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Study Factors and Their Impact on Military School Performance Measures

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☐ In traditional academic settings, personal aids or skills to enhance learning usually have been limited to reading comprehension, memory, or prose-learning content areas. The primary reason is that both teachers and theorists have long recognized that reading and its comprehension are fundamental to the learning process (Wittrock, 1974). Thus, prior to 1940 the primary topics for learning how to study consisted of time mangement, systematic note taking, outlining or underlining, and selecting a place to study (Schulte & Weinstein, 1981).

A major departure from this limited focus of study skills occurred with the formal presentation and then later acceptance of Robinson's (1946) Survey-Question-Read-Recite-Review (SQ3R) method. (Robinson referred to it as the "Survey Q3R Method.") Although the SQ3R method proved extremely useful for addressing specific deficits in studying, education theorists recognized that the composite of study skills was much more extensive and complex than previously thought. In particular, the investigation of cognitive issues, as opposed to simple individual differences and behavioristic approaches, became more pronounced.

Starting in the mid-1970s, the U.S. military services funded several learning-skills research projects that were to occupy a prominent place in the scientific literature. For example, Dansereau, Actkinson, Long, and McDonald (1974), under contract with the Air Force, reviewed the research literature related to academic learning. From that basis, Dansereau

and his colleagues (e.g., Dansereau et al., 1979) developed their Learning Strategy System, which they partitioned into two parts—Primary Strategies and Support Strategies. The Primary Strategies consist of Comprehension-Retention and Retrieval-Utilization, each of which contains the following components: understanding, recall, digesting/detailing, expansion, and review. Adding the letter "M" from "mood" to the first letter of these Primary Strategies provides the well-known acronym, MURDER. The Support Strategies consist of goal setting, concentration management, monitoring and diagnosing, mood setting, and mood maintenance.

Shortly thereafter, in the late 1970s and early 1980s, Weinstein and her co-workers (Weinstein et al., 1980; Weinstein, Washington, Wicker, Duty, & Underwood, 1980) developed a set of cognitive learning strategies for the Army. Like Dansereau, Weinstein developed a comprehensive model of the teaching-learning process, only one part of which involves study skills. From a study skills perspective, Weinstein and Mayer (1986) defined eight learning strategies identified as basic rehearsal, complex rehearsal, basic elaboration, complex elaboration, basic organizational, complex organizational, comprehension monitoring, and affective and motivational strategies. Currently the Army has incorporated five learning strategies into its Job Skills Education Program: time management, reading strategies, problem solving (mathematics), test taking, and motivational skills (Hoffman, Hahn, Hoffman, & Dean, 1988; Wilson, 1990). The work of Brown and her co-workers (e.g., Brown, Bransford, Ferrara, & Campione, 1983) on metacognition also has stimulated both research and application in this area.

The Navy took a different tactic. In a series of studies in Navy schools, researchers differentiated two types of reading, called Reading to Do and Reading to Learn. Students were asked to report which activities "had helped them to learn the information in a reading-to-learn task" (Sticht, 1979, p. 279). Four major categories were identified: reread-rehearse, problem solve-question, relate-associate, and focus attention. In his review of cognitive psychology research in the military, Wittrock (1979, p. 309) commented that "the armed services are in the forefront of application of principles of cognitive psychology to instruction."

Although the military services have been productive in this area, there has been no deficiency of academic research activity on the topic of study skills. This research has resulted in the development of several instruments to assess study skills. Among these are the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1988); the Study Attitudes and Methods Survey (SAMS) (Bachelor & Michael, 1988; Nadson, Michael, & Michael, 1988); the Survey of Study Habits and Attitudes (SSHA) (Davou & McKelvie, 1984; Gadzella, 1982); the Study Skills Questionnaire (SSQ) (Bartlett & Knoblock, 1988); and the Study Process Questionnaire (SPQ) (O'Neil & Child, 1984). Derry and Murphy's (1986) review of learning methods training confirmed that the study skills topic and research are expanding.

