	457	35	48	305	24	32	901
OTM[a]	80	2	3	53	2	1	141
STS[a]	845	72	54	564	43	41	1,619
STG	715	43	38	477	28	25	1,326

[a]Academic and nonacademic attrites were not distinguished for statistical procedures for these schools.

Two methods were used with the test selection sample to identify the most predictive ASVAB composite. Both methods use a forward multiple regression procedure in which the prediction equation starts with the ASVAB test that has the highest correlation with FSG followed by tests that provide the largest increase in the multiple correlation.[1] The first four tests to enter the regression equation were designated as the experimental selector composite. Method I did not correct for restriction in range of ASVAB test scores, while Method II did. Appendix C explains the multivariate correction procedure (Lawley, 1943) using data from the ET-NF BE&E school. Appendix D provides the results of the multiple regression for both methods I and II using ET-NF BE&E school data.

The most predictive composites identified by the two methods and the operational composite were then cross-validated in the hold-out sample. Validities were compared after correcting for restriction in range. Composite scores used to correlate with FSG were calculated by summing the standardized scores for the composite tests. This procedure integer weights each test. Integer weights add stability and can be generalized to future samples more successfully than the exact weights derived from regression analysis, which are sample specific.

[1] For the multiple regression, WK and PC were combined into the ASVAB Verbal (VE) composite.

Follow-on Class "A" School Samples

The operational and experimental selector composites identified for each BE&E school sample were validated for the total of each follow-on Class "A" school sample. Results of the t-tests used in determining whether to combine academic and non-academic attrite criterion scores are shown in Table B-2. Table 5 lists follow-on Class "A" school compositions.

Table 5

Number of Graduates, Nonacademic, and Academic Attrites for the Follow-on Class "A" Schools

School	Graduates	Non-academic Attrites	Academic Attrites	Total
AX	1,258	42	91	1,391
AT	5,306	179	339	5,824
AQ	1,802	121	163	2,086
ET-AEF	2,309	14	23	2,346
ET-NF	1,883	0	186	2,069
EW	324	11	6	341
FTG	124	1	2	127
FTM	158	8	5	171
OTM	965	2	10	977
STG	1,864	33	19	1,916

Results and Conclusions

This section contains two parts, one for the BE&E schools and the other for the follow-on Class "A" schools.

BE&E Schools

Table 6 lists the experimental composites identified in the test selection samples using Methods I and II.

Table 7 lists the uncorrected and corrected cross-validities in the BE&E school hold-out samples for the experimental composites obtained from Methods I and II, and for the operational selector (AR+MK+EI+GS).

Replacing the operational selector composite was recommended when the experimental composite demonstrated: (1) a .05 increase in validity, or (2) a 2-percent reduction in attrition or improvement in the graduation rate. Table 7 shows that, in general, the cross-validities for the experimental and operational composites were comparable for the BE&E school holdout samples. Therefore, these results support continued use of the operational selector composite for the OG occupational group.

Table 6

Experimental Composites Identified Using BE&E Test Selection Samples

School	Method I		Method II
AX	MK+AR+AS+EI		AR+MK+AS+MC
AT	MK+AR+EI+MC	<---------->	AR+MK+EI+MC
AQ	MK+MC+AR+EI		MK+MC+AR+AS
ET-AEF	MK+EI+CS+AR	<---------->	MK+EI+CS+AR
ET-NF	EI+AR+CS+AS		AR+EI+MK+AS
EW	MK+AS+NO+AR	<---------->	MK+AS+NO+AR
FTG	MK+AR+EI+CS		MK+MC+AR+EI
FTM	MK+EI+NO+MC	<---------->	MK+EI+NO+MC
OTM	AR+GS+MK+CS	<---------->	AR+GS+MK+CS
STS	MK+EI+CS+AR	<---------->	AR+EI+MK+CS
STG	MC+MK+CS+AS	<---------->	MC+MK+CS+AS

Note. Arrows indicate both Methods I and II identified the same composite.

