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IDENTIFICATION OF NAVAL ACADEMY APPLICANTS WITH ENGINEERING AND SCIENCE INTERESTS

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Navy Personnel Research and Development Center
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Due to the Navy's increasing manpower needs for high quality officers with engineering and science training, it has become necessary for the Naval Academy to increase the numbers of midshipmen electing engineering and science majors.

To obtain the necessary increased numbers of midshipmen electing engineering and science majors and avoid the mandatory placement of midshipmen in these programs, it was planned to investigate the use of an interest inventory to aid in selecting those Naval Academy applicants with a high likelihood of choosing an engineering or science major.

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20. ABSTRACT (cont'd)

The Strong Vocational Interest Blank (SVIB) was selected for empirical scale construction. A dichotomous criterion based on midshipmen major selections, i.e., engineering-science vs. "other" majors, was used to construct a scale [E-S(1)], utilizing the SVIB responses of half the 1973 graduating class. This scale was cross-validated on the remaining 1973 graduates, as well as the 1976 and 1977 classes. The class of 1976 was also used to investigate the relationship between the E-S(1) Scale and disenrollment at the Academy. Scale test-retest stability with the additional factor of two administrative sets, selection and experimental, was determined for a subsample of the 1977 class.

Cross-validated biserial correlations of .57, .62, and .63 were obtained for the 1973, 1976, and 1977 classes, indicating a high degree of statistical and practical significance for the E-S(1) Scale for differentiating between midshipmen selecting engineering-science rather than an "other" major. Test-retest correlations of .80 and .81 were computed for two subsamples of the 1977 class based on pre- and post-selection SVIB administrations. A linear progression was observed between E-S(1) Scale scores and disenrollment rates for the 1976 class. The highest scoring group (upper fifth) showed a 20 percent disenrollment and the lowest scoring (bottom fifth) group experienced a 35 percent disenrollment rate.

The Engineering-Science Scale is highly recommended for use by the Naval Academy to make selection decisions in those cases where candidates are otherwise equally qualified on other selectors such as Scholastic Aptitude Test (SAT) scores, high school rank, etc.

Prior to incorporating the Engineering-Science Scale into the selection composite where a candidate's score would enter into virtually all decisions, its effect on other predictors and criteria should be determined for various cut-off scores on the E-S(1) Scale.

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IDENTIFICATION OF NAVAL ACADEMY APPLICANTS WITH ENGINEERING AND SCIENCE INTERESTS

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FOREWORD

This research was performed as part of a larger effort under Advanced Development Objective TDP 43-07X, Subproject 02 (Officer Career Development System). As requested by the Dean of Admissions of the U. S. Naval Academy, it focused on using an interest measure to screen Academy applicants. Specifically, this study investigated the use of the Strong Vocational Interest Blank to identify individuals more likely to select an engineering or science program at the Naval Academy.

The assistance of the Naval Academy throughout all phases of this research is gratefully acknowledged. The considerable efforts of LCDR Robert D. McCullah, Department of Behavioral Science, who was appointed as NPRDC's official liaison at the Naval Academy, were responsible for expediting this study at all stages and thereby ensuring its successful completion. Finally, the support and cooperation of RADM Robert W. McNitt, USN (Ret.), Dean of Admissions, Dr. Gregory Mann, Chairman, Department of Behavioral Science, and Dr. John F. Kelley, Jr., Assistant Dean of Academic Affairs, is greatly appreciated.

J. J. CLARKIN
Commanding Officer

SUMMARY

Problem

The Navy has an increasing need for high quality officers with engineering and science training. Thus, it is necessary to increase the number of Naval Academy midshipmen electing engineering and science majors.

Objective

To increase the number of midshipmen electing engineering and science majors, without having to resort to mandatory placement of midshipmen in these programs, this study investigated the use of the Strong Vocational Interest Blank to identify individuals more likely to select an engineering or science program at the Naval Academy.

