January 1993

Educational Reform and Technical Education?

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Abstract

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Keywords

education, reform, product, market, learning, economic, skill, program, job, performance, school, worker

Comments

This paper was presented at the American Eonornics Association Meetings in Anaheim California on January 6 1993.

1/3/93TECHEDUC

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Working Paper # 93- 04

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This paper was presented at the American Eonomics Association Meetings in Anaheim California on January 6 1993. Its preparation was funded by a grant to the Center on the Educational Quality of the Workforce, agreement number R117Q00011-91, as administered by the Office of Educational Research and Improvement, U.S. Department of Education and by a grant to Cornell from the Pew Charitable Trust. I would like to thank William Firestone, John Gary, Paul Campbell, Larry Hotchkiss, Robert Meyer, David Goodwin, Morgan Lewis and Mac MacCaslin for helpful comments on earlier versions of the paper. The findings and opinions expressed in this report do not reflect the position or policies of the Office of Educational Research and Improvement or the U.S. Department of Education. This paper has not undergone formal review or approval of the faculty of the ILR school. It is intended to make results of Center Research, conferences, and projects available to others interested in human resource management in preliminary form to encourage discussion and suggestions.

EDUCATION REFORM AND TECHNICAL EDUCATION

> If only to keep and improve on the slim competitive edge we still retain in world markets, we must dedicate ourselves to the reform of our educational system....Learning is the indispensable investment required for success in the "information age" we are entering. (National Commission on Excellence in Education, 1983, p. 7).

Even though educational reform marches under a banner of economic renewal, the school subjects that appear to be most directly related to worker productivity--business education, vocational education, economics, computers--have received little attention from reformers. The five "core" subjects proposed for periodic assessment are English, mathematics, science, history/civics and geography. Yet, if competitiveness is the objective, it is not clear why geography, a subject that is not taught in most American universities, has higher priority than subjects like computers, economics, management and technology? Some of the reform reports have expressed doubt about the economic benefits of vocational education (Committee on Economic Development 1986). Indeed, new graduation requirements introduced by reformers have contributed to an 8 percent reduction in vocational course taking between 1982 and 1987.

Are these doubts justified? Are workers who develop the technical skills taught in trade and technical programs more productive when they get a job in the field? Are the skills taught in these programs still valued by the labor market? Has the payoff to high school vocational training increased along with the payoff to other skills? This paper attempts to answer these questions by examining six different kinds of evidence on the economic payoffs to occupationally specific training in high school:

* Comparisons of the training success and job performance of young military recruits who have strong technical competency prior to entering the armed forces to those whose technical competency is weak.

* Comparisons of job performance in civilian jobs of those who have strong technical competency to those whose technical competency is weak.

* Comparisons of the job performance of workers who score well on content valid occupational competency tests to those who score poorly.

* Comparisons of labor market outcomes for young men who have demonstrated competency in the technical arena to the outcomes for those who do not have these competencies.

- Comparisons of the job performance of workers who have and have not received relevant occupational training from a school.
- Comparisons of labor market outcomes for those who received vocational education in high school versus the outcomes of those who did not.

The analyses of these six very different types of evidence on the impact of vocational education imply that the skills being taught in the typical vocational program are not obsolete and are valued by the labor market. Young men who have the skills and knowledge that trade and technical programs try to impart are indeed more productive in blue collar and technical jobs, are less likely to be unemployed and obtain higher wage rates and earnings. In addition, during the 1980s non-college bound youth who took 4 or more vocational courses in high school earned substantially more than the non-college bound youth who took no vocational courses in high school.

I. The Effect of Technical Competence on Training Success and Job Performance in the Military

What impact does technical competence have on the ability to learn new tasks and on job performance? The military services have extensively researched this question.

The military uses the Armed Services Vocational Aptitude Battery (ASVAB), a three hour battery of tests, to select recruits and assign them to occupational specialties. The ability of this test battery to predict job performance in a variety of Military Occupational Specialties (MOS) has been thoroughly researched and the battery has been periodically modified to incorporate the findings of this research (Booth-Kewley 1983, Maier and Truss 1983 & 1985, Wilbourn, Valentine & Ree 1984). Most of the research has involved correlating scores on ASVAB tests taken prior to induction with final grades in MOS specific training courses (generally measured at least 4 months after induction).

The ASVAB test battery is made up of 10 subtests: Mechanical Comprehension, Auto and Shop Knowledge, Electronics Knowledge, Clerical Checking (Coding Speed), Numerical Operations (a speeded test of simple arithmetic), Arithmetic Reasoning, Mathematics Knowledge (covering the high school math curriculum), General Science, Word Knowledge and Paragraph Comprehension. A fuller description of each of these subtests together with sample questions is given in Appendix A. Even though the

ASVAB was developed as an "aptitude" test, the current view of testing professionals is that:

> Achievement and aptitude tests are not fundamentally different....Tests at one end of the aptitude-achievement continuum can be distinguished from tests at the other end primarily in terms of purpose. For example, a test for mechanical aptitude would be included in a battery of tests for selecting among applicants for pilot training since knowledge of mechanical principles has been found to be related to success in flying. A similar test would be given at the end of a course in mechanics as an achievement test intended to measure what was learned in the course (National Academy of Sciences Committee on Ability Testing, 1982, p.27)."

The universe of skills and knowledge sampled by the mechanical comprehension, auto and shop information and electronics subtests of the ASVAB roughly corresponds to the vocational fields of trades and industry and technical. Some of the material is also covered in physics courses. These subtests have some similarities with the occupational competency examinations developed to assess high school vocational students. However, the ASVAB technical subtests assess knowledge in a much broader domain and the individual items are, consequently, more generic and less detailed. The ASVAB technical composite is interpreted as a measure of knowledge and trainability for a large family of jobs involving the operation, maintenance and repair of complicated machinery and other technically oriented jobs.

Since recruits are selected into the army and into the various specialties by a nonrandom process, mechanisms have been developed to correct for selection effects--what I/O psychologists call restriction of range (Thorndike 1949; Lord and Novick 1968; Dunbar and Linn 1986). These selection models assume that selection into a particular MOS is based on ASVAB subtest scores (and in some cases measures of the recruit's occupational interests). For the military environment, this appears to be a reasonable specification of the selection process for attrition is low and selection is indeed explicitly on observable test scores. This ability to model the selection process is an advantage that validity research in the military has over research in the civilian sector.[1]

Success in Training

A reanalysis was conducted of data from two large scale studies of Marine recruits (Sims and Hiatt 1981 reprinted in Hunter, Crossen and Friedman 1985; Maier and Truss

1985). These studies were selected because they used versions of the ASVAB that were quite similar to the one administered to the NLS Youth Cohort which will be analyzed in section 3. Correlation matrices which had been corrected (for restriction of range and selection effects) were obtained from the appendices of these studies and LISREL was employed to estimate models in which training grades were regressed on the full set of ASVAB subtests. The standardized regression coefficients from this analysis are reported in table 1.

The first major finding is that technical competency as indexed by the mechanical, auto-shop and electronics subtests had major effects on success in training for all military occupations with the single exception of the clerical occupation (Bishop 1989b). The second major finding was that math knowledge and arithmetic reasoning subtests had substantial effects on training success while computational speed had only modest effects on training success. Both the science and verbal subtests had strong positive impacts on success in training.

Job Performance--Skill Qualification Tests

Since, however, both the criterion--training success--and the predictors--competence in particular areas--are measured by paper and pencil tests, there is a danger that results may be biased by common methods bias. Therefore, it would be desirable to check these findings in a data set in which ASVAB subtest scores predict a hands-on measure of job performance. Maier and Grafton's (1981) study of ASVAB 6/7's ability to predict the hands-on Skill Qualification Test (SQTs) provides such a data set. Maier and Grafton described the hands-on SQTs they used in their study as follows:

> SQTs are designed to assess performance of critical job tasks. They are criterion referenced in the sense that test content is based explicitly on job requirements and the meaning of the test scores is established by expert judgment prior to administration of the test rather than on the basis of score distributions obtained from administration. The content of SQTs is a carefully selected sample from the domain of critical tasks in a specialty. Tasks are selected because they are especially critical, such as a particular weapon system, or because there is a known training deficiency. The focus on training deficiencies means that relatively few on the job can perform the tasks, and the pass rate for these tasks therefore is expected to be low. Since only critical tasks in a specialty are included in SQTs, and then only the more difficult tasks tend to be selected for testing, a reasonable inference is that performance on the SQTs should be a useful indicator of

> proficiency on the entire domain of critical tasks in the specialty; that is, workers who are proficient on tasks included in an SQT are also proficient on other tasks in the specialty. The list of tasks in the SQT and the measure themselves are carefully reviewed by job experts and tried out on samples of representative job incumbents prior to operational administration. The process of developing SQTs may be characterized as follows:
>
> 1. Identify tasks for testing.
> 2. Identify behaviors or steps essential for performing each task.
> 3. Develop measures to cover essential behaviors, and have these measures reviewed by job experts.
> 4. Tryout the measures on representative workers to verify accuracy of measurement; i.e., make sure that measures discriminate between task performers and nonperformers.
>
> After each step, the products are reviewed for content validity. The test content cannot be changed after step 3, when the measures are approved by experts. The tryout of step 4 can be used only to improve the measures, and not to change content. When the development process is followed, the validity of the SQTs as measures of job proficiency is assured by job experts and representative workers.(pp. 4-5)

A more extensive discussion of the procedures for developing SQTs is available in a handbook (Osborn et al, 1977). A thorough discussion of their rationale is provided in Maier and Hirshfeld (1978).