Table 7

Experimental and Operational Selector Composite Cross-validities for the BE&E School Holdout Samples

School	Experimental Composite				Operational Selector Composite	
	Method I		Method II			
	r_u	r_c	r_u	r_c	r_u	r_c
AX	-.30	-.55	-.33	-.57	-.29	-.55
AT	-.42	-.61	--	--	-.39	-.60
AQ	-.30	-.58	-.28	-.57	-.31	-.59
ET-AEF	-.43	-.63	--	--	-.38	-.60
ET-NF	-.38	-.71	-.38	-.72	-.36	-.71
EW	-.42	-.66	--	--	-.40	-.65
FTG	-.40	-.64	-.34	-.61	-.36	-.62
FTM	-.35	-.66	--	--	-.41	-.70
OTM	-.44	-.69	--	--	-.43	-.69
STS	-.39	-.62	--	--	-.29	-.58
STG	-.36	-.55	--	--	-.27	-.51

Notes.

1. See Table 6 for tests in the experimental composites and Table 3 for the school (rating) names.

2. Correlations (Pearson product moment uncorrected, r_u, and corrected, r_c) are not listed when Methods I and II identified the same composite.

3. Negative correlations are expected for self-paced BE&E schools because of the inverse relationship between ASVAB composite scores and the criterion-number of days to completion. In general, students with high composite scores will require fewer days to complete the course than will students with low composite scores.

4. The correction procedure used to determine r_c estimates composite validities for an unrestricted population (i.e., for a typical applicant group). Guilford (1965) gives the formulas for r_c (pp.340-345). Case I was used for the operational selector composite; Case III, for the experimental composites.

Follow-on Class "A" Schools

For each total follow-on Class "A" school sample, corrected and uncorrected validities were computed for the experimental composites (those developed using the BE&E test samples) and the operational selector composite. These validities are listed in Table 8.

Table 8 shows that, in general, the validities for the experimental and operational composites are comparable for the Class "A" school samples. These results also support continued use of the operational selector composite for the OG occupational group.

Table 8

Experimental and Operational Selector Composite Cross-validities for the Follow-on Class "A" Schools

	Experimental Composite				Operational Selector Composite	
	Method I		Method II			
School	r_u	r_c	r_u	r_c	r_u	r_c
AX	-.26	-.47	-.26	-.47	-.23	-.46
AT	-.30	-.48	--	--	-.28	-.47
AQ	-.27	-.50	-.28	-.50	-.24	-.49
ET-AEF	.28	.54	--	--	.30	.55
ET-NF	.30	.67	.32	.68	.32	.68
EW	.32	.65	--	--	.40	.69
FTG	.43	.70	.38	.68	.41	.70
FTM	.52	.78	--	--	.47	.76
OTM	.14	.09	--	--	.00	.00
STS	.30	.55	--	--	.27	.53
STG	.25	.50	--	--	.27	.52

Notes.

1. See Table 6 for tests in the experimental composites and Table 3 for the school names.

2. Correlations (Pearson product moment uncorrected, r_u, and corrected, r_c are not listed when Methods I and II identified the same composite.

3. Negative correlations are expected for the self-paced AX, AT, and AQ schools because of the inverse relationship between ASVAB composite scores and the criterion--number of days to completion. In general, students with high composite scores will require fewer days to complete the course than will students with low composite scores.

4. The correction procedure used to determine r_c estimates composite validities for an unrestricted population (i.e., for a typical applicant group). Guilford (1965) gives the formulas for r_c (pp.340-345). Case I was used for the operational selector composite; Case III, for the experimental composites.

5. The low and zero validities for the OTM "A" school (Table 8) are attributed to the fact that the ASVAB does a poor job in distinguishing graduate and attrite school performance, and not to use of the dichotomous pass/fail performance measure.