Nevertheless, several major considerations confront the topic of study skills assessment and evaluation. One of these is the absence of a consensus concerning the domain of study skills. In addition, many of the current diagnostic instruments address issues that are not germane in all settings. For example, many such instruments assume that a student is taking general education courses instead of one course, as is common in military or technical schools. Others assume more flexibility in study time than most military students have. Finally, some study skills surveys—like the SSQ, because of its specialized vocabulary—were designed primarily for administration by specialists. For these reasons, a new instrument to assess student skills related to the study process was devised and evaluated in military contexts. Further, Wade and Trathen (1989) reported that most of the early research on study methods failed to assess the relationship between study techniques and recall. Lastly, Weinstein and Underwood (1985) reported that many research studies have used grade-point average (GPA) as a criterion. Whereas GPA is an unambiguous criterion, traditionally it embodies several deficits, namely, course self-selection, a wide variety of course requirements, and diverse grading systems.

These issues were addressed in the research described in this article. More generally, this report describes the development of a study skills survey and four related research studies—two addressing its reliability and two validity studies.

INSTRUMENT DEVELOPMENT

During an iterative process, NPRDC researchers devised a model of study activity and related factors based on military research reports and their own experiences in military school settings. The objective was to identify and define all possible categories of student behaviors or factors that relate to study performance. Once the initial set of categories was developed, independent lists of possible questions were written and categorized. Group meetings served to simplify and clarify both the dimensions and questions for use in a self-report questionnaire. During the process, the number of dimensions was expanded and the questions were modified. Notable goals during this process were: (a) item development and revision consistent with the study factor definitions, to address the continuously revised model, (b) preserving conceptual distinctions between the dimensions, (c) maintaining a low requirement for readability, so that the eventual survey could be used widely, (d) keeping questions as short as possible, in consideration of the respondent, and (e) use of a single and simple response format.

Study factors, not just study skills, served as the focus because important aspects of an individual's study behavior may not be classified as a skill. A good example is test anxiety. Spielberger (e.g., Spielberger, Gonzalez, & Fletcher, 1979) has been particularly active in promoting the concept of test anxiety as an essential component of learning strategies. Additionally, although some researchers may not consider motivation a study skill, both Dansereau (1985) and McCombs and Dobrovolny (1982) have effectively used motivational training in their systems. Similarly, McKeachie and his co-workers (e.g., Pintrich et al., 1988) emphasize a motivational component because their Motivated Strategies for Learning Questionnaire has 55 motivational items and 55 cognitive items. Given that factors other than study skills have been important for study, this instrument was identified as the NPRDC (Navy Personnel Research and Development Center) Study Factors Survey.

Table 1 lists the 16 conceptually independent study factors and their operational definitions. Whereas all 16 study factors are conceptually distinct, some dimensions were expected to be related empirically, perhaps in different populations, for two reasons. First, one dimension often may imply another dimension. For example, memorization may be much easier and thus more useful for students who do not have test anxiety. Second and more importantly, students with good academic backgrounds may develop and use several of these study factors automatically, whereas students with poor academic backgrounds might use few or none of them. Although the development of distinct factors was a goal, the conceptual differentiation of characteristics among the study factors was viewed as the more critical objective.

The unadministered version of the NPRDC Study Factors Survey consisted of 16 study factors as assessed by 98 items using a 4-point response scale that ranged from *Almost Always* (4) to *Almost Never* (1). This number of factors, 16, is larger than typically reported by other study skills researchers; however, the level of specificity in each researcher's model usually accounts for such differences. The survey was evaluated for both reliability and validity. Each of the two reliability estimations and two methods of validity assessment are described individually below.