Correlation matrices relating the ASVAB subtests and SQTs were taken from Appendices A and B in Maier and Grafton (1981). The correlation matrices were corrected for selection effects and restriction of range by Maier and Grafton using procedures described in Dunbar and Linn (1986). Regressions were estimated using LISREL for eight major categories of Military Occupational Specialties (MOS): Skilled Technical, Skilled Electronic, General Maintenance, Mechanical Maintenance, Clerical, Operators (of Missile Batteries) and Food, Combat and Field Artillery. Except for combat and field artillery, these MOSs have close counterparts in the civilian sector. The independent variables were the 10 ASVAB 6/7 subtest scores which had counterparts in the ASVAB 8A battery used in the analysis of NLS Youth presented in section 3 of the paper.

The standardized regression coefficients from this analysis are reported in Table 2. The effects of the four "technical" subtests--mechanical comprehension, auto information, shop information and electronics information--on job performance are substantial in all of the nonclerical occupations. The impact of a one standard deviation increase in all four of these subtests is an increase in the SQT of .415 SD in skilled technical jobs, of .475 SD in skilled electronics jobs, of .316 SD in general maintenance jobs, .473 SD in mechanical maintenance jobs, of .450 SD for missile battery operators and food service workers, of .345 SD in combat occupations and .270 SD in field artillery. Note further that, in standard deviation units, the job performance effects of the technical subtests are much larger than their effects on training grades. Methods bias does seem to be at work. Clearly the technical competencies being measured by the four ASVAB technical subtests are important determinants of worker productivity in these jobs.

Science and word knowledge have significant effects on job performance in skilled technical, general maintenance, clerical, operator/food and combat arms MOSs. With the sole exception of the mechanical maintenance MOS cluster, the two mathematical reasoning subtests have much larger effects on SQTs than the computational speed subtest. A one standard deviation increase in both of the mathematical reasoning subtests raises predicted job performance by .183 SD in skilled technical jobs, .24 SD in skilled electronic jobs, .34 SD in general maintenance jobs, .447 SD in clerical jobs, .22 SD for missile battery operators and food service jobs, .209 SD in combat arms and .416 SD in field artillery. While the effects of the two tests of mathematical reasoning tests on job performance in non-clerical jobs are substantial, their effects are substantially smaller than the effects of the technical composite.

Supervisory Assessments in the Military

Most of the ASVAB validity studies have studied MOS specific measures of performance which reflect the soldier's ability to do the job not their willingness to do it on a regular basis or under adverse conditions. Do the results change when other dimensions of job performance are studied? The Joint-Service Job Performance Measurement/Enlistment Standards (JPM) Project has collected data which allows us to address this issue. Besides the MOS specific SQTs already examined, Project A offers three other performance constructs which have some applicability to civilian jobs: General Soldiering Proficiency, Effort and Leadership and Maintaining Personal Discipline. General Soldiering Proficiency assesses skills that all soldiers must have (eg.

use of basic weapons, first aid, map reading, use of a gas mask) and is a combination of job knowledge tests and hands-on performance tests. This construct is a measure the can do element of job performance.

The other two constructs attempt to measure the will do element of job performance. John P. Campbell (1986) described the constructs and their measurement as follows:

> Peer Leadership, Effort, and Self Development: Reflects the degree to which the individual exerts effort over the full range of job tasks, perseveres under adverse or dangerous conditions, and demonstrates leadership and support of peers. That is, can the individual be counted on to carry out assigned tasks, even under adverse conditions, to exercise good judgement, and to be generally dependable and proficient? Five scales from the Army-wide BARS rating form (Technical Knowledge/Skill, Leadership, Effort, Self-development, and Maintaining Assigned Equipment), the expected combat performance rating, and the total number of commendations and awards received by the individual were summed for this factor.
>
> Maintaining Personal Discipline: Reflects the degree to which the individual adheres to Army regulations and traditions, exercises personal self-control, demonstrates responsibility in day-to-day behavior, and does not create disciplinary problems. Scores on this factor are composed of three Army-wide Bars scales (Following regulations, Self-Control, and Integrity) and two indices from the administrative records (number of disciplinary actions and promotion rate). (p. 150)

It had been planned to obtain information on commendations, awards, promotions, and disciplinary actions from administrative records. However, the cost of this approach was extremely high so "everyone crossed their fingers and we collected eight archival performance indicators via a self report questionnaire....Field tests on a sample of 500 people showed considerable agreement between self-report and archival records"(Campbell, 1986, p 144).

These two constructs were related to each other (they correlate .59) but were clearly quite distinct from the two "can do" constructs. Correlations with General Soldiering Proficiency were only .27 for Effort and Leadership and .16 for Personal Discipline. The "can do" constructs were based on ratings made by the same person, so they share some common measurement error. Campbell, consequently, developed residualized "can do" performance constructs by subtracting a ratings method factor from the raw score. With the ratings methods effect removed, General Soldiering Proficiency (raw) had a correlation of .45 with Effort and Leadership (residual) and .19 with Personal Discipline (residual). In the view of the JPM research team, soldiers must have both qualities--the technical competence to do their job and the willingness to do it under stressful circumstances.

Table 3 presents results of regressions predicting General Soldiering Proficiency (raw), Effort and Leadership (both raw and residualized) and Personal Discipline (raw) (Campbell, 1986, Table 10 & 12). In this analysis the 10 ASVAB subtests were reduced to four composites: Technical, Speed (Numerical Operations and Clerical Checking), Quantitative (Arithmetic Reasoning and Mathematics Knowledge) and Verbal/Science. Model 1 regresses the performance construct on these four ASVAB composites.

For General Soldiering Proficiency, the results were quite similar to the results obtained predicting hands-on SQTs. The technical and quantitative composites had the largest effects, and the verbal/science composite had a substantial effect. Speed had almost no effect.

The pattern was different for the "will do" performance constructs. The technical composite had large positive effects on both measures of Effort and Leadership. The quantitative composite had a modest positive effect on Maintaining Personal Discipline and the residualized Effort and Leadership. Speed had a modest positive effect on Effort and Leadership. The verbal/science composite had no effect on the residualized Effort and Leadership and a small negative effect on raw score measures of both constructs.

The inclusion in Model 2 of controls for temperament, occupational interests and cognitive constructs not found in the ASVAB such as spatial relations and perceptual speed modifies these results only a little. The control variables were all measured concurrently and consisted of 6 interest variables (combat, food service, audio/visual arts, protective service, skilled technical and structural/machines), six computer administered perceptual speed and accuracy tests, four measures of temperament (dependability, physical condition, emotional stability and achievement/surgency), a composite of paper and pencil spatial relations tests and three indexes assessing the individual's preference of autonomy, routine and support from the organization and co-workers on the job.[2] These control variables are described in Campbell (1986).

For the two "can do" performance constructs, adding the new concurrently measured cognitive and non-cognitive predictors to the model somewhat increases the explanatory power of the model above that obtainable with ASVAB test scores alone. The multiple R rises from .461 to .540 for General Soldiering Proficiency (McHenry et al 1986). The coefficients on the ASVAB composites shrink but the pattern across composites is similar. The verbal/science and quantitative composites have effects that are each about three-quarters the effect of the technical composite. Spatial relations composite is the most important variable.

The pattern is quite different for the "will do" performance constructs. The new non-cognitive predictors contributed significantly to the explanation of the "will do" performance constructs. Adding all the new concurrently measured predictors to a model based solely on ASVAB test scores raised the multiple R (uncorrected for restriction of range and unreliability of the criterion) for Effort and Leadership (raw) from .206 to .366 and raised the multiple R for Maintains Personal Discipline from .106 to .317. The technical composite had large positive effects on both of these performance constructs. The quantitative composite had a modest positive effect on Maintaining Personal Discipline. Speed had a modest positive effect on Effort and Leadership. The verbal/science composite had negative effects on both of these constructs. Among the non-cognitive constructs the important ones were "interest in combat" and the temperament scales assessing dependability and achievement/surgency. Interest in food service occupations and audio/visual arts had negative effects.