Minimum Qualifying Scores

The impact of raising the minimum qualifying score (MQS) for the operational selector composite, AR+MK+EI+GS, was examined using the data for the BE&E AT-AEF, ATM, and FTG schools. These schools experienced the highest BE&E attrition rate (see Table 3). The analyses are presented in Appendix E.

For the ET-AEF school (Table E-1), raising the MQS from 218 to 221 did not reduce attrition rate from the current level of 17%. It did, however, disqualify 131 (2135-2004) graduates from

school selection. Likewise, for the FTM school (Table E-2), raising the MQS from 218 to 221 did not reduce attrition from the current level of 15%. It did, however, disqualify 37 (748-711) graduates from school selection. For the FTG school (Table E-3), raising the MQS to 221 reduced the attrition rate by 2% (16%-14%). However, nearly twice as many graduates as attrites would be disqualified (41 disqualified graduates to 22 disqualified attrites).

The expectancy analyses do not support raising the MQS from 218 for the OG ratings. In addition, because only 39% (See Appendix E) of the recruit population qualified for school assignment, raising the MQS for the OG ratings could create shortages of qualified students for other occupational groups as well as OG. Finally, only 6 of the 11 BE&E schools experienced attrition rates greater than 10% (See Table 3).

Three of the six OG ratings (ET-AEF, FTG, and STS) with BE&E school attrition rates higher than 10% experienced low attrition rates (1% or 2%) at the follow-on "A" school (see Table 3). This inverse relationship between BE&E and "A" school attrition rates suggests that the criteria for successful BE&E school performance for these ratings are stringent. The relationship is reversed for the OTM follow-on Class "A" school where a low attrition rate (6%) in the BE&E school is followed by a high attrition rate (27%) in the follow-on Class "A" school. This suggests that the criterion for successful BE&E school performance for this rating is not stringent enough. These inconsistencies may be resolved by incorporating the BE&E schools into the follow-on Class "A" schools; performance evaluation and curriculum should become more standardized.

Recommendations

The following recommendations are addressed to PERS-23:

1. The ratings in the OG occupational group should retain their operational selector composite, AR+MK+EI+GS, and minimum qualifying score, 218, for school selection.

2. Expectancy analyses should be conducted for the OG ratings after the BE&E schools are incorporated into the follow-on Class "A" schools to determine if the current minimum qualifying score, 218, is adequate.

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[2]Cited in Appendix D.

Appendix A

Scoring of Failures

Scoring of Failures

The scoring of failures procedure is based on the assumption that criterion scores for successes (graduates) and failures (attrites), when combined, are normally distributed. Criterion scores are assigned at the appropriate point of the criterion distribution. The following formulas pertain to the case where academic and nonacademic attrites are not statistically distinguised based on selector composite scores. Final School Grade (FSG) is the criterion.

p = the proportion of graduates

q = the proportion of attrites

$\overline{X}_g$ = the mean final school grade for the graduates

SD_g = the standard deviation of FSGs for graduates

z = the z-score (standard score) above which the proportion p falls

y = the height of the normal curve at z

Step 1

The mean for attrites, $\overline{X}_a$, can be determined as follows:

$\overline{X}_a = \overline{X}_g - A(SD_g)$, where

$$A = \frac{y/(pq)}{\sqrt{1+ (zy/p) - (y/p)^2}}$$

Step 2

Assign the estimated mean criterion score determined in step 1 to each attrite.

Step 3

Compute the correlation between each predictor and the criterion for the combined distribution of graduates and attrites.