INITIAL RELIABILITY ASSESSMENT

Method

Subjects

Because the scales had no previous empirical analysis, reliability was assessed using a two-step process. The survey was initially administered at two Navy schools (N = 117 and 127) that train new enlistees in electrical/electronic occupations following their entry-level train-

TABLE 1 ☐ Study Factor Definitions

Anxiety	Generalized fear associated with learning or testing.
Competition	A tendency to compare one's performance to that of classmates. The perception of one's performance as being evaluated in comparison to others.
Concentration	The ability to focus on learning despite either internal or external distractions.
Elaboration	The use of any of several methods to integrate and understand information.
Graphic Study Aids	The appreciation and use of charts, figures, and tables for study.
Group Study	The tendency to interact with other students during study.
Mastery Beliefs	Attitudes relating academic achievement to personal effort.
Memorization	The use of any of several mental devices to store and later recall information.
Motivation	The level of drive or perceived incentive to either: (a) complete training at this school or (b) learn assigned training materials.
Organization	The use of structure and preparation of materials to be learned.
Questioning	The verbal process of seeking clarification.
Review	A selective examination of previously read course materials to enhance learning.
Self-Monitoring	A mental review of cognitive process to ensure it is logical and compatible with previous knowledge and assumptions.
Study Resource Management	The foresight to maximize environmental resources to permit study.
Test Anticipation	The ability to predetermine test content.
Test Strategy	The use of techniques during a test to maximize the number of correct responses.

TABLE 2 ☐ Two Reliability Estimates of the NPRDC Study Factors Survey

	TWO SCHOOLS		ALL FIVE SCHOOLS		
Scale	*Items*	*Alpha*	*Alpha*	*Mean*	*S.D.*
Anxiety	5	.662	.712	11.66	2.94
Competition	3	.657	.626	8.74	2.23
Concentration	7	.649	.669	19.51	3.30
Elaboration	6	.734	.731	15.40	3.41
Graphic Study Aids	3	.681	.680	9.10	1.79
Group Study	5	.910	.903	11.06	4.01
Mastery Beliefs	7	.609	.585	16.66	2.35
Memorization	5	.600	.632	14.65	2.60
Motivation	8	.738	.732	27.10	3.41
Organization	8	.748	.728	22.39	4.14
Questioning	3	.729	.727	9.86	1.94
Review	5	.718	.650	15.88	2.50
Self-Monitoring	8	.706	.668	22.69	3.51
Study Resource Management	5	.727	.716	14.68	2.81
Test Anticipation	5	.676	.645	14.07	2.67
Test Strategy	3	.594	.625	8.95	2.16
N range	237-241			688-700	

ing in boot camp. The typical student in these two schools is just out of high school, has a high school diploma, and may be considered an average or slightly below average student.

Results

Based on the initial administration of the Study Factors Survey, items were deleted from the scales until no further improvement in reliability estimates was obtained. No item was added to any scale. After item deletion, the values of coefficient alpha for the 16 scales ranged from .594 to .910 and the number of items per scale ranged from 3 to 8. These statistics are shown in the second and third columns of Table 2.

SECOND RELIABILITY ASSESSMENT

Method

Subjects

As part of a larger Navy-wide project, NPRDC Study Factor Survey forms were administered at and received from three additional Navy schools (N = 62, 98, and 301, reflecting their relative enrollment rates). These schools also train enlisted personnel in a variety of technical occupations immediately following boot camp training.

Results and Discussion

Table 2 also shows the coefficient alpha estimates of internal consistency that were obtained using the data from all five Navy schools and the scale means and standard deviations obtained for these schools. As shown, the coefficients fluctuated somewhat between the first and second reliability assessments; however, most remained relatively stable. For the entire sample, coefficient alpha ranged from .585 to .903, whereas most values were in the moderate .6 and .7 ranges. The form's total internal consistency estimate was .918. Adding items that had been deleted in the previous reliability analysis did not increase the more recent alpha estimates.

Whereas a few of the scales demonstrated relatively low reliability estimates, most of them are considered acceptable or very good. The *a priori* dimensions are logically compatible with the results from the internal consistency analysis. Moreover, these reliability estimates are consistent both with the previous analysis and with the reliability estimates for commercial study skill instruments as reported in Weinstein and Underwood (1985).