Eighty percent of the jobs held by enlisted personnel in the military have civilian counterparts so the research on the validity of the ASVAB in military settings just presented should generalize quite well to major segments of the civilian economy (US Department of Defense, 1984). The test is highly correlated with the cognitive subtests of the General Aptitude Test Battery, a personnel selection test battery used by the US Employment Service, the validity of which has been established by studies of over 500 occupations. A validity generalization study funded by the armed forces concluded "that ASVAB is a highly valid predictor of performance in civilian occupations" (Hunter Crossen and Friedman, 1985, p. ix).

Nevertheless, it would be useful to examine civilian data on the effect of technical competence on job performance. It is to the analysis of civilian data we now turn.

II. The Effect of Technical Competence on Supervisory Assessments of Job Performance in the Civilian Sector

Over the last 50 years, industrial psychologists have conducted hundreds of studies, involving many hundreds of thousands of workers, on the relationship between supervisory assessments of job performance and various predictors of performance. In 1973 Edwin Ghiselli published a compilation of the results of this research organized by type of test and occupation. Table 4 presents a summary of the raw validity coefficients (correlation coefficients uncorrected for measurement error and restriction of range) for six types of tests: mechanical comprehension tests, "intelligence" tests, arithmetic tests, spatial relations tests, perceptual accuracy tests and psychomotor ability tests. As pointed out earlier, mechanical comprehension tests assess material that is covered in physics courses and applied technology courses such as auto mechanics and carpentry.

For craft occupations and semi-skilled industrial jobs, the mechanical comprehension tests are more valid predictors of job performance than any other test category. For protective occupations, mechanical comprehension tests tie intelligence tests for top rank in the validity sweepstakes. For clerical jobs, mechanical comprehension tests are not as good predictors of job performance as tests of intelligence, arithmetic and perceptual accuracy. This result is consistent with the analysis of job performance in the military data reported in Table 2.

It appears that measures of generic technical competence are highly correlated with job performance in technical and blue collar jobs. What about paper and pencil occupational competency tests for specific occupations? How highly do they correlate with job performance.

III. The Relationship between Occupational Competency Tests and Job Performance

Meta-analyses of the hundreds of studies of the validity of occupational competency tests have found that content valid occupational competency tests are highly valid predictors of job performance. Dunnette's (1972) meta-analysis of 262 studies of occupational competency tests found that their average correlation with supervisory ratings was .51. This correlation was higher than the correlation of any other predictor studied including cognitive ability tests (.45), psychomotor tests (.35), interviews (.16) and biographical inventories (.34). Vineberg and Joyner's (1982) meta-analysis of military studies found that grades in training school (which were based on paper and pencil tests of occupational competency) had a higher correlation (.27) with global performance ratings by immediate supervisors than any other predictor. The correlations for the other predictors were .21 for ASVAB ability composites, .14 for years of schooling, .20 for biographical inventory and .13 for interest. Hunter's (1982) meta-analysis found that content valid job knowledge tests had a correlation of .48 with supervisory ratings and an even higher correlation of .78 with work sample measures of job performance. Consequently, for training program graduates who are employed in the occupation for which their competency was assessed, scores on these competency exams are highly valid predictors of job performance and promotion probabilities.

It has also been established that vocational education programs have substantial effects on occupational competency test results. The findings of two studies comparing students at various stages of their training are reported in Table 5. The first column of the table reports the differences between trained and untrained students on the occupational competency tests developed by American Institutes of Research (1982) under a contract with the Office of Vocational and Adult Education. The second column reports the difference between Ohio high school juniors and seniors on most of the competency tests available from the Ohio Vocational Education Achievement Test Program. Since the tests are normally given in the spring, this column is an estimate of the gain in competency that occurs between the end of the first and the end of the second year of a high school vocational program (Instructional Materials Laboratory 1988). Mean differences have been put into a common metric by dividing them by the sample standard deviation of the program completers who took the test. While some of the mean differences are less than a third of a standard deviation, most are over half of a standard deviation and some are substantially greater than one standard deviation. The difference between sophomores and juniors and between juniors and seniors on academic achievement tests are generally between 20 and 30 percent of a standard deviation in the final years of high school. Thus, when test standard deviations are the metric of comparison, vocational education appears to produce larger gains (on a narrower front to be sure) than the academic side of high school.

Selective attrition and maturation effects are probably contributing to the differences in competency between trained and untrained individuals (and also between sophomores and seniors on academic achievement tests). Consequently, the true value added of vocational programs is probably somewhat less than the numbers reported.

Thus workers who score well on paper and pencil assessments of specific occupational competency and generic technical competence are indeed more productive on the job. Does this result in young men with technical competencies getting better jobs and spending less time unemployed? It is to this question we now turn.

IV. The Effect of Technical Competence on the Wages, Earnings and Unemployment of Young Men

A study was conducted to determine to what degree achievement in the various subjects taught in high school were rewarded by the labor market during the 1980s. This was accomplished by estimating models predicting wage rates, earnings and unemployment as a function of competence in the academic fields of mathematics, science and language arts and in the trade/technical arena while controlling for years of schooling, school attendance, ethnicity, age, work experience, marital status and characteristics of the local labor market.

The data set for this analysis was the Youth Cohort of National Longitudinal Survey (NLS)--all eight waves from 1979 to 1986. At the time of the 1986 interview the NLS Youth ranged from 21 to 28 years of age. The measures of achievement were derived from the ASVAB 8A. During the summer of 1980 all members of the NLS Youth sample were asked to take this test battery and, with the inducement of a $50 honorarium, the battery was successfully administered to 94 percent of the sample. The ASVAB 8A test battery has 10 subtests: Mechanical Comprehension, Auto and Shop Knowledge, Electronics Knowledge, Clerical Checking (Coding Speed), Numerical Operations (a speeded test of simple arithmetic), Arithmetic Reasoning, Mathematics Knowledge (covering the high school math curriculum), General Science, Word Knowledge and Paragraph Comprehension.

The mechanical comprehension, auto and shop information and electronics subtests of the ASVAB assess acquisition of knowledge in the trades and industry and technical field. These subtests were aggregated into a single composite which is interpreted as an indicator of competence in the "technical" arena.

Two dimensions of mathematical achievement were measured: the speed of doing simple mathematical computations is measured by a three minute 50 problem arithmetic computation subtest which will be referred to as computational speed. Mathematical reasoning ability was measured by a composite of the mathematics knowledge and arithmetic reasoning subtests. Science achievement was indexed by the ASVAB's General Science subtest. This test focuses on science definitions and has minimal coverage of higher level scientific reasoning. Verbal achievement was measured by a composite made up of the word knowledge and paragraph comprehension subtests.

Four measures of labor market success were studied: the log of the hourly wage rate in the current or most recent job, the log of calendar year earnings if they exceed $500, earnings in dollars (with nonworkers over age 16 included in the sample) and the share of labor force time that the individual was unemployed (defined only for people who were in the labor force for at least 8 weeks during the calendar year).

The model estimated assumed that technical and academic competencies have linear and additive effects on labor market outcomes:

(1) $\underline{Y}_t = \underline{a}_t\underline{A} + b_tC + c_tT + e_tS + \underline{g}_t\underline{Z}_t + \underline{u}_t$ for t = 1979...1986

where $\underline{Y}_t$ is a vector of labor market outcomes (wage rates, earnings and unemployment) for year t.

$\underline{A}$ is a vector of test scores measuring competence in mathematical reasoning, reading and vocabulary and science knowledge.

C is a measure of speed in simple arithmetic computation.

T is the technical composite measuring mechanical comprehension and electronics, auto and shop knowledge.

S is clerical checking speed.

$\underline{Z}_k$ is a vector of control variables such as age, work experience, schooling, school attendance, marital status, parenthood, minority status, past and current military service, region, residence in an SMSA and local unemployment rate.

$\underline{u}_t$ is a vector of disturbance terms for each year.

An extensive set of controls was included in the estimating equations. Reports of weeks spent in employment are available all the way back through 1975. For each individual, these weeks worked reports were aggregated across time and an estimate of cumulated work experience was derived for January 1 of each year in the longitudinal file. This variable and its square was included in every model as was age and its square. School attendance was controlled by four separate variables. The first variable indicated whether the youth is in school at the time of the interview. The second was a dummy variable indicating whether the youth has been in school since the last interview. The third was a dummy variable indicating whether the student is attending school part time. The fourth variable was a measure of the share of the calendar year that the youth reported attending school derived from the NLS's monthly time log. Years of schooling was also controlled for by four variables: years of schooling, a dummy for high school graduation, years of college education completed, and years of schooling completed since the ASVAB tests were taken. The individual's family situation was controlled by dummy variables for being married and for having at least one child. Minority status was controlled by a dummy variable for Hispanic and two dummy variables for race. Characteristics of the local labor market were held constant by entering the following variables: dummy variables for the four Census regions, a dummy variable for rural residence and for residence outside an SMSA and measures of the unemployment rate in the local labor market during that year.