Step 4

Correct the correlations from step 3 for coarse grouping (assigning a mean criterion score to every attrite reduces variance and, therefore, the correlation coefficient). The formula used for this correction is:

$r_c = r_{xy} / SD_{z'}$, where

$$SD_{z'} = \sqrt{1 - q + zy + y^2/q}$$

When academic and nonacademic attrites have selector composite scores that are not significantly different, each group is assigned a different criterion mean. The formulas for assigning means require the following values:

p_1 = the proportion of academic attrites

p_2 = the proportion of nonacademic attrites

p_3 = the proportion of graduates

$\overline{X}_g$ = the mean final school grade for the graduates

SD_g = the standard deviation of final school grade for the graduates

z_1 = the z-score (standard score) above which the proportion p_1 falls

z_2 = the z-score (standard score) below which the combined proportion p_1 and p_2 falls

y_1 = the height of the normal curve at z_1

y_2 = the height of the normal curve at x_2

Step 1

The mean for academic attrites, $\overline{X}_a$, can be determined as follows:

$\overline{X}_a = \overline{X}_g - A(SD_g)$, where

$$A = \frac{\left[\left(\frac{y_2}{p_3}\right) + \left(\frac{y_1}{p_1}\right)\right]}{\sqrt{1 + \frac{(z_2 y_2)}{p_3} - \left(\frac{y_2}{p_3}\right)^2}} .$$

The mean for nonacademic attrites, $\overline{X}_{na}$, can be determined as follows:

$\overline{X}_{na} = \overline{X}_g - A(SD_g)$, where

$$A = \frac{\left[\left(\frac{y_2}{p_3}\right) + \frac{(y_2 - y_1)}{p_2}\right]}{\sqrt{1 + \frac{z_2 y_2}{p_3} - \left(\frac{y_2}{p_3}\right)^2}} .$$

Step 2

Assign the estimated mean criterion scores, $\overline{X}_a$ and $\overline{X}_{na}$, determined in step 1, to the academic and nonacademic attrites, respectively.

Step 3

Compute r_{xy}, the correlation between each ASVAB test and the criterion (FSG) using the combined distribution of graduates, academic attrites, and nonacademic attrites.

Step 4

Correct each r_{xy} from step 3 for the effects of course grouping (assigning a mean criterion score to every attrite reduces variance and, therefore, the correlation coefficient). The formulas used for this correction are:

$r_c = r_{xy}/SD_{z'}$, where

$$SD_{z'} = \sqrt{1 - (p_1 s^2_a) - (p_2 s^2_{na})} \quad ,$$

s^2_a, the variance of the academic attrite segment =

$$1 - \frac{(z_1 y_1)}{p_1} - \left(\frac{y_1}{p_1}\right)^2 \quad , \text{ and}$$

s^2_{na}, the variance of the nonacademic attrite segment =

$$1 + \left[\frac{(z_1 y_1 - z_2 y_2)}{p_2}\right] - \left[\frac{(y_1 - y_2)}{p_2}\right]^2 .$$

Appendix B

t Test for BE&E and Class "A" School Samples

Table B-1

t Test for BE&E and Class "A" School Samples

School[a]	Academic Attrites Mean	Academic Attrites SD	Nonacademic Attrites Mean	Nonacademic Attrites SD	*T* value	Decision to Combine
AX	226.16	10.62	227.47	10.57	0.65	YES
AT	223.43	14.70	228.58	13.70	3.83***	NO
AQ	221.18	110.79	223.98	10.88	2.01*	NO
ET-AEF	226.43	15.80	230.36	14.47	2.95**	NO
ET-NF	243.12	11.08	249.74	10.85	4.51***	NO
EW	225.70	13.08	232.56	14.11	3.25***	NO
FTG	227.70	09.49	230.83	13.87	1.61	YES
FTM	229.08	10.30	234.37	14.09	2.56*	NO
OTM	236.00	11.69	230.50	08.81	-0.75	YES
STS	229.68	10.35	232.06	11.77	1.54	YES
STG	228.19	12.57	232.87	11.29	2.27*	NO

Note. BE&E = Basic Electicity and Electronics.

[a]See Table 3 for names of school (rating) names.

*$p < .05$.
**$p < .01$.
***$p < .001$.