FIRST VALIDITY STUDY

Method

Generally, students in Navy enlisted schools attend classes daily and are tested at least once a week. There are typically from 20 to 25 multiple-choice items per test. The tests are knowledge based and performance is measured using percentage correct. Test performance standards are fairly rigid, typically 80% correct. Those students who do not meet test performance standards usually are either put on academic probation, set back to another class, or dismissed from the school. For this study, test scores from the four most difficult tests in one of the five Navy schools (N = 117) served as an index of student performance. More specifically, the mean percentage of correct answers on at least three of the four most difficult tests was used as an index of student performance.

The major reasons for using this performance index were: (a) scores on several knowledge tests are more representative of academic performance than any single test score; (b) although the means and standard deviations differed slightly, the difficult nature of all the tests, the consistent course theme, and the use of percentage scoring allowed a reasonable combination of the scores; (c) one score could be missing (e.g., for a student who was dismissed or set back to another class) without discarding that poor performer's data; and (d) unlike traditional GPA scores, these test scores

derived from homogeneous testing and performance standards. Two other performance measures were available. These dichotomous indices (0 = no; 1 = yes) indicated whether a student was assigned to academic probation or set back to another class, either event signaling poor academic performance.

Results and Discussion

Correlations were computed between the 16 study factors and the three performance criteria, the results of which are provided in Table 3. The statistics in Table 3 show that all but one of the significant correlations were in the expected direction. The exception was Test Strategy. Five other study factors were related significantly to test performance: Competition, Concentration, Memorization, Motivation, and Questioning. Thus, those students who were more competitive or motivated, had higher concentration or memorization skills, asked more questions, or were low on test strategy skills performed significantly better on the most difficult tests in this school. The relatively large correlations (greater than .4) for the Competition and Concentration scales should be noted.

To explore the contribution of the significant study factors to test performance, a regression analysis was performed. The results are shown in Table 3. A subsequent stepwise regression analysis included three of the six significant factors and produced an $R(3, 88) = .618$. Thus, the joint contribution of Competition, Concentration, and Test Strategy significantly and independently accounted for 38.2% of the test performance variance.

Further, students who were placed on academic probation (21.4%) reported low scores for two of the study factors: Competition ($r = -.346$, $p < .001$) and Memorization ($r = -.206$, $p = .031$). Also, two of the scales—Competition and Memorization—were significantly correlated with both test performance and academic probation, thus providing some indication of the relative importance of these study factors to school performance. Students who were set back for academic reasons (15.4%) were distinguished only by their poor Motivation ($r = -.217$, $p = .023$).

TABLE 3 ☐ Study Factors and Test Performance Analyses

	FOUR TESTS		REGRESSION ANALYSIS		
Scale	*r*	*p(r)*	*Beta*	*t-test*	*p(t)*
Anxiety	−.000				
Competition	.443	.000	.398	4.26	.000
Concentration	.420	.000	.262	2.81	.006
Elaboration	.071				
Graphic Study Aids	.055				
Group Study	−.147				
Mastery Beliefs	.094				
Memorization	.362	.000	.146	1.44	.153
Motivation	.196	.048	−.054	−.511	.611
Organization	.093				
Questioning	.214	.028	.047	.464	.644
Review	.135				
Self-Monitoring	.056				
Study Resource Management	.075				
Test Anticipation	.072				
Test Strategy	−.213	.031	−.284	−3.231	.002

Note. r = correlation coefficient, $p(r)$ = probability of r under the null hypothesis: recorded only if ≤ .05. Beta is the standardized regression coefficient for the significant variables model which is evaluated by the t-test and its associated probability

SECOND VALIDITY STUDY

Method

A second validity analysis examined the relationships between the study factors and test performance while controlling for the effect of student ability. This issue is germane because one could argue that most or all of a student's test performance could be accounted for by ability, and that some or most of the study factors simply represent alternate measures of ability.