The results of the estimations are presented in Tables 6, 7, 8, and 9. **Technical competence has large and significant positive effects on wage rates and earnings and negative effects on unemployment.** The F tests indicate that in all eight years analyzed, technical competence had significantly more positive effects on wage rates and earnings than the aggregated academic tests. A one population standard deviation increase in the technical composite increased wage rates by 5.6 percent and yearly earnings by $1065 (12.5 percent) and reduced the rate of unemployment by 1.9 percentage points. This is a very substantial return to technical achievement.

The second major finding is that **high level academic competencies do <u>not</u> have positive effects on wage rates and earnings.** The mathematics reasoning, verbal and science composites all had negative effects on wage rates and earnings and often positive effects on unemployment. In the wage rate models, 23 of 24 coefficients were negative. F tests on the sum of the coefficients on the three academic composites were calculated. This sum was significantly (at the 5 percent level) negative in 5 of the 8 years. In the log earnings models, 20 of 21 coefficients were negative. In the dollar earnings models, 19 of 21 coefficients were negative. F tests on the sum of the coefficients on academic tests in the dollar earnings models find they are significantly negative in 5 of the 7 years. In the unemployment models, about half of the coefficients were positive and the F test on the sum of the coefficients was never significantly different from zero at even the 10 percent level.

Speed in arithmetic computation had substantial positive effects on labor market success of young men. A one population standard deviation increase in computational speed raised wage rates by 5.3 percent and earnings by $837 (10.4 percent) on average. The wage and earnings effects grew over time. The unemployment effects, in contrast, diminished with time. They were significant in 1979-80 but not later. In all eight of the years studied, computational speed had a significantly larger impact on wage rates and earnings than the aggregated academic tests. Computational speed, however, is something that calculators do better than people and is not viewed by most educators as an appropriate goal for a high school mathematics curriculum (National Council of Teachers of Mathematics 1989). Being able to do clerical checking rapidly significantly lowered unemployment in 4 of the 7 years, significantly increased dollar earnings in 6 of 7 years but had no effect on wage rates.

In sum, analysis of labor market data for young males finds strong evidence that measures of technical competence are strongly related to higher wages, greater earnings and lower rates of unemployment. Since competence in this arena is the primary objective of trade and technical vocational programs, it would be reasonable to hypothesize that students who participate in trade and technical programs should be rated as better employees by their employers and should receive higher earnings than students who took no vocational courses in school. It is to these question we now turn.

V. The Effect of School-based Occupational Training on Job Performance

A 1987 survey of a stratified random sample of the National Federation of Independent Business (NFIB) provides us with unique data for examining the effect of relevant school based vocational training. A four page questionnaire was mailed to approximately 11,000 firms, and after 3 follow up waves, 2599 response were obtained.[3]

The questionnaire focused on the owner/manager's experiences in hiring and training workers in a particular job. This job was selected by asking the owner the following question: "For which job have you hired the most people over the last two or three years. (If you have more than one job for which you have done a lot of hiring, please select the job requiring the greatest skill.) **All future questions refer to this job."** After a series of general questions about the character of the job and the worker qualities that were sought when filling that job, the manager was asked to select two individuals who had been hired for this job and answer all future questions specifically with reference to those two workers. The selection was made in response to the following question:

> Please think of the last person hired for this job (job X) by your firm **prior** to August 1986 **regardless of whether that person is still employed by your firm.** Call this individual person A. The individual hired for job X immediately before person A is called person B. Do not include rehires of former employees.

Managers described the background characteristics of the two workers and also ranked them on six different abilities: reading, writing and math skills, occupational skills, learning ability, work habits, people skills and leadership. Information of varying degrees of completeness was obtained on 1624 person A's and 1403 person B's. Models were estimated predicting the relative ranking of the occupants of the job as a function of differences in their background characteristics, as ~~is~~ shown in Equation 1.

$$(2)\ \Delta R_{jk} = \beta_0 + \boldsymbol{\beta}_k(\underline{X}_A - \underline{X}_B) + (u_{Aj} - u_{Bj})$$

where person A and B both work in the same job "j".

ΔR_{jk} is a ranking of employee A relative to B on the "k" th ability dimension. (It ranges from +2 when person A is "a lot better" to -2 when person B is "a lot better."

$\underline{X}_i$ is a vector of background characteristics of person "i."

u_{ij} is a random error that is specific to the match between person and the job.

Estimating this model produces unbiased estimates of $\boldsymbol{\beta}_k$ if the X_i's are not correlated with the u_{ij}'s. The results are presented in Table 10. The first row presents the effect of differentials in years of schooling (either vocational or academic) on the relative ranking of the two workers. Schooling has significant positive effects on 5 of the 6 rankings of worker abilities and competencies. The second row presents the <u>additional</u> effect on rankings of a year of schooling being occupational in nature and relevant to the job. As one might expect, relevant occupational training at a school significantly increases the individual's occupational skills at hire ranking. It is also associated with significantly higher rankings of the worker's basic skills (reading, writing and mathematics), learning ability, work habits and people skills. Comparisons of the first two rows with row three which contains estimates of the effect of relevant work experience suggests that a year of occupational schooling has substantially bigger effects on rankings of abilities than a year of relevant work experience.

VI. The Effect of School-based Occupational Training on Wages?

The Payoff during the 1970s

There have been quite a few studies of the impact of high school vocational education on labor market success of non-college bound youth. Most of the studies analyzing data collected during the 1970s used student reports of their track to define participation in vocational education (Grasso and Shea 1981, Gustman and Steinmeier 1981, Woods and Haney 1981). When, however, these student reports of track were cross checked against transcripts, it was found that some of the self-identified vocational students had only a few vocational courses on their transcript and many "general track" students had taken 3 or 4 vocational courses (Campbell, Orth and Seitz 1981). Since it is the number and types of courses taken which are influenced by school policy, studies of the impact of vocational education need to employ objective measures of participation and not self-assessments of track, which apparently measure the student's state of mind as much as they measure the courses actually taken.

The solution to this problem is to use transcripts or reports of actual courses taken to measure participation in vocational education. In his analysis of longitudinal data on approximately 3500 men and women who graduated from high school in 1972, Meyer (1981) used school reports of the number of courses taken in vocational and nonvocational fields to define a continuous variable: the share of courses that were vocational. He found that females who devoted one-third of their high school course work to clerical training earned 16 percent more during the seven years following graduation than those who took no vocational courses (see Table 11). Those who specialized in home economics or other non-clerical vocational courses did not obtain higher earnings. Males who specialized in trade and industry earned 2.8 percent more than those in the general curriculum. Males in commercial or technical programs did not earn significantly more than those who pursued a general curriculum.

Rumberger and Daymont (1982) used transcripts to define variables for the share of course work during the 10th, 11th and 12th grades that was vocational and the share that was neither academic nor vocational. Analyzing 1979/80 data on 1161 young adults in the National Longitudinal Survey (NLS) who were not attending college full time and had attended high school during the early and middle 1970s, they found that males who devoted one-third of their time to vocational studies instead of pursuing a predominantly academic curriculum spent about 12 percent more hours in employment, but experienced slightly greater unemployment and received a 3 percent lower wage. Females who similarly devoted one-third of their time to vocational studies at the expense of academic course work were paid the same wage but spent about 8 percent more time in employment and 1.6 percent less time unemployed.

The Payoff during the 1980s

Studies of vocational education that have used more recent data sets have obtained much more positive results. Kang and Bishop's (1986) study of 2485 men and women who graduated from high school in 1980 and did not attend college full-time used student reports [transcripts were not available] of courses taken in three different vocational areas--business and sales, trade and technical, and other--and five academic subjects--English, math, science, social science and foreign languages--as measures of curriculum. Males who took 4 courses (about 22 percent of their time during the final three years of high school) in trade and technical or other vocational subjects by cutting back on academic courses were paid a 7 to 8 percent higher wage, worked 10 to 12 percent more, and earned 21 to 35 percent more during 1981, the first calendar year following graduation. Males who took commercial courses did not have higher earnings or wage rates. Females who substituted 4 courses in office or distributive education for 4 academic courses were paid an 8 percent higher wage, worked 18 percent more, and earned 40 percent more during 1981. Females who took trade and technical courses did not receive higher wage rates and earned 6 percent more than those who pursued an academic curriculum. The benefits probably diminish in later years, but this is of little consequence since the incremental costs of four vocational courses can be recovered in just one or two years at this rate.