Table B-2

t Test for BE&E and Class "A" School Samples

School[a]	Academic Attrites Mean	Academic Attrites SD	Nonacademic Attrites Mean	Nonacademic Attrites SD	*T* value	Decision to Combine
AX	226.57	11.15	230.73	13.63	1.73	YES
AT	225.21	17.54	234.65	14.01	6.67***	NO
AQ	222.52	10.43	227.77	12.76	3.70***	NO
ET-AEF	233.07	16.18	239.04	14.75	1.15	YES
ET-NF[b]	-	-	-	-	-	-
EW	225.64	10.88	241.83	08.82	3.12**	NO
FTG	221.00	00.00	224.50	09.19	0.31	YES
FTM	230.00	11.33	243.20	05.76	2.39*	NO
OTM	227.53	08.69	232.47	09.86	1.49	YES
STS	252.00	12.73	232.00	16.79	-1.57	YES
STG	226.42	16.78	231.95	12.33	1.25	YES

Note. BE&E = Basic Electicity and Electronics.

[a] See Table 3 for names of school (rating) names.

[b] All attrites were categorized as nonacademic for the ET-NF school.

*$p < .05$.
**$p < .01$.
***$p < .001$.

Appendix C

Correction Procedure Used in Method II

Correction Procedure Used in Method II

In order for the regression analysis used to derive the ASVAB composite most predictive of final school grade (FSG) not to be biased against tests used for school selection, test scores must be corrected for restriction in range. This is accomplised in Method II by using a Navy applicant population ASVAB/FSG intercorrelation matrix where correlations between ASVAB tests and FSG are estimated using multivariate correction formulas (Lawley, 1943).

The next page gives two intercorrelation matrices (including means and standard deviations) required for the multivariate correction procedure. The first is the ASVAB/FSG intercorrelation matrix for the ET-NF BE&E test selection sample (see Table 1 for the full test names). The second is an ASVAB intercorrelation matrix for a Navy applicant population. At the bottom of the page are the estimated population correlations between ASVAB and FSG.

Required Multivariate Matrices and Output

	GS	AR	NO	CS	AS	MK	MC	EI	VE	FSG	Mean	SD
ET-NF BE&E Test Selection Sample Intercorrelation Matrix With Means and Standard Deviations												
GS	1.000	.139	-.072	-.021	.317	.194	.346	.397	.423	-.175	62.15	4.28
AR		1.000	.133	.089	.137	.292	.206	.079	.126	-.228	63.32	2.58
NO			1.000	.515	-.072	.103	-.063	-.064	.013	-.138	57.35	5.36
CS				1.000	-.028	.111	-.008	-.016	.091	-.162	56.44	7.04
AS					1.000	.055	.439	.505	.153	-.276	59.57	6.29
MK						1.000	.227	.118	.176	-.209	64.89	2.74
MC							1.000	.376	.180	-.259	62.47	5.53
EI								1.000	.254	-.297	61.61	5.86
VE									1.000	-.135	58.47	3.00
Population (Applicant FY 86) Intercorrelation With Means and Standard Deviations												
GS	1.000	.601	.234	.223	.505	.591	.635	.666	.773		62.15	4.28
AR		1.000	.133	.089	.137	.292	.206	.079	.126		63.32	2.58
NO			1.000	.515	-.072	.103	-.063	-.064	.013		57.35	5.36
CS				1.000	-.028	.111	-.008	-.016	.091		56.44	7.04
AS					1.000	.055	.439	.505	.153		59.57	6.29
MK						1.000	.227	.118	.176		64.89	2.74
MC							1.000	.376	.180		62.47	5.53
EI								1.000	.254		61.61	5.86
VE									1.000		58.47	3.00
Correlations (Validities) for Population From Correction Program and Above Matrices												
FSG	-.581	-.714	-.412	-.368	-.486	-.664	-.628	-.603	-.572			