A good index of ability to perform well in Navy schools is provided by students' composite scores on the Armed Services Vocational Aptitude Battery (ASVAB). Every enlisted person who enters the U.S. military takes the ASVAB, and the battery of 10 tests has been shown repeatedly to serve as a reliable measure of students' academic ability. The current version of the ASVAB assesses knowledge and skills in 10 areas: Word Knowledge, Arithmetic Reasoning, Coding Speed, Numerical Operations, Math Knowledge, Mechanical Comprehension, General Science, Electronics Information, Auto-Shop Information, and Paragraph Comprehension. Moreover, each school has a minimum ASVAB composite criterion score for entry into the school. Further details about the ASVAB can be found in Wegner and Ree (1986).

Thus, one answer to the question of whether ability serves to moderate the effect of study factors on test performance is to describe the proportion of variance in test performance that is not associated with the ASVAB composite but is associated with the study factors. In other words, what is the correlation between each study factor and test performance after controlling for (or partitioning) the effects of student ability?

Subjects

The sample of 301 students who completed the Study Factors Survey for the reliability analysis was used for this analysis. Performance data obtained from the school consisted of test scores with the highest failure rates—three early in the course, three approximately halfway through the course, and three near the end of the course. Not all subjects had taken all of the tests at the time the data were received. Scores were available for 241 students who completed the three most difficult tests given early in the course, 159 who also completed the tests halfway through the course, and 80 of them completed the three tests near the course end. ASVAB composite scores were available for most of the students.

Results

Table 4 reports the results of the test performance analysis for the early tests. Columns two and three of Table 4 identify the significant correlation coefficients between the study factors and the test performance criterion. Seven of the 16 study factors were significant.

The column headed "Partial r" in Table 4 reports the significant partial correlation coefficients between each study factor and test performance, controlling for ability (the ASVAB composite score). Student ASVAB composite scores ranged from 191 to 268 and had a mean value of 233.03 and a standard deviation of 14.65. Four of the relationships remained significant ($p \leq .05$; one-tailed) after the variance attributed to ability was partitioned. These findings indicate that, irrespective of their academic ability, those students who had low anxiety levels as well as relatively good concentration or memorization skills performed significantly better on the three most difficult tests early in the school. In addition, students who indicated that they made relatively little use of test strategies also performed better.

To explore the contribution of the significant study factors to test performance, a regression analysis was performed. The results are shown in the last three columns of Table 4. A subsequent stepwise regression analysis included three of the factors and produced an $R(3,238) = .379$. Thus, the joint contribution of Anxiety, Memorization, and Test Strategy significantly and independently accounted for 14.4% of the test performance variance.

TABLE 4 ☐ Study Factors and Early Test Performance Analyses

	EARLY TESTS		PARTIAL *r*		REGRESSION ANALYSIS		
Scale	*r*	*p(r)*	*r*	*p(r)*	*Beta*	*t-test*	*p(t)*
Anxiety	−.321	.000	−.230	.001	−.266	−.415	.000
Competition	.146	.024					
Concentration	.231	.000	.175	.010	.081	1.22	.224
Elaboration	.103						
Graphic Study Aids	.105						
Group Study	−.134	.040					
Mastery Beliefs	.116						
Memorization	.172	.007	.162	.014	.102	.161	.108
Motivation	.067						
Organization	−.047						
Questioning	.093						
Review	.063						
Self-Monitoring	.136	.035					
Study Resource Management	−.117						
Test Anticipation	.046						
Test Strategy	−.199	.002	−.166	.012	−.122	−1.97	.049

Note. r = correlation coefficient; $p(r)$ = probability of the r under the null hypothesis. Partial correlation controlling for the effect of ability: recorded only if ≤ .05. Beta is the standardized regression coefficient for the significant variables model which is evaluated by the t-test and its associated probability.