Approach

The Strong Vocational Interest Blank was selected for empirical scale construction. A dichotomous criterion based on midshipmen major selections (i.e., engineering-science vs. "other" majors) was used to construct a scale [E-S(1)], utilizing the Strong Vocational Interest Blank responses of half the 1973 graduating class. This scale was cross-validated on the remaining 1973 graduates, as well as the 1976 and 1977 classes. The 1976 class was also used to investigate the relationship between the E-S(1) Scale and disenrollment at the Academy. Scale test-retest stability was determined for a subsample of the 1977 class, who completed the Strong Vocational Interest Blank under selection and experimental conditions.

Results

Cross-validated biserial correlations of .57, .62, and .63 were obtained for the 1973, 1976, and 1977 classes, indicating a high degree of statistical and practical significance for the E-S(1) Scale for differentiating between midshipmen selecting engineering-science rather than an "other" major. Test-retest correlations of .80 and .81 were computed for two subsamples of the 1977 class

based on pre- and post-selection Strong Vocational Interest Blank administrations. A linear progression was observed between E-S(1) Scale scores and disenrollment rates for the 1976 class. The highest scoring group (upper fifth) showed a 20 percent disenrollment, and the lowest scoring (bottom fifth) group, a 35 percent disenrollment rate.

Recommendations

1. The Engineering-Science Scale is highly recommended for use by the Naval Academy to make selection decisions in those cases where candidates are otherwise equally qualified on such selectors as Scholastic Aptitude Test (SAT) scores, high school rank, etc. (p. 5).

2. Prior to incorporating the Engineering-Science Scale into the selection composite where a candidate's score would enter into virtually all decisions, its effect on other predictors and criteria should be determined for various cut-off scores on the E-S(1) Scale (p. 8).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

IDENTIFICATION OF NAVAL ACADEMY APPLICANTS WITH ENGINEERING AND SCIENCE INTERESTS

BACKGROUND AND PURPOSE

Present demands and future requirements for high quality naval officers with engineering and science training are placing increasing demands upon the various sources of commissioned officers. To meet future requirements, the Naval Academy has a goal of increasing the proportion of engineering and science majors.

The current system for selection of majors is commendable in that it is largely voluntary. Unfortunately, it does not provide the desired numbers of midshipmen in engineering and science curricula. If the characteristics of incoming midshipmen remain constant and the choice of major remains voluntary, there is little reason to expect an increase in the number of midshipmen selecting engineering or science majors. On the other hand, if increased placement of midshipmen into engineering-science majors is based on a mandatory system, undue pressures, lottery, or other questionable means, serious loss could result in terms of premature separation, academic failures, and frequent requests for changes in major.

One approach that would permit retraining the voluntary system while increasing the number choosing engineering or science majors is by modifying the selection procedures so that those selected for future classes are more likely to choose engineering or science majors. The present report describes the development and evaluation of a scale utilizing vocational interests to identify applicants having the highest levels of personal motivation toward engineering and science training. It is expected that this scale might also be used to guide midshipmen in selecting a major towards the end of their plebe year.

PROCEDURES

Instrument

We used the Strong Vocational Interest Blank (SVIB) as a potential predictor of engineering-science interests for a number of reasons:

(1) The SVIB has been successfully used in civilian occupational choice research over a 40-year period.

(2) Positive results have been obtained with the SVIB in earlier research in various officer programs (Abrahams & Neumann, 1973; Abrahams & Neumann, 1971a; Abrahams & Neumann, 1971b; Abrahams, Neumann, & Rimland, 1973; Neumann & Abrahams, 1972).

(3) The SVIB has been administered at the Naval Academy since 1967, and the availability of this data bank made it the ideal choice.

The 1966 edition of the SVIB used in the present study contains 399 items. It includes items concerning school subjects, amusements, occupations, and hobbies, most of which require a response of "like," "dislike," or "indifferent."

Criterion

The criterion of primary concern in this study was the midshipman's choice of major. In the second semester of the first academic year, each midshipman must select a major from one of four broad groups: (I) Engineering, (II) Science, (III) U. S. and International Studies/english and history, and (IV) Management. The individual majors within each category are listed in Table 1. Since this study sought to determine whether the SVIB could distinguish those midshipmen who ultimately select an engineering or science major from those who select other majors, we developed a criterion variable reflecting this dichotomy. Accordingly, all midshipmen included in this study were categorized into two broad groups. The first consisted of all engineering or science majors (Groups I and II), and the second consisted of all other majors (Groups III and IV).