Appendix D

Multiple Regression for Methods I and II

Multiple Regression for Methods I and II

TEST	STEP	MULTR	RSQ	F	FSIG	RSQCH	FCH	SIGCH	REG-DF	RES-DF
ET-NF BE&E Test Selection Sample Method I (EI + AR + CS + AS)										
EI	1	.2970	.0882	211.87	.000	.0882	211.87	.000	1	2,190
AR	2	.3610	.1303	164.04	.000	.0421	106.04	.000	2	2,189
CS	3	.3906	.1525	131.27	.000	.0222	57.31	.000	3	2,188
AS	4	.4112	.1691	111.28	.000	.0166	43.61	.000	4	2,187
Recruit Applicant Population (FY86) Method II (AR + EI + MK + AS)										
AR	1	.7140	.5098			.5098				
EI	2	.7621	.5807			.0709				
MK	3	.7794	.6074			.0267				
AS	4	.7862	.6181			.0107				

Note. See Table 1 for full test names.

The multiple regression results (SPSSX^x, 1983) for Method I show that AR is entered into the composite equation at Step 2, at which point the multiple correlation for the composite EI + AR is .3610. The squared multiple correlation (the proportion of final school grade variance accounted for by the composite) is .1303. The F statistic to determine the significance of the predictive relationship between the composite EI + AR and final school grade is 164.04. The probability that this predictive relationship is due to chance is less than .001. The chance in the squared multipule correlation upon entering this test (AR) into the equation is .0421. The F statistic for change (to determine the significance of the increase in the predictive relationship by adding the AR test into the equation) is 106.04. The probability that the significance of this addition is due to chance is less than .001. The degrees of freedom (number of observations minus the number of estimated parameters) are 2 for regression and 2,189 for residual.

Method II is based on corrected correlations. Since there are no appropriate significance tests for corrected correlations, the F tests for this method do not apply.

Appendix E

Expectancy Tables for the BE&E Schools (ET-AEF, FTM, and FTG Ratings)

Expectancy Tables for the BE&E Schools (ET-AEF, FTM, and FTG Ratings)

The following tables show a range of operational selector composite scores for the ET-AEF, FTM, and FTG BE&E schools that include the current minimum qualifying score. A breakdown for each score includes actual graduation and attrition rates for the school sample and expected rates (per 1,000) for the recruit population (FY86, $N = 89,816$).

Table E-1

Expectancy Table for the Operational Selector Composite (AR + MK + EI + GS) for the BE&E ET-AEF School (*N* = 2,878)

Composite Score	School Sample Grad *N*	Drop *N*	Total *N*	Grad %	Drop %	At or Above Composite Score in Recruit Population (%)	Expectancies per 1000 Recruits Total *N*	Grad *N*	Drop *N*
≥ 152	2,350	528	2,878	82	18	99	990	812	178
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
≥ 215	2,173	433	2,616	83	17	43	430	357	73
≥ 216	2,162	440	2,602	83	17	41	410	340	70
≥ 217	2,152	436	2,588	83	17	40	400	332	68
≥ 218 [a]	**2,135**	**435**	**2,570**	**83**	**17**	**39**	**390**	**324**	**66**
≥ 219	2,096	426	2,522	83	17	38	380	315	65
≥ 220	2,054	417	2,471	83	17	36	360	299	61
≥ 221 [b]	**2,004**	**401**	**2,405**	**83**	**17**	**35**	**350**	**290**	**60**
≥ 222	1,958	387	2,345	84	16	34	340	286	54
≥ 223	1,909	377	2,286	84	16	32	320	269	51
≥ 224	1,864	354	2,218	84	16	31	310	260	50
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
≥ 272	2	0	2	100	0				

Notes. 1. AR = Aritmetic Reasoning, MK = Mathematics Knowledge, EI = Electronics Information, GS = General Science, BE&E = Basic Electricity and Electronics, ET-AEF = Electronics Technician-Advanced Electronics Field.

