

# MEDICAL RESEARCH DEPARTMENT



## U. S. Submarine Base New London

Report on

AN EVALUATION OF THE OFFICER CLASSIFICATION TEST AS A DEVICE  
FOR SELECTING OFFICER CANDIDATES FOR SUBMARINE SCHOOL

by

Lt. (jg) N. R. Bartlett, H(S), USNR

7 July 1945

Final Report

Bureau of Medicine and Surgery

Research Project No. X-530 (Sub No. 107)

APPROVED: Captain C. W. Shilling, (MC), U. S. Navy, H)-in-C

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Report on

AN EVALUATION OF THE OFFICER CLASSIFICATION TEST AS A DEVICE FOR  
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This is a final report on Project No. X-530 (Sub. No. 107)

Bureau of Medicine and Surgery

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Relationship of scores on the Officer Classification Test  
(Navpers 16680) to grades in Officer's Submarine School.

Medical Research Department  
U. S. Submarine Base  
New London, Connecticut

7 July 1945

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Summary and Conclusions:

In this paper the sections of the Officer Classification Test are evaluated in terms of a criterion of success in learning the duties of a submarine officer. The results also are analyzed after refining the data according to the submarine training the officers receive prior to assignment to the New London school. Correlations and scattergrams of results are tabulated and discussed; and a follow-up study in which these findings will be elaborated has been undertaken by the Test and Research Section of the Bureau of Naval Personnel. In brief summary the following four points are concluded from this paper:

1. Officer Classification Test scores are correlated significantly with performance in submarine school. Overall coefficients of the order of 0.40 are reported.
2. A score combining sections of the test is the most efficient index of subsequent academic standing, but if any single section score must be employed, the mathematical score is probably the most satisfactory of the four scores.
3. Candidates with previous submarine indoctrination achieve higher standings than do those without indoctrination.
4. The class standings of officers with previous indoctrination can be predicted with more confidence from the aptitude scores than can the standings of officers without indoctrination. The coefficients for those with indoctrination are of the order of 0.45.

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### Introduction:

On the basis of earlier studies,<sup>1</sup> the Officer Classification Test (Form X-1) was adopted in 1944 as one device for selecting officers for Submarine School. It was first used for choosing candidates for the class assembled at Now London in July, 1944. Sufficient data are now available to warrant an evaluation of the four parts of the instrument. Final grades are available for two classes who were examined prior to admission.

One research problem on this test as it applies to Submarine training has been investigated by the Test and Research Section of the Bureau of Naval Personnel.<sup>2</sup> This problem was the relationship between each of the sections and grades in various courses of the School; the problem was a part of a survey for validation and for revision of the existing form of the test. The efficiency of the sections in the light of the overall grade assigned by the Submarine School has not been determined, and if the present form is to continue in use as a submarine personnel selection device, each section should be so appraised.

### Problem:

A determination of how well each section predicts an overall measure of an individual's performance in training is in order. Such a study will afford a comparison of the four parts as well as a measure of the overall efficiency of the instrument in terms of a general submarine training criterion. The most obvious choice for a criterion of training performance is the final grade assigned by the Submarine School. Therefore the problem is defined as an investigation of the relationship between section scores on the test and subsequent grades in school.

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<sup>1</sup>Report on Project No. X-382 (Sub. No. 71) dated 9 August 1944.

<sup>2</sup>"Test Development and Personnel Research in the Navy", Report of Joint Meeting of NDRC Project N-106 and Test and Research Section, Bureau of Naval Personnel, dated 16 February, 1945.

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Method:

The Officer Classification Test was administered to all candidates for training before those candidates were interviewed by the Examining Board. Every candidate realized that his scores would be communicated to the Board, and realized that the Board utilized aptitude marks as one of the bases for accepting candidates. Each one presumably was motivated to work for a high score, since each was a firm volunteer for this type of duty. Similarly there was incentive to attain a good standing in school.

The general content of the submarine academic course has been outlined previously. The curriculum was the same for the two classes utilized in this study, and test score and school grade distributions for the two were comparable. Similar correlation findings would be anticipated for the two. Two hundred thirty-eight officers graduated from the July-September Class, and two hundred fifty-nine from the September-December Class.

Decile class standings rather than the grade assigned were assumed as the academic performance criterion. Standings, rather than grades, are the objectives of the student. Differences at the extremes of the scale are thus equated to differences in the middle, but after consideration of causes for unusually high or low grades it was decided that the differences should be equated. And except for the small factor involved in equating differences, the substitution of a rectangular distribution of standings for a curvilinear distribution of grades does not affect the determinations of product-moment coefficients. Correlations with grades thus would approximate closely the data reported herein. It is noted that the use of a rectangular distribution with relatively coarse grouping, as in this paper, should yield conservative estimates.