Subjects

Three classes of midshipmen were selected to develop and evaluate an interest scale for predicting choice of major. We

TABLE 1

Majors Offered at the U. S. Naval Academy for the 1973, 1976, and 1977 Classes

Group I - Engineering	Group III - U. S. & International Studies/english & history
Aerospace Engineering	European Studies - French or German
Electrical Engineering	Far Eastern Studies - Chinese
Mechanical Engineering	Latin American Studies - Spanish
General Engineering	Soviet Studies - Russian
Marine Engineering	Economics
Naval Architecture	American Political Systems
Ocean Engineering	International Security Affairs
Systems Engineering	English
Engineering Physics[a]	History
Group II - Science	
Mathematics	
Chemistry	
Bioscience	**Group IV - Management**
Oceanography	
Physical Science	Analytical Management
Physics	General Management[b]
Operations Analysis	

Note.--

[a]Replaces Applied Science offered to the Class of 1973.

[b]Available only for the Class of 1973.

selected the 1973 class for developing a scale since they were the most recent class with a mature criterion. The 1976 and 1977 classes afforded the opportunity to assess the scale's validity on other classes. The SVIB was administered to midshipmen of all three classes during their first week at the Academy.

Scale construction. After determining major group membership for each midshipman, two separate subsamples consisting of 435 men each were formed from those members of the 1973 graduating class for whom SVIBs were available (N=870), which represented 98 percent of all graduates. Each subsample consisted of 251 midshipmen with engineering-science majors and 184 with "other" majors. We used one subsample for scale construction, and the other to cross-validate the scale.

A comparison of the SVIB item response proportions of the two major groups in the scale-construction subsample revealed the 75 item responses that best differentiated the engineering-science majors from other majors. These responses were then unit-weighted according to Campbell's dimensionality procedure (Campbell, 1971) and incorporated into a single engineering and science scale, hereafter referred to as E-S(1).

Scale validation. The E-S(1) Scale was evaluated in the following ways:

1. Cross-validation

a. Class of 1973. Scores were computed on the cross-validation subsample of the 1973 class to determine the scale's effectiveness in discriminating between the two major groups. Discrimination was assessed by a biserial correlation, with group membership as the dichotomous variable and E-S(1) Scale scores as the continuous variable.

b. Classes of 1976 and '977. E-S(1) Scale scores were related to choice of major for the 1976 and 1977 classes to determine whether the scale's validity would be temporally stable.

2. Selection versus experimental response sets. The availability of SVIB responses for some members of the 1977 class under the two response sets, selection and experimental, afforded the opportunity to determine whether scores are stable under these different conditions.

3. Disenrollment. Since the scale's usefulness would be impaired if engineering-science interests were positively related to disenrollment, E-S(1) Scale scores for the 1976 and 1977 classes were examined in relation to midshipman status, i.e., those remaining versus those who left the Academy.

RESULTS AND DISCUSSION

Scale Validity

As shown in Table 2, the initial cross-validation on the class of 1973 yielded a biserial correlation of .57 between scale score and major group membership. The magnitude of the correlation coefficient expresses a statistically and practically significant relationship. It represents almost a full standard deviation difference between the mean scores for the two major groups.

The results from additional cross-validations conducted on the 1976 and 1977 classes are also included in Table 2. The biserial correlations of .62 and .63, respectively, that were obtained indicated that the E-S(1) seems to be consistently effective over time.

To illustrate the practical significance of using the E-S(1) Scale in a selection situation, we prepared an expectancy chart. First, the score distribution for the class of 1976 was divided into fifths as nearly equal in sample size as possible. Next, we computed the percentage of midshipmen with an engineering-science major for each fifth. Figure 1 shows that those midshipmen in the top fifth of the score distribution selected an engineering-science major three times as frequently as those who scored in the lowest fifth. Further, the cumulative percentage column of Figure 1 shows that 82 percent of applicants who are otherwise qualified and who score in the upper 60 percent of the scale, can be expected to select an engineering or science major. Since only 67 percent of the 1976 class actually selected an engineering or science major, this represents an expected increase of 15 percent.