2. Of the 308 waivers (students who scored below the minimum qualifying score of 218), 93 (30%) attrited (attrites are designated as drops). Waivers represent approximately 7% of the total sample.

[a] Current minimum qualifying score.

[b] Proposed minimum qualifying score.

Table E-2

Expectancy Table for the Operational Selector Composite (AR + MK + EI + GS) for the BE&E FTM School (N = 901)

Composite Score	School Sample Grad *N*	Drop *N*	Total *N*	Grad %	Drop %	At or Above Composite Score in Recruit Population (%)	Expectancies per 1000 Recruits Total *N*	Grad *N*	Drop *N*
≥ 166	762	139	901	85	15	97	990	824	146
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
≥ 215	753	134	887	85	15	43	430	366	64
≥ 216	753	133	886	85	15	41	410	348	62
≥ 217	751	133	884	85	15	40	400	340	60
≥ 218 [a]	**748**	**133**	**881**	**85**	**15**	**39**	**390**	**332**	**58**
≥ 219	741	131	872	85	15	38	380	323	57
≥ 220	732	129	861	85	15	36	360	306	54
≥ 221 [b]	**711**	**123**	**834**	**85**	**15**	**35**	**350**	**298**	**52**
≥ 222	696	119	815	85	15	34	340	289	51
≥ 223	675	112	787	86	14	32	320	275	45
≥ 224	661	109	770	86	14	31	310	267	43
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
≥ 272	4	0	2	100	0				

Notes. 1. AR = Aritmetic Reasoning, MK = Mathematics Knowledge, EI = Electronics Information, GS = General Science, BE&E = Basic Electricity and Electronics, FTM = Fire Control Technician-Missile.

2. Of the 20 waivers (students who scored below the minimum qualifying score of 218), 6 (30%) attrited (attrites are designated as drops). Waivers represent approximately 2% of the total sample.

[a] Current minimum qualifying score.

[b] Proposed minimum qualifying score.

Table E-3

Expectancy Table for the Operational Selector Composite (AR + MK + EI + GS) for the BE&E FTG School (N = 959)

Composite Score	School Sample Grad N	Drop N	Total N	Grad %	Drop %	At or Above Composite Score in Recruit Population (%)	Expectancies per 1000 Recruits Total N	Grad N	Drop N
≥ 182	800	159	959	83	17	85	850	706	144
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
≥ 215	778	147	925	84	16	43	430	361	69
≥ 216	777	146	923	84	16	41	410	344	66
≥ 217	774	146	920	84	16	40	400	336	64
≥ 218 [a]	**763**	**143**	**906**	**84**	**16**	**39**	**390**	**328**	**62**
≥ 219	757	139	896	84	16	38	380	319	61
≥ 220	736	134	870	85	15	36	360	306	54
≥ 221 [b]	**722**	**121**	**843**	**86**	**14**	**35**	**350**	**301**	**49**
≥ 222	702	119	821	86	14	34	340	292	48
≥ 223	682	114	796	86	14	32	320	275	45
≥ 224	662	109	771	86	14	31	310	267	43
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
≥ 272	1	0	2	100	0				

Notes. 1. AR = Aritmetic Reasoning, MK = Mathematics Knowledge, EI = Electronics Information, GS = General Science, BE&E = Basic Electricity and Electronics, FTG = Fire Control Technician-Gun.

2. Of the 53 waivers (students who scored below the minimum qualifying score of 218), 16 (30%) attrited (attrites are designated as drops). Waivers represent approximately 2% of the total sample.

[a] Current minimum qualifying score.

[b] Proposed minimum qualifying score.

Distribution List

Chief of Naval Personnel (PERS-2), (PERS-23), (PERS-234)
Commander, Navy Recruiting Command
HQ USMEPCOM/MEPCPAT-A, North Chicago, IL
Commanding Officer, U.S. Coast Guard Research Development Center, Avery Point, Groton, CT
Superintendent, Naval Postgraduate School
Defense Technical Information Center (4)