Standings and test scores are punched in Hollerith cards maintained routinely for all candidates for Submarine School. Certain other data are recorded on the Hollerith cards, and one column (number of months pre-school submarine indoctrination) was singled out in this study in a first attempt to refine further the overall relationship between aptitude scores and performance.

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1<sup>st</sup> Op. Cit.

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Results and Discussions:

Table I presents the product-moment correlation coefficients for scores on the several sections with class standings for both classes. All differences in previous training were ignored deliberately for these computations; the coefficients represent the relationship which obtains when all the other factors affecting the grades are operating. Regardless of everything else, then, the class standings of the graduates could have been forecast by a single section of the OCT with a degree of accuracy depending on the coefficients in Table I.

TABLE I

Product-moment Coefficients of OCT Scores with  
Final Grades in Submarine School.

Selection Device	July-Sept. Class	Sept.-Dec. Class
Verbal Section	0.28	0.20
Mechanical Section	0.27	0.28
Mathematical Section	0.35	0.27
Spatial Section	0.24	0.29
Sum of Coded Math. and Mech. Scores	0.37	0.35
Total OCT Score	0.41	0.40

Table II indicates the mean Navy Standard score for the two groups of graduates. It appears that the graduates are high on each of the four sections, and especially so on the mathematical section. This emphasizes the need for increasing the coefficients in Table I in order to correct for homogeneity; the findings reported in this paper are very conservative since they are based on the graduates from two selected groups. In other words, they were derived from a population that is relatively selected and homogeneous. The variability for the graduates of the two classes on each section can be discerned in the scattergrams of Tables III, IV, V and VI; a correction should be made before applying these results to the Navy officer population as a whole. Obviously the correction for such application will involve a greater emphasis on test scores.

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TABLE II

Mean OCT Standard Scores for Two Graduating Classes,  
U. S. Submarine School.

Section	July-Sept. Class	Sept-Dec. Class
Verbal	52.5	53.4
Mechanical	60.1	59.2
Mathematical	62.2	62.9
Spatial	58.8	58.3

Tables III, IV, V, VI and VII are scatter diagrams showing, respectively, the degree of relationship between class standings and the scores for the following sections or combinations of sections: (III) Verbal; (IV) Mechanical; (V) Mathematical; (VI) Spatial; and (VII) Total OCT Score. Table VIII illustrates the correspondence between standings and a combination of mechanical and mathematical scores. Standings are grouped into deciles, with 1 representing the highest ten percent of the two classes, 2 the next ten percent, and so on to 10 for the lowest ten percent. All data are pooled in these scattergrams; no refinements whatever have been made. Just as with the coefficients in Table II, these diagrams depict the relationship obtaining when all the varying factors in the situation besides basic aptitudes also are operating.

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TABLE III

Scattergram of Verbal Scores and Class Standings.\*

Verbal Section Score	Decile Standing---Combined Classes										Total
	1	2	3	4	5	6	7	8	9	10	
70-72	5		1	1	4	2	1				14
65-69	3	5	5	5	4	6	5	3	2	1	39
60-64	13	13	6	2	6	2	11	3	4	4	64
55-59	9	8	12	3	11	11	5	9	7	9	89
50-54	6	9	11	10	10	6	11	12	6	6	87
45-49	9	9	9	11	6	10	10	13	9	17	103
40-44	3	6	4	8	6	8	6	6	13	12	72
35-39	2		1	4	2	3	1	3	6	1	23
30-34			1	1				1	3		6
Total N	50	50	50	50	49	48	50	50	50	50	497

\* In this study raw scores are coded, rather than standard scores, in order to equate sizes of score intervals for statistical treatment. Hence in some scattergrams the interval size may appear to change in terms of Navy Standard scores.

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TABLE IV

Scattergram of Mechanical Scores and Class Standing.

Mechanical Section Score	Decilo. Standing---Combined Classes										Total	
	1	2	3	4	5	6	7	8	9	10		
78-84		1	1		3							5
72-77	7	11	8	5	6	7	3	5				52
66-71	12	8	15	15	10	6	12	6	9	5		98
59-64	13	14	9	6	13	15	11	4	14	15		114
53-58	13	12	11	17	3	8	12	19	10	11		116
47-52	5	3	1	5	5	5	4	9	7	12		56
41-46		1	3	2	9	5	6	5	8	6		45
34-40			2			2	2	1	2	1		10
28-33								1				1
Total N	50	50	50	50	49	48	50	50	50	50		497

TABLE V

Scattergram of Mathematical Scores and Class Standing.