TABLE 2

Means, Standard Deviations, and Cross-Validated Correlation Coefficients for the SVIB Engineering-Science(1) Scale on the Naval Academy Classes of 1973, 1976, and 1977

Class	Major Group	N	$\bar{X}$	S.D.	r_b
1973	E-S	251	112.69	11.31	.57**
	Others	184	99.57	14.63	
1976[a]	E-S	761	111.79	13.35	.62**
	Others	380	96.05	14.63	
1977[a]	E-S	761	112.17	12.72	.63**
	Others	459	96.64	14.12	

Note.--

[a]Data presented for the 1976 and 1977 classes are based on those midshipmen for whom a final major choice was available. Therefore, these results do not include all those midshipmen who disenrolled prior to March 1973 (class of 1976) or March 1974 (class of 1977).

**Class of 1973: $r_b \geq .157$, $p \leq .01$.

Class of 1976: $r_b \geq .106$, $p \leq .01$.

Class of 1977: $r_b \geq .104$, $p \leq .01$.

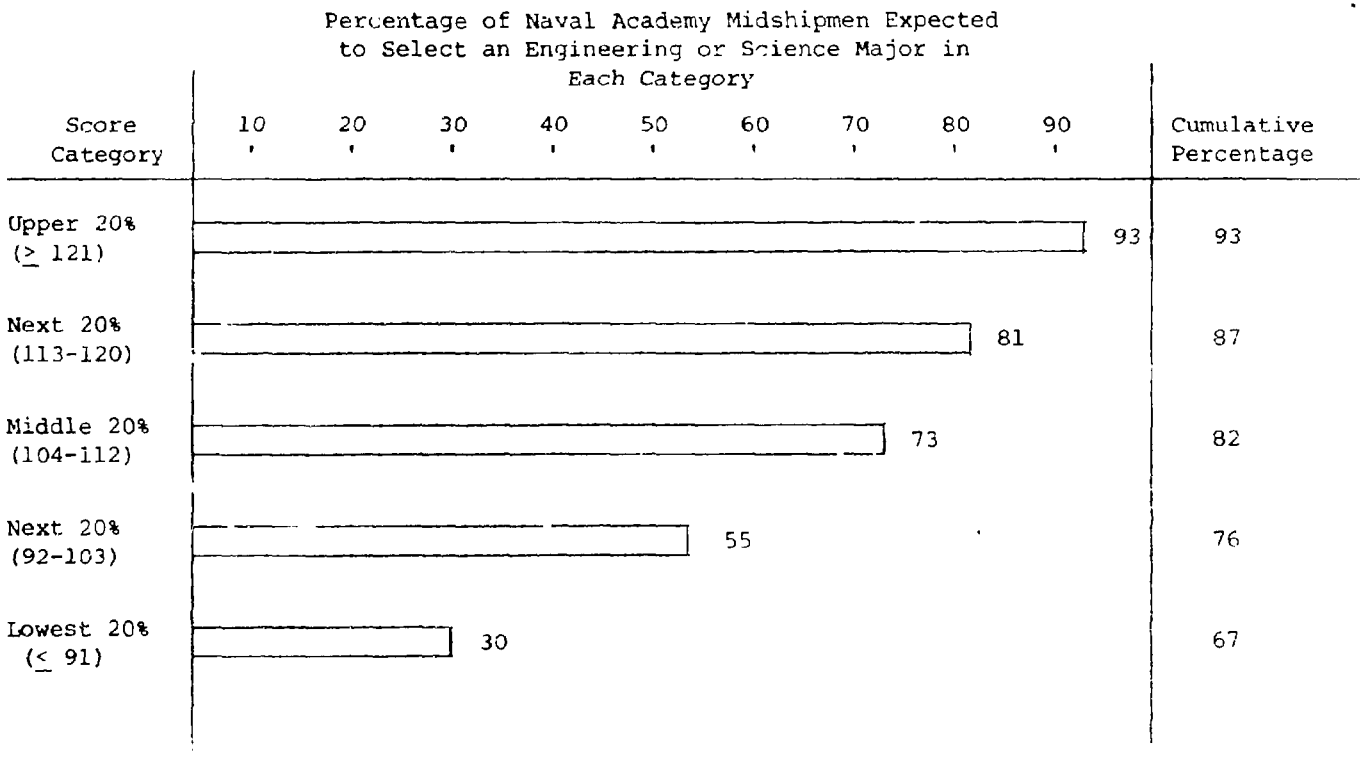

Fig. 1. Expectancy chart showing the relationship between the Engineering-Science(1) Scale and choice of major for the Naval Academy class of 1976.

An expectancy chart was also prepared for the class of 1977. Since the results closely paralleled those for the 1976 class, the figure was omitted from this report. However, the results indicate that 79 percent of those midshipmen scoring in the upper 60 percent of the scale selected either an engineering or science major. This represents an increase of 17 percent over the base rate of 62 percent for this class.

It is important to emphasize that the results just presented for the E-S(1) Scale are based on midshipmen who have qualified with respect to present Naval Academy selectors. Therefore, if the E-S(1) Scale is to be incorporated into the selection program, its impact on the existing predictors or criterion performance should first be assessed.

Test-Retest Stability

Responses to questionnaire items obtained from individuals already selected into a program may differ from responses given by the same individuals prior to their selection. Since the scale was developed on SVIBs administered shortly after selection, it was important to determine whether similar E-S(1) Scale scores would be earned if administered prior to selection.