Joseph Altonji's (1988) study of the NLS Class of 72 followup surveys for 1973 through 1986 found modest positive effects of vocational course work on hourly wage rates. Holding years of further education constant, four trade and technical courses substituted for a mix of academic courses (English, foreign language, social studies, science and mathematics) raised wage rates by 5 to 10.3 percent depending on specification. Substituting four commercial courses for a mix of academic courses had no effect on wages in OLS models but raised wage rates by 3 percent in instrumental variable models intended to correct for selection bias.

Recent studies of students who graduated in the late 1970s and early 1980s by Paul Campbell and his colleagues at the National Center for Research on Vocational Education also obtained positive findings. Controlling for test scores and past and present enrollment in higher education, their analysis of 1983 and 1985 National Longitudinal Survey data on 6953 young men and women between the ages of 19 and 28 found that graduates of vocational programs had 16.5 percent higher earnings than those who had specialized in academic courses [comparison is made with academic rather than general track students because most general track students take one or two vocational courses]. A parallel analysis of High School and Beyond data on 6098 students who graduated in 1982 (which also controlled for test scores and college attendance) found that the vocational graduates were 14.9 percent more likely to be in the labor force in 1983/84, were one percentage point less likely to be unemployed, and were paid about 9 percent more per month than the academic graduates. The overall earnings effect was 27 percent. The differential between vocational and general curriculum graduates [who generally took 1 to 2 vocational courses] was generally about half the size of the differential between vocational and academic graduates (Campbell et. al., 1986, 1987).

These positive results contrast markedly with the negative findings regarding JTPA and CETA classroom occupational skills training programs for youth and the Supported Work Demonstration (see the right hand side of Table 10). Only the Job Corps, a considerably more costly training program, appears to have positive impacts that even approach these in magnitude.

<u>Why did the Payoff Increase?</u>

There are three reasons for viewing the more recent studies as more accurate descriptions of the current impacts of vocational education than the studies published prior to 1983. First, vocational education has been changing rapidly. During the 1970s, competency based instruction tied to competency profiles certifying the skills learned became common practice, career education courses preceding the selection of an occupational specialty were introduced, job search skills were added to the curriculum of most vocational programs, home economics was reoriented from a focus on home making to a focus on preparation for work, and the content of many individual programs was upgraded and updated. Consequently, the data on the younger members of the NLS Youth sample and on High School and Beyond students, who received their vocational instruction between 1978 and 1982, is more relevant to vocational education as it is now practiced than the Class of 1972 data analyzed by Meyer, Gustman/Steinmeier and Woods/Haney.

Second, the labor market reward for the skills taught in high school appears to be experiencing secular growth. The 1980s were a period of dramatic increases in all kinds of skill premiums. Rewards for work experience and for college degrees rose substantially. Between 1979 and 1988 the real wage of male college graduates with fewer than 10 years of work experience increased by 5.5 percent while the real wage of high school graduates with fewer than 10 years of post-school work experience declined by 20 percent (Kosters 1989). High school graduates with vocational training suffered a decline in their real wage during this period but those without any vocational training suffered even bigger declines.

Third, large samples are preferable to small samples. In the four year interval between the Rumberger/Daymont analysis of NLS youth data and Campbell et al's analysis, the number of graduates for which high school transcript data was available nearly doubled. This makes the findings in Campbell et al's 1986 and 1987 papers a more reliable estimate of vocational education's effect than those provided by Rumberger/Daymont's 1982 study and the early studies of NLS data done by Mertens and Gardner (1982) and others.

VII. Has the Return to Occupationally Specific Training Fallen because of Rising Rates of Obsolescence?

In most jobs productivity derives directly from social abilities (such as good work habits, people skills and leadership) and cognitive skills that are specific to the job, the occupation and the occupational cluster: not from reading, writing and mathematics skills. When employers are asked which skills they look for when hiring, they almost always cite work habits and occupational skills ahead of reading and mathematics skills. The applicants knowledge of history, geography and literature is seldom evaluated.

In the NFIB data previously described, regressing a global rating of relative productivity at the time of the interview of worker A and B on tenure, tenure squared and the rankings of the six worker abilities produces the following results:

$$\text{(3)}\quad \underset{\text{betw. A \& B at Interview}}{\text{Productivity Differential}} = \underset{(.015)}{-.015}(\text{Basic Skills}) + \underset{(.013)}{.063^{***}}(\text{Occ Skills at hire}) + \underset{(.016)}{.081^{***}}(\text{Learning Ability})$$

$$+ \underset{(.014)}{.104^{***}}(\text{Work Habits}) + \underset{(.015)}{.046^{***}}(\text{People Skills}) + \underset{(.016)}{.007}(\text{Leadership}) \qquad R^2 = .504 \quad \text{Obs} = 756$$

Occupational skills, learning ability, work habits and people skills rankings (and tenure and its square not shown) all had significant positive effects on relative global productivity ratings. Basic skills and leadership did not.

When paper and pencil tests of occupational knowledge appropriate for the job compete with reading and mathematics tests to predict supervisor ratings of job performance, the job knowledge tests carry all of the explanatory power, the reading and mathematics tests none. When judged performance on a sample of critical job tasks is the measure of job performance, the beta coefficient on the job knowledge test is 2 to 4 times larger than the beta coefficient on a basic skills composite (Hunter, 1983). Thus, basic skills make little direct contribution to a worker's productivity. Their contribution is to help the individual learn the occupation and job specific skills that are directly productive. Since large improvements in job knowledge are easier to achieve than equivalent (in proportions of a standard deviation) improvements in verbal and mathematical skills, occupationally specific training would appear to be highly desirable if the student is likely to put the knowledge to use by working in the occupation or a closely related one.

Occupational knowledge is cumulative and hierarchical in much the same way that mathematics and science is cumulative and hierarchical. Everyone must start at the bottom of the ladder of occupational knowledge and work their way up. The spread of information technology and of high performance work systems is forcing workers to learn new skills, but the new skills are generally additions to, not replacements for, old skills. While learning a new skill is easier when the worker has good basic skills, a foundation of job knowledge and occupational skills is more essential. At some point every individual must start building his/her foundation of occupational skills. At the start, the period that might occur in high school, the foundation building process involves learning skills relevant in a broad cluster of occupations (eg. office and management, construction occupations). The foundation building should begin at least two years before the individual plans to leave school, probably in 11th grade for those not planning to attend college.

It is sometimes argued that high school students should now concentrate on academic courses rather than occupational skills because jobs are changing more rapidly than in the past with the result that occupational skills learned in school become obsolescent more rapidly than in the past. But job mobility has always been high in the United States and, consequently, workers have always had to learn new skills frequently. Rates of job turnover and rates of exit from agriculture are lower now than in the first half of the twentieth century. Separation rates in manufacturing were 5 percent per month during the 1920's and 4.4 percent during the 1970's. The changes experienced by current workers are modest in comparison to the changes experienced by the generation that lived through the depression, the mobilization for World War II and the rapid demobilization after the war.

Rates of obsolescence of a skill are higher in fast changing fields close to the frontier of knowledge. The labor market responds to high rates of skill obsolescence by paying a higher premium for the skill. The high starting salaries of engineers derive in part from the high rate of skill obsolescence in their profession. Consequently, there is no reason to expect a negative correlation between rates of skill obsolescence and the rate of return to an investment in a skill.

Skills and knowledge deteriorate from non-use more rapidly than they become obsolescent. In one set of studies, students tested 2 years after taking a course had forgotten 1/2 of the college psychology and zoology, 1/3 of the high school chemistry, and 3/4 of the college botany that had been learned (Pressey and Robinson, 1944). Reading, writing and arithmetic are used in most occupations and many adult roles and probably do not deteriorate as much after leaving school as the other subjects taught in high school. In general, forgetting is a more serious threat to knowledge and skills than obsolescence. Consequently, when deciding what to study, the probability of using a skill or knowledge base is more important than the rate of obsolescence of that knowledge.

Since occupational skills are useful in a limited cluster of occupations, occupationally specific training needs to be conditioned on a reasonable prospect of soon working in that occupational cluster. There are three reason for this conclusion: (1) vocational education pays off only if the skills are used (Bishop 1989a); (2) skills deteriorate with lack of use; and (3) motivation to learn is weak if there is little prospect of using what is learned. Intensive occupationally specific training should begin after a student has made a reasonably well informed tentative career choice and be for occupations with good job prospects.