Mathematical Section Score	Decile Class Standing---Combined Classes										Total
	1	2	3	4	5	6	7	8	9	10	
79-80	3	1		2	1		1				8
73-77	7	10	9	2	4	7	7	5	4	2	57
67-72	13	14	14	19	11	6	4	6	5	7	99
62-66	12	13	13	9	9	15	19	10	7	11	118
56-60	8	9	8	9	9	6	8	11	13	14	95
50-54	7	2	5	6	10	3	9	11	9	6	68
44-49		1	1	2	5	9	1	2	10	6	37
38-43				1		2		4	1	3	11
33-37							1	1	1		3
27-31										1	1
Total N	50	50	50	50	49	48	50	50	50	50	497

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TABLE VI

Scattergram of Spatial Scores and Class Standing.

Spatial Section Score	Decile Class Standing---Combined Classes										Total
	1	2	3	4	5	6	7	8	9	10	
74-77	2	2	1	2			1				8
68-73	6	9	8	9	11	6	6	2	2	2	61
62-67	17	12	12	13	11	8	7	8	8	10	106
56-61	7	19	15	14	11	16	14	14	11	10	131
50-55	11	6	11	9	11	10	14	13	18	12	115
44-49	5	2	1	2	4	5	7	9	8	13	56
38-43			2	1	1	2	1	2	3	2	14
32-36	1					1		2		1	5
26-31											0
20-24	1										1
Total N	50	50	50	50	49	48	50	50	50	50	497

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TABLE VII

Scattergram of Total OCT Scores and Class Standing.

Total OCT Raw Score	Decile Class Standing --- Combined Classes										Total	
	1	2	3	4	5	6	7	8	9	10		
220-229	3	2	1	1	1	1						9
210-219	4	2	4	2	3	2	3	2				22
200-209	5	9	5	5	6	3	5		1			39
190-199	11	10	9	5	8	7	5	3	1	3		62
180-189	8	12	13	11	7	8	10	9	3	6		92
170-179	7	10	6	8	9	3	6	6	8	7		70
160-169	6	1	7	15	8	12	8	7	8	12		84
150-159	3	3	1		5	4	8	11	10	10		55
140-149	3		3	2	2	3	3	7	2	7		38
130-139		1		1		5	2	3		2		9
120-129								2	5	2		9
110-119			1						1	1		3
Total N	50	50	50	50	49	48	50	50	50	50		497

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TABLE VIII

Scattergram for Class Standing and the sum of coded Mathematical and Mechanical Scores.

Sum of Math. & Mech. Coded Scores	Decile Class Standing--Combined Classes										Total	
	1	2	3	4	5	6	7	8	9	10		
17			1		1							2
16	4	4	1			2		1				12
15	4	5	8	4	2	3	0	1	2			34
14	7	11	5	9	7	5	1	3	2	2		52
13	10	8	13	6	6	7	10	4	1	4		69
12	8	9	6	12	8	5	11	7	10	9		85
11	6	5	6	5	7	5	6	8	5	9		62
10	7	2	3	4	8	7	3	8	11	6		59
9	1	5	2	8	6	6	9	5	5	7		54
8	3	1	2	1		2		5	5	8		27
7			3	1	3	2	3	4	5	2		23
6					1	1	1	2	2	1		8
5						3		1	1	1		6
4							1	1				2
3									1			1
2										1		1
Total N	50	50	50	50	49	48	50	50	50	50		497

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The value of the OCT as a selection index can be appreciated better if the school population is screened for other variables which have a bearing on the final grade. One such variable is the submarine indoctrination given the candidates prior to examination for qualification for school. Candidate officers are ordered to training aboard ships until the date of convention for the class; this policy means varying durations of shipboard experience. Thus some officers are aboard for four or five months, and some for only a few weeks, and indeed, a few receive no indoctrination. A reliable relationship exists between the duration of this training and subsequent performance in the school. On the other hand there is no reason to expect a relationship between the length of indoctrination and the scores on the OCT, and the data reveal little or none. Insofar as prediction of the final school grade for an individual is concerned, then, a more accurate forecast could be made if the length of indoctrination be taken into account. Likewise, for assessing the predictive capacity of the selection test from data influenced by varying pre-school training, the varying training factor should be controlled. In other words, insofar as this study is concerned, indoctrination might be regarded as one of the extraneous factors which is throwing additional variance into the criterion data.

In order to control the extraneous factor to some extent, both classes were separated into two groups according to whether two months indoctrination had been completed. In each class, as might be expected, the group with pre-school training show a significantly higher average class standing. In terms of class standings, those with and those without the factor show about the same relative variability in performance. The mean OCT score was higher in both instances for the indoctrinated group but test score variability was of about the same order. Table IX presents these findings.