During the time applicants were being processed for the class of 1977, the SVIB was administered on an experimental basis (but with a selection set) to two separate nomination sources--Presidential nominees and Naval Academy Preparatory School (NAPS) applicants. After the class of 1977 was convened in July 1973, the SVIB was administered to the entire class. Thus, two separate administrations (pre- and post-selection) were available for 166 Presidential nominees and 170 NAPS applicants. E-S(1) Scale scores were computed for both SVIBs. As shown in Table 3, the resulting mean scores for both nomination sources indicated virtually no shift. Further, the test-retest correlations (r = .80 and .81) are well within the acceptable range for a 6-8 month interval between administrations.

TABLE

E-S(1) Scale Score Means, Standard Deviations, and Correlation Coefficients for the Class of 1977 Pre- and Post-Selection SVIB Administrations

Nomination Source	Administration	Mean	S.D.	Test-Retest r
Presidential nominee (N=166)	Pre-	111.89	12.30	.80
	Post-	110.33	14.12	
NAPS (N=170)	Pre-	105.09	13.63	.81
	Post-	104.77	13.92	

This comparison also revealed that the mean score for Presidential nominees exceeded the mean score for NAPS by one-half standard deviation in both administrations. For the pre-selection administration, a test of significance for the difference between source means yielded a t of 4.80, which is statistically significant beyond the .01 level. Similarly, for the post-selection administration, a t of 3.63 was obtained, which is also significant beyond the .01 level.

The Relationship Between Disenrollment and the Engineering-Science Scale

One final consideration in evaluating the E-S(1) Scale as a possible selection criterion is its relationship to disenrollment. If, for example, high scoring midshipmen experienced higher disenrollment rates than those scoring lower, it would be difficult to consider using the scale in selection. For this reason, the proportion of disenrollees within each fifth of the score distribution was computed. Inspection of Table 4 reveals a linear

TABLE 4

Expectancy Chart Showing the Relationship Between the E-S(1) Scale and Disenrollment[a] for the Class of 1976

E-S Score Category	Remaining Class	Disenrollees	Total Sample N	Total Sample Percent Disenrolled
≥ 121	205	52	257	20
113-120	195	68	263	26
104-112	193	73	266	27
92-103	185	81	266	30
≤ 91	165	88	253	35
N	943	362	1305	
$\bar{X}$	107.36	103.66	106.33	
S.D.	15.41	15.64	15.54	
r_b	.14**			

Note.--

[a]Midshipman status for the class of 1976 was determined as of 5 June 1974.