VII. Summary and Implications

Applied technology courses taken in high school significantly increase the wages and earnings of graduates who do not go to college. Tests assessing technical competence are powerful predictors of wage rates and earnings of young males and highly valid predictors of training success and job performance in technical, craft and industrial occupations. A one population SD increase in technical competence raises the average earnings (regardless of occupation) of young men by $1333. per year in 1985 dollars. Averaging over the six non-clerical non-combat occupations, and assuming that the standard deviation of true productivity is 30 percent of the wage, a one population SD increase in all four of the technical subtests raises productivity by about 11.5 percent of the wage or about $2875. per year in 1985 dollars.[4] With a working life of 40 years and a real discount rate of 5 percent, the present discounted value of such a learning gain is about $50,000. These results imply that broad technical literacy is essential for workers who use and/or maintain equipment that is similar in complexity to that employed in the military.

The skills taught in typical trade and technical programs raise productivity and yield substantial labor market benefits if jobs are found in a related field. These benefits alone are sufficient to justify trade and technical programs (Bishop 1989a).

The A Nation at Risk report recommendation that all students take a course in computers recognized the need for including computersin the curriculum. High school students see the usefulness of these courses. Sophomores taking such courses described them as "Very Useful" for their career 53 percent of the time and as of "No Use" only 6 percent of the time (LSAY, Q. AACOMF)(see Table 12). However, only 58 percent of middle school students and 43 percent of high school students report using computers at school (U.S. Census Bureau, Current Population Reports, 1991). The decline in computer use with age is particularly worrisome. Furthermore, computers are only one of the technologies we interact with on a daily basis. The findings just reviewed suggest that students headed into technical training programs or directly into a job should receive a thorough technology education.

An example of the kind of course that is needed is the Principles of Technology (PT) course developed by a consortium of vocational education agencies in 47 states and Canadian provinces in association with the Agency for Instructional Technology and the Center for Occupational Research and Development. This 2 year applied physics course is both academically rigorous and practical. Each six day subunit deals with the unit's major technical principle (eg. resistance) as it applies to one of the four energy systems--mechanical (both rotational and linear), fluid, electrical and thermal. A subunit usually consists of two days of lectures/discussion, a math skills lab, two days of hands-on physics application labs, and a subunit review. This approach appears to be quite effective at teaching basic physics concepts. When students enrolled in regular physics and Principles of Technology courses were tested on basic physics concepts covered in the PT course at the beginning and end of the school year, the PT students started out behind the regular physics students but obtained an average score of 81 at completion as compared to an average of 66 for those completing a physics course (Perry 1989). Another study by John Roper (1989) comparing PT and physics students obtained similar results. In 29 states students get science and/or math credit when they take PT. Courses in applied biology/chemistry and in applied mathematics are currently being field tested. This is an area of study that needs much more attention than it has been getting from educational reformers and curriculum developers.

An argument that is often made for vocational education is that it helps motivate students who have been doing poorly in core academic subjects to apply themselves to learning English and mathematics by showing its applications in a real work setting. It is also argued that, by offering opportunities for more concrete/hands-on type of learning, vocational education reduces dropout rates of at-risk students. Indeed, there is research support for this claim. Mertens, Seitz and Cox (1982) analysis of NLS Youth data found that taking and passing a vocational course in 9th grade reduced the dropout rate for dropout prone youth during 10th grade from 9 percent to 6 percent. Taking and passing vocational courses in 9th, 10th and 11th grade also significantly reduced dropping out during 12th grade.

One possible explanation of this dropout reducing effect is that students may view these courses as more relevant to their career plans. When 10th graders were asked to rate career utility on a five point scale, "very useful" was the description given by 58 percent of business/vocational classes, by 28 percent of science students in science courses and 47 percent of math students (see Table 12). Another possible explanation is that at risk students find vocational courses to be easier for them than academic courses. When asked "How difficult or easy is___ course?," 54 percent characterize their vocational course as "very easy," while only 20-23 percent so characterize their science and mathematics courses. When asked to respond to "How much does the ___ course challenge you to use your mind?" on a 5 point scale ranging from "challenges a lot" to "never challenges", 16 percent of the vocational courses were placed in the bottom response category while only 6-7 percent of the mathematics and science courses were so classified. Sixty percent of business and vocational classes assign no homework.

In my view these statistics imply that despite the demonstrated success of vocational education in helping students get better jobs, that vocational education is not now achieving its promise. It is well known that achievement levels in most high school academic subjects are very low.[5] What this data implies is that the expectations placed on vocational students are too low, not just in their academic classes but in their vocational classes as well. As a consequence, many graduates of high school vocational programs do not have the occupational skills that employers are seeking and some employers are turning to post-secondary voc-tech institutions to meet their needs for technically qualified workers.

Identifying problems, however, is a lot easier than solving them. American senior high school students average only 3.8 hours of homework a week while their Japanese counterparts average over 19 hours a week (Juster and Stafford 1990). Unfortunately, the sentiment expressed by one student, **"You're going to work your whole life,..[High school should be a place to] enjoy life and have fun"** (Powell et al, 1985, p 43) is quite common. Sixty-two percent of 10th graders agree with the statement, "I don't like to do any more school work than I have to" (Longitudinal Survey of American Youth or LSAY, Q. AA37N). Many of these students end up in vocational courses. When one asks vocational teachers to raise their standards, many complain that students will not take their courses if they set the expectations too high. Principles of Technology is a demanding course. Student fear of its heavy work demands has been a barrier to its spread. Powell describes "An angry math teacher [who remembering] the elimination of a carefully planned program in technical mathematics for vocational students simply because not enough signed up for it,...[said] 'Its easy to see who really makes decisions about what schools teach: the kids do.'(p. 9)"

How then can students be convinced to choose rigorous technical and occupational programs and work hard to excel in them? The answer is by (1) developing rigorous courses that teach students concepts and material that they will use after leaving high school, (2) defining accomplishment in a way that students who work hard will perceive themselves as successful, (3) organizing apprenticeship programs for high skill occupations, (4) measuring the student's performance using a valid external assessment and then (5) insuring that accomplishment is recognized and rewarded by the labor market.

Usefulness is essential for three reasons. First, the social benefits of learning derive from the use of the knowledge and skills not from the fact they are in someone's repertoire. Secondly, skills and knowledge that are not used deteriorate. Consequently, if learning is to produce long term benefits, the competencies developed must continue to be used after the final exam (either in college, the labor market or somewhere else). Finally, usefulness is essential because students are not going to put energy into learning things they perceive to be useless. Furthermore, the labor market is not in the long run going to reward skills and competencies that have no use. Indeed, selecting workers on the basis of competencies that are not useful in the company's jobs is in most circumstances a violation of Title VII of the Civil Rights Act.

It is also essential that the occupational competencies developed by students be assessed not just by the teacher but by some external group--local employers, the state department of vocational education or the National Occupational Competency Testing Institute. This simultaneously accomplishes three goals: it helps to insure that the curriculum is both up to date and rigorous, it signals to prospective employers the skills that the student has developed and generates stronger economic incentives for the student to put greater effort into the course.

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Table 1
Cognitive Determinants of Success
in Marine Training Programs

	Mechanical Comprehension	Auto & Shop Knowledge	Electronics	Clerical Speed	Computational Speed	Math Reasoning	Math Knowledge	Verbal	Science	Spatial	R^2
<u>Sims & Hiatt</u> ASVAB 6/7 (23061)											
All Occupations	.043*** (5.20)	.098*** (12.46)	.047*** (5.78)	.013** (2.29)	.060*** (8.96)	.116*** (14.44)	.205*** (25.26)	.086*** (11.68)	.089*** (10.68)	.037 (5.89)	.345
<u>Maier & Truss</u> ASVAB 8/9/10											
Electronics Repair (4103)	.055*** (2.73)	.027 (1.40)	.102*** (4.81)	.009 (.69)	.062*** (3.44)	.151*** (6.41)	.256*** (11.91)	.031 (1.40)	.130*** (5.73)	---	.492
Mechanical Maintenance (5841)	.058*** (3.29)	.253*** (15.02)	.094*** (5.02)	.063*** (4.44)	.014 (.87)	.086*** (4.16)	.135*** (7.14)	.120*** (6.27)	.005 (.27)	---	.444
Operators, Food (1897)	.079*** (2.72)	.063** (2.27)	.018 (.57)	.086*** (3.66)	.022 (.82)	.137*** (4.02)	.199*** (6.41)	.164*** (5.20)	.093*** (2.84)	---	.490
Clerical (5231)	.014 (.74)	-.022 (1.22)	.026 (1.33)	.136*** (9.03)	.037** (2.26)	.125*** (5.70)	.259*** (13.02)	.206*** (10.14)	-.101 (.47)	---	.443
Combat (8191)	.087*** (4.98)	.078*** (4.68)	.020 (1.09)	.027* (1.95)	.056*** (3.62)	.069*** (3.40)	.143*** (7.71)	.073*** (3.88)	.061*** (3.12)	---	.251
Field Artillery (1062)	.055 (1.34)	.237*** (6.01)	-.009 (.21)	.178*** (5.36)	.060 (1.64)	.148*** (3.07)	.138*** (3.13)	-.011 (.24)	.065 (1.41)	---	.448

Table 2 Effect of competencies on job performance (SQT).