TABLE IX

Means and Standard deviations of OCT Scores and Class Standings for two classes differentiated according to length of submarine indoctrination.

Class	Group	Number	Total OCT Score		Class Percentile Standing	
			Mean	$\sigma$	Mean	$\sigma$
Sept.-Dec. Class	2 mo. or more	116	172.8	19.8	46	29
	0-1 month	143	169.9	21.9	53	28
July-Sept. Class	2 mo. or more	152	173.9	25.5	46	28
	0-1 month	86	164.1	23.1	56	28

The correlation coefficients for the Total OCT score, and the standard errors in estimating the class standing from the regression equations established by these data, are shown in Table X.

TABLE X

Product-moment coefficients of class standing with total OCT scores, and standard errors of estimating the Percentile Standing from the total scores.

Class	Group	r	$\sigma$ est
Sept.-Dec. Class	2 mo. or more	0.53	25.0
	0-1 month	0.34	26.3
July-Sept. Class	2 mo. or more	0.38	26.0
	0-1 month	0.26	27.9

The numbers of individuals involved in the above calculations are large enough to warrant confidence in the differences reported. For either class, one can predict the grade in school from the scores on the Officer Classification Test better for the group with indoctrination than for the group without. And the increase in predictability apparently has no relation to differing heterogeneity.

By limiting the study to those with two or more months of indoctrination, the OCT seems to be a more effective instrument. Inspection of Table XI combining both classes shows that, despite the advantages of indoctrination, only one person out of fifty-one with total scores below one hundred sixty stood in the top fifth of the class; and of forty-six with scores two hundred or better, none stood in the bottom fifth of the class or in the bottom fifth of the standings in their own group.

TABLE XI

Scattergram of total OCT scores and class standings for officers with two or more months of pre-school shipboard indoctrination.

Total OCT Raw Score	Decile Standing---Combined Classes										Total
	1	2	3	4	5	6	7	8	9	10	
220-229	3	1	1	1	1	1					8
200-219	8	8	5	4	6	3	2	2			38
180-199	14	13	12	10	8	6	6	7	5	3	84
160-179	8	9	6	15	8	8	9	7	7	10	87
140-159	1		2	2	3	2	5	12	9	5	41
120-139						3	1	3		3	10
Total N	34	31	26	32	26	23	23	31	21	21	268

Many hypotheses might be advanced to account for the fact that there is a closer association between aptitude test scores and academic performance for those with indoctrination. The first one to suggest itself is that academic training is placed at a very difficult level, and that the men with more ability have availed themselves during indoctrination with a superior fund of information which is drawn upon later in the more difficult questions of examinations. Unfortunately, even though such a hypothesis is so obvious, it is not readily susceptible to test.

A second theory concerns the nature and content of the training course. If, for example, a technical vocabulary is more or less prerequisite and those without much indoctrination devote considerable energy in acquisition of the vocabulary, it would be reasonable to suppose that the success of the two groups with and without previous indoctrination might depend on different factors. Or it might be that related civilian experience would be a telling factor in the group unfamiliar with submarine terminology and procedures, whereas it would have little bearing on the performance of those who have had opportunity beforehand to acquire a skeleton background of technical language and procedures. Or perhaps considerable work is required to change a standing at the top of the class, whereas a small amount of study makes a big difference in standings at the bottom.

Still a third appealing hypothesis is that the indoctrination instills a confidence in one's own ability. For one thing, the candidate has already experienced many of the novelties in his own field. And furthermore, he has had an opportunity to measure himself in terms of the others in his own new group. It would be expected that both would give him more confidence, and hence that he would be less distractable. In other words, measures of his aptitudes and of his performance would be more reliable, and this increased reliability in the data would yield a higher coefficient of relationship.

Yet another likely circumstance which would lead to more reliable measures of both academic performance and aptitudes could be hypothesized. It may be that the work habits and attitudes of those with indoctrination are significantly different. For example, at least some officers with a background of training and experience which they considered should preclude disqualification have not put forth a maximum effort in taking the aptitude tests, and at least some studied only enough in school to pass scholastic examinations; and such cases may occur more often in the men started in school without indoctrination. If they do, there would be less correspondence between aptitude scores and performance for the group.

Theories involving reliabilities of data are supported by the irregular distribution of cases at the extremos of the scattergrams; it is in the group without indoctrination that a man with an OCT total score of only one hundred sixteen achieved a school grade placing him in the top third of the class, and of those scoring high on the OCT test in this group, less than the number expected from the rest of the group data excelled in school.