**Statistically significant at the .01 level.

progression in disenrollment rate. The highest scoring group shows a 20 percent disenrollment rate and the lowest scoring group exhibits a 35 percent disenrollment rate. A comparison of the E-S(1) Scale mean scores revealed a statistically significant difference between disenrollees and remaining midshipmen, with the disenrollees scoring lower on the scale.

To illustrate the reduction in numbers of disenrollees possible with the use of the E-S(1) Scale, consider selecting a class comprised of only those scoring in the upper 60 percent. By applying the disenrollment rate of 24.6 percent for this category to a total class of 1,305 midshipmen, 321 members can be expected to disenroll within the first two years. This represents 41 fewer disenrollees than were reported for the class of 1976. If we assume that the average disenrollee spends one year at the Academy at a cost of approximately $13,000 per year per student, eliminating 41 disenrollees would result in monetary savings of $533,000. This, of course, is a benefit in addition to that accruing from the original purpose of the E-S(1) Scale, i.e., providing greater numbers of potential naval officers selecting engineering or science training.

The foregoing comparisons were based on all midshipmen from the 1976 class, regardless of major. To determine whether the E-S(1) Scale has differential validity for predicting disenrollment within major, we conducted separate analyses for those who disenrolled after the selection of major. The disenrollees and remaining midshipmen were compared within each major group and the results are presented in Table 5. These comparisons reveal that the validity of the E-S(1) Scale for predicting disenrollment is significant at the .05 level for those selecting an engineering or science major and not significant for those choosing an "other" major. We computed, for each major group, the difference between the mean E-S(1) score of remaining and disenrolled midshipmen. These differences were then compared statistically (t test), to determine whether the scale discriminates better between remaining and disenrolled midshipmen within either major group. Since the obtained t ($p > .05$) was not significant, we concluded that, although the E-S(1) Scale is positively related to remaining at the Academy, there is no significant differential validity by major group choice.

CONCLUSIONS

The investigation into the use of the SVIB to help identify midshipmen who are likely to select an engineering or science major resulted in the following conclusions:

TABLE 5

E-S(1) Scale Means and Standard Deviations by Midshipman Status for the Class of 1976 Major Groups

Midshipman Status	Major: Engineering-Science N	$\bar{X}$	S.D.	r_{pb}	Major: Others N	$\bar{X}$	S.D.	r_{pb}
Remain	652	112.27	13.22	.14*	291	96.35	14.25	.05
Disenroll	109	108.92	13.90		89	95.04	16.03	

Note.--

*Statistically significant at the .05 level.

(1) An E-S(1) Scale was successfully constructed and cross-validated on the class of 1973, the most recent class with a mature criterion. A biserial of .57 was obtained for the holdout sample, which indicated a high degree of effectiveness in differentiating between those midshipmen graduating from an engineering or science program and those graduating from other programs.

(2) Two additional year groups, the 1976 and 1977 classes, whose SVIB responses were scored on the E-S(1) Scale, yielded biserial correlations of .62 and .63, respectively. These findings indicate there is a high likelihood that the E-S(1) Scale can be applied to future Naval Academy classes.

(3) Comparisons made on a portion of the class of 1977 for whom pre- and post-selection SVIBs were available revealed test-retest correlations of .80 and .81 for each of two nomination sources. This indicates a high degree of stability for E-S(1) Scale scores from one administrative set to another.

(4) When the E-S(i) Scale was examined in relation to disenrollment from the Academy, it was found that midshipmen obtaining high scores on the scale were less likely to disenroll than low scoring midshipmen (biserial $\underline{r}$ = .14).

These results, when viewed as a whole, indicate that the SVIB scale constructed to aid in identifying midshipmen with engineering-science interests is highly effective. As previously indicated, the scale's impact on other selectors and criteria should be assessed. The scale's ability to generalize to other year groups, to show little response distortion from one administrative set to another, and to relate positively to retention at the Academy indicates its potential utility for Naval Academy selection.

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