Performance data for the three difficult tests midway through the course indicated that three of the study factors were significant. These were Anxiety ($r = -.215$, $p = .007$), Concentration ($r = .214$, $p = .007$), and Study Resource Management ($r = -.204$, $p = .010$). Correlations for the later performance measures indicated that four study factors were significant: Anxiety ($r = -.301$, $p = .007$), Concentration ($r = .261$, $p = .020$), Mastery Beliefs ($r = .259$, $p = .022$), and Questioning ($r = .319$, $p. = .005$). Partial correlations were not performed for the later performance measures because of insufficient data.

DISCUSSION

The results from two validity analyses indicate that:

1. Study factors correlated significantly with test performance in two independent schools.
2. Different study factors correlated significantly at each school.
3. Although more study factors were significant at the beginning of the course, different study factors correlated significantly at different portions of the course.
4. The study factor relationship to test performance was significant irrespective of student ability.
5. Regression analyses supported the independent contribution of several study factors to test performance at two schools.

When these validity studies are viewed together, a pattern emerges. Of the 16 study factors, 11 were significant in one or both schools. What is most conspicuous in this pattern are the findings for Memorization, Concentration, and Questioning. Memorization was related to test performance in both schools, related to academic probation, and survived the partial correlation analysis. Likewise, Concentration was related to test performance in both schools and also survived the partial correlation analysis. Because Questioning was significantly related to test performance only late in the course, it did not undergo the partial correlation analysis, but was significant in both schools. These study factors deserve attention, at least for technical training schools. Moreover, these study factors may have implications for the education-technology interface in that technology may be able to affect how students memorize, concentrate, and question.

The findings for Anxiety and Motivation may have been school specific. Anxiety was related to all three performance measurements in one school, and it also survived the partial correlation analysis. In the other school, Motivation was related to both test performance and academic probation. It is not clear whether Anxiety and Motivation are antithetical or simply school specific. Other study factors either did not pass the partial correlation test (Competition, Group Study, Self-Monitoring) or were not subjected to it (Mastery Beliefs and Study Resource Management). Also, although Competition failed the partial correlation test, its affects should be investigated further due to the influence of this factor in military training. This topic deserves further study.

Reasoning suggests that factors such as Anxiety, Concentration, Memorization, and Questioning have important ties to the study-learning-performance process. These analyses provide solid evidence for the consideration of such factors in learning environments. Only three study factors provided a significant result in an unexpected direction—Group Study (which did not pass the partial correlation analysis), Study Resource Management, and Test Strategy. The item content for the Test Strategy scale concerns the order of answering easy versus difficult questions on a test. It may be that in these and similar schools it is necessary or functional to answer test questions from first to last rather than answer the easy questions first. This topic also deserves further study.

The three key issues associated with study skills research are their selection and development, training, and effectiveness assessment (Dansereau, 1985). This article addressed two of those issues in a military context. Based on these findings, evaluations should be undertaken to determine whether study factor training can be implemented to influence test performance. For example, training may be indicated for students whose scores fall below selected cutoff points for Concentration, Memorization, Questioning, or other skills. Dobrovolny, McCombs, & Judd (1980), Hoffman et al. (1988), and McCombs & Dobrovolny (1982) are resources that describe military training aids for several study factors, including Reading Comprehension, Concentration, Memorization, and Motivation. A fourth key issue that should be raised and addressed by future research is whether study skills/factors are compensatory or necessary. Two regression analyses provided evidence that some of these study factors made independent contributions to test performance. Yet, if students are low on one or a few factors, can other factors compensate for that deficit? Such issues require dedicated research effort if we are to make advances into understanding the study-learn-performance process and how technology can contribute to that process.

Although the NPRDC Study Factors Survey was designed to assess study factors in military technical schools, the factors obtained in this research have high face validity, seem to be generic, and thus may underlie learning and study in the general population. Consequently, the findings from this research effort may have applications to non-military academic settings. Moreover, research is required to delineate whether different learning objectives or different topics of varying content and difficulty require different study factors for effective learning. □

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