	Mechanical Comprehension	Auto. Info.	Shop Info.	Electr. Info.	Attention to Detail	Comp. Speed	Word Knowl.	Arith. Reasoning	Math Knowl.	Science	R^2
Skilled technical	0·092***	0·017	0·132***	0·174***	0·024	0·031	0·215***	0·062**	0·121***	0·057*	0·548
(1324)	(3·07)	(0·58)	(4·28)	(5·09)	(1·12)	(1·17)	(6·77)	(1·96)	(3·76)	(1·83)	
Skilled electronic	0·086	0·098	0·246***	0·045	0·084	−0·013	−0·004	−0·021	0·261***	0·072	0·426
(349)	(1·30)	(1·49)	(3·64)	(0·60)	(1·81)	(0·22)	(0·06)	(0·30)	(3·67)	(1·05)	
General (const.) maintenance	−0·004	0·082**	0·117***	0·121***	0·043*	0·068***	0·066*	−0·101***	0·441***	0·134***	0·592
(879)	(0·11)	(2·34)	(3·25)	(3·05)	(1·76)	(2·19)	(1·80)	(2·73)	(11·70)	(3·67)	
Mechanical maintenance	0·042	0·314***	0·206*	−0·089	0·055	0·235**	−0·004	−0·068	0·061	0·096	0·412
(131)	(0·38)	(2·88)	(1·84)	(0·71)	(0·72)	(2·43)	(0·03)	(0·59)	(0·52)	(0·85)	
Clerical	−0·068	0·087***	−0·030	0·065	0·015	0·085**	0·118***	0·241***	0·206***	0·064	0·425
(830)	(−1·59)	(2·05)	(−0·69)	(1·33)	(0·50)	(2·24)	(2·61)	(5·33)	(4·46)	(1·44)	
Operators and food	0·109*	0·179***	0·062	0·100**	0·050	−0·037	0·061	0·114*	0·106**	0·076*	0·41
(814)	(2·50)	(4·11)	(1·39)	(2·02)	(1·62)	(0·96)	(1·33)	(2·47)	(2·25)	(1·66)	
Unskilled electronic	0·004	0·027	0·062*	0·077**	0·036	0·053*	−0·010	0·058*	0·018	−0·025	0·05
(2545)	(0·14)	(0·87)	(1·93)	(2·15)	(1·65)	(1·92)	(0·31)	(1·75)	(0·55)	(0·76)	
Combat	0·147***	0·060***	0·080***	0·058***	0·048***	0·035**	0·069***	0·070***	0·139***	0·070***	0·35
(5403)	(8·28)	(3·38)	(4·42)	(2·86)	(3·82)	(2·23)	(3·71)	(3·74)	(7·29)	(3·82)	
Field artillery	0·059	0·047	0·030	0·134**	0·088**	−0·009	0·000	0·186***	0·230***	0·061	0·42
(534)	(1·10)	(0·89)	(0·56)	(2·21)	(2·33)	(0·19)	(0·01)	(3·28)	(3·99)	(1·10)	

Source: Reanalysis of Maier and Grafton's (1981) data on the ability of ASVAB 6/7 to predict Skill Qualification Test (SQT) scores. The correlation matrix was corrected restriction of range by Maier and Grafton.

Table 3
Determinants of Army-Wide Performance Constructs

Predictor Constructs	General Soldiering (raw score) M1	M2	Effort & Leadership (residual) M1	M2	Effort & Leadership (raw score) M1	M2	Personal Discipline (raw score) M1	M2
ASVAB Composites								
Technical	.26	.12	.21	.11	.21	.15	.06	.07
Speed	.03	--	.07	.04	.09	.06	.04	.03
Quantitative	.20	.09	.08	.04	.03	--	.07	.05
Verbal	.10	.09	.03	.03	-.07	-.06	-.03	--
Overall Spatial	--	.25	--	.13	--	--	--	--
Complex Percept. Accuracy	--	.08	--	--	--	.04	--	--
Complex Perceptual Speed	--	--	--	--	--	.05	--	--
Temperament								
Dependability	--	.11	--	.06	--	.11	--	.30
Achievement/Surgency	--	-.04	--	.15	--	.20	--	.03
Physical Condition	--	--	--	.03	--	--	--	-.05
Interests								
Combat	--	.13	--	.11	--	.10	--	--
Food Service	--	-.04	--	-.08	--	-.06	--	-.04
Audiovisual Arts	--	--	--	-.02	--	-.04	--	-.03
Job Values								
Prefers Routine	--	-.03	--	-.04	--	-.03	--	--
Prefers Autonomy	--	--	--	--	--	--	--	-.05
Corrected Multiple R	.461	.540	.280	.392	.206	.366	.106	.317

Source: Beta coefficients from Table 10 and 12 of Campbell (1986). M1 includes only the four ASVAB composites that were measured prior to entry into the army. M2 is the result of a stepwise regression using 24 predictor constructs. Variables with very low contributions to explanatory power were dropped. The Multple R has been corrected for shrinkage but not for restriction of range or unreliability of the criterion. Sample size was approximately 10,000. All 20 non-ASVAB constucts were measured concurrently with the measurement of performance. The overall spatial construct is a composite of 6 paper and pencil tests of spatial orientation, spatial visualization and induction-figural reasoning. The Complex Perceptual Accuracy is the percent correct on computerized tests of short term memory, target identfication and perceptual speed and accuracy. The Complex Perceptual Speed factor is average reaction time on these same tests times -1. The Dependability factor combines a conscientiousness scale and a non-delinquency scale. The Achievement/Surgency factor is composed of scales measuring self-esteem, work orientation and energy level. The Combat Interest Factor is a composite of a combat, rugged individualism and firearms enthusiast scales. Variables which entered none of the regressions--skilled technical and structural/machines interest factors, an emotional stability scale, simple reaction accuracy and an index measuring preference for organizational and co-worker support--are not shown. The other variables not shown had very small and inconsistent betas (< .04): 4 perceptual speed tests and an interest in protective service occupations factor.

Table 4

Raw Validity Coefficients

	Mechanical Comprehension	Intelligence	Arithmetic	Spatial Relations	Perceptual Accuracy	Psychomotor Abilities
Foreman	23[c]	28[e]	20[d]	21[d]	27[d]	15[b]
Craftworkers	26[d]	25[f]	25[f]	23[f]	24[e]	19[f]
Industrial Workers	24[d]	20[f]	21[f]	21[f]	20[f]	22[f]
Vehicle Operators	22[d]	15[d]	25[c]	16[c]	17[b]	25[d]
Service Occupations	---	26[d]	28[d]	13[d]	10[d]	15[d]
Protective Occupations	23[b]	23[d]	18[c]	17[d]	21[c]	14[d]
Clerical	23[d]	30[f]	26[f]	16[c]	29[f]	16[f]

Source: Ghiselli (1973) compilation of published and unpublished validity studies for job performance. The raw validity coefficients have not been corrected for restriction of range or measurement error in the performance rating. The Perceptual Accuracy category include number comparison, name comparison, cancellation and perceptual speed tests. They assess the ability to perceive detail quickly. Psychomotor tests measure the ability to perceive spatial patterns and to manipulate objects quickly and accurately. This category of tests includes tracing, tapping, doting, finger dexterity, hand dexterity and arm dexterity tests.

[a] Less than 100 cases.
[b] 100 to 499 cases.
[c] 500 to 999 cases.
[d] 1,000 to 4,999 cases.
[e] 5,000 to 9,999 cases.
[f] 10,000 or more cases

Table 5
Effects of Vocational Education on Occupational Competency

Occupation	AIR Trained Versus Untrained	Ohio Seniors Versus Juniors
Word Processing Specialist	88%	43%
Computer Operator	137	--
General Office Clerk	--	--
Clerk Typist	--	34
Grocery Clerk/Food Marketing	21	27
Apparal Sales	22	86
Dental/Medical Assisting	166	63
Restaurant/Food Service	26	25
Electronics Technician	111	--
Water Treatment Technician (avg)	132	--
Diesel Mechanic	132	47
Carpentry	76	60
Construction Electricity	--	63
Drafting	--	51
Machine Trades	--	47
Welding	--	67
Cosmetology	--	63

Source: Table reports estimates of mean competency test score differences between students at different stages of an occupational training program divided by the standard deviation of program completers. Column 1 is from American Institutes of Research's (1982) report on the Vocational Competency Measures it developed under a contract with the Office of Vocational and Adult Education. Samples ranged from 100 to 296 for the trained students and from 24 to 51 for the untrained students. These tests are now available from AAVIM in Athens Ga. Column 2 gives the mean differences between Ohio high school seniors tested in the spring of the year and juniors also tested in the spring of the year (Instructional Materials Laboratory, 1988).

Table 6

Effect of Competencies on Log Wage Rate

	Technical	Clerical Speed	Computational Speed	Math	Verbal	Science	R^2	N	F Test Academic vs. Zero	F Test Academic vs. Tech	F Test Academic vs. Comp
Male											
1986	.080***	.005	.064***	-.007	-.021	-.008	.264	4272	4.35	17.3	18.4
	(6.10)	(.51)	(5.75)	(.51)	(1.49)	(.60)					
1985	.074***	.004	.064***	.007	-.015	-.006	.270	4206	.66	10.2	11.5
	(5.75)	(.37)	(5.84)	(.57)	(1.08)	(.43)					
1984	.066***	.006	.070***	.005	-.015	-.014	.239	4527	2.05	10.8	17.2
	(5.08)	(.60)	(6.38)	(.42)	(1.07)	(1.04)					
1983	.063***	.004	.068***	-.025**	-.036**	.018	.245	4401	6.55	15.2	24.2
	(4.92)	(.40)	(6.27)	(2.01)	(2.53)	(1.32)					
1982	.051***	.006	.041***	-.014	-.011	-.010	.220	4477	4.6	10.3	11.9
	(3.98)	(.62)	(3.84)	(1.16)	(.78)	(.77)					
1981	.033***	-.001	.050***	-.001	-.009	-.024*	.238	3881	4.4	6.4	14.3
	(2.61)	(.09)	(4.65)	(.10)	(.63)	(1.83)					
1980	.048***	-.011	.039***	-.025**	-.006	-.024*	.225	3552	10.8	14.3	16.9
	(3.72)	(1.00)	(3.48)	(2.01)	(.42)	(1.75)					
1979	.034**	.003	.030**	-.004	-.003	-.027	.248	2249	1.6	3.3	3.9
	(2.20)	(.23)	(2.21)	(.26)	(.14)	(1.61)					

Table 7

Effects of Competencies on Log Earnings

	Technical	Clerical Speed	Computational Speed	Math	Verbal	Science	R^2	N	F Test Academic vs. Zero	F Test Academic vs. Tech	F Test Academic vs. Comp.
Male											
1985	.133***	.004	.119***	-.037*	.014	-.021	.358	4521	2.4	15.3	18.3
	(6.26)	(.21)	(6.55)	(1.78)	(.61)	(.93)					
1984	.115***	.017	.089***	-.002	.009	-.003	.372	4564	0.0	6.0	5.1
	(5.38)	(.98)	(4.89)	(.09)	(.37)	(.14)					
1983	.018***	.027	.110***	-.014	.028	-.025	.376	5004	.1	7.1	10.9
	(5.08)	(1.52)	(6.21)	(.69)	(1.21)	(1.14)					
1982	.120***	.013	.133***	-.036*	-.007	-.020	.416	4959	5.1	16.2	27.1
	(5.56)	(.72)	(7.32)	(1.77)	(.31)	(.88)					
1981	.131***	.018	.111***	-.054**	-.001	-.032	.400	4574	9.4	22.1	26.7
	(5.96)	(1.01)	(6.00)	(2.55)	(.05)	(1.39)					
1980	.151***	.042**	.087***	-.009	-.052**	-.079***	.392	3955	22.2	36.3	31.9
	(6.66)	(2.26)	(4.49)	(.42)	(2.07)	(3.27)					
1979	.114***	.017	.082***	-.034	-.058**	-.023	.380	3411	14.5	21.4	23.2
	(4.85)	(.86)	(4.11)	(1.57)	(2.20)	(.91)					

Effects of Competencies on Earnings ($)

	Technical	Clerical Speed	Computational Speed	Math	Verbal	Science	R^2	N	F Test Academic vs. Zero	F Test Academic vs. Tech	F Test Academic vs. Comp
Male											
1985	1365*** (5.42)	251 (1.39)	1241*** (5.85)	-96 (.39)	-87 (.32)	-218 (.84)	.350	4900	1.5	10.9	13.6
1984	1321*** (5.96)	96 (.53)	1035*** (5.54)	14 (.06)	-213 (.89)	-30 (.13)	.350	5007	0.6	10.9	10.4
1983	1228*** (6.89)	307** (2.10)	1053*** (7.05)	-141 (.82)	-194 (1.00)	-158 (.86)	.367	5642	4.5	20.9	24.6
1982	1114*** (6.71)	280** (2.06)	926*** (6.65)	-304* (1.92)	-314* (1.74)	-187 (1.08)	.354	5742	14.2	30.2	35.9
1981	937*** (6.06)	330*** (2.60)	665*** (5.07)	-360** (2.43)	-76 (.45)	-278* (1.73)	.355	5237	12.9	25.8	26.2
1980	912*** (6.69)	219* (1.95)	493*** (4.28)	-207 (1.58)	-109 (.73)	-428*** (2.99)	.344	4543	17.7	32.8	26.8
1979	580*** (4.42)	41 (.38)	457*** (4.14)	-375*** (3.08)	-241* (1.67)	89 (.65)	.320	3836	10.0	16.3	19.0
Female											

Table 9

Effects of Competencies on Unemployment

	Technical	Clerical Speed	Computational Speed	Math	Verbal	Science	R^2	N	F Test Academic vs. Zero	F Test Academic vs. Tech	F Test Academic vs. Comp
Male											
1985	-2.22***	-.84	.11	.42	-.40	1.24*	.206	4459	2.2	6.5	1.0
	(3.46)	(1.61)	(.21)	(.67)	(.57)	(1.84)					
1984	-2.31***	.16	-.83	.17	-.55	.15	.229	4523	0.1	2.1	.3
	(3.40)	(.29)	(1.45)	(.25)	(.74)	(.22)					
1983	-1.00	-1.25**	-.96	-.89	-.92	.26	.212	4888	2.5	.1	.2
	(1.35)	(2.02)	(1.52)	(1.23)	(1.13)	(.33)					
1982	-2.41***	-2.07***	-.70	-2.08***	.20	1.13	.200	4835	.5	1.0	0.0
	(3.03)	(3.19)	(1.06)	(2.76)	(.23)	(1.38)					
1981	-2.38***	-1.32**	-.96	-1.20	-.25	1.95*	.180	4761	0.0	2.2	.5
	(3.10)	(2.07)	(1.47)	(1.64)	(.29)	(1.82)					
1980	-1.52*	-1.68**	-1.62**	-1.59**	1.69*	.00	.163	4305	0.0	.9	1.4
	(1.84)	(2.43)	(2.31)	(2.00)	(1.86)	(.00)					
1979	-1.77**	-1.08	-2.24***	-.50	2.25**	-.46	.177	3057	8.4	3.0	5.6
	(2.07)	(1.48)	(3.05)	(.62)	(2.36)	(.50)					

[illegible]

Table 10
Impact of Worker Characteristics
on
Employer Assessments of Worker Skills

Worker Characteristics	Employer Rating of Worker's Relative Skill: Reading Writing & Math	Occup. Skills at hire	Learning Ability	Work Habits	Teamwork People Skills	Leader ship	Logarithimn of Tenure
Years of Schooling	.160*** (.023)	.123*** (.027)	.122*** (.026)	.055** (.027)	.032 (.025)	.106*** (.024)	.013 (.017)
Years of Relevant Occ. Training in School	.112*** (.031)	.075** (.035)	.076** (.034)	.102*** (.035)	.106*** (.032)	.045 (.031)	.014 (.023)
Years of Relevant Work Experience	.036** (.016)	.128*** (.019)	.038** (.019)	.042** (.019)	.018 (.018)	.057*** (.017)	-.003 (.011)
Years of Rel. Work Experience Squared	-.0010* (.0006)	-.0030*** (.007)	-.0012 (.0007)	-.0015** (.0007)	-.0005 (.0007)	-.0016** (.0006)	.0003 (.0004)
Formal On-Job-Training	.102 (.076)	.137 (.093)	.064 (.090)	-.040 (.092)	-.040 (.086)	.060 (.082)	-.009 (.060)
Formal Off-Job-Training	.040 (.153)	-.157 (.183)	.132 (.177)	.029 (.181)	-.036 (.168)	.159 (.161)	-.006 (.120)
Age - 18	.0089 (.0094)	-.013 (.011)	-.010 (.011)	.009 (.011)	.021** (.010)	.015 (.010)	.009 (.007)
(Age-18)squared	-.0004 (.0003)	-.0001 (.0003)	-.0001 (.0003)	-.0001 (.0003)	-.0004 (.0003)	-.0004 (.0003)	-.0001 (.0002)
Female	.040 (.102)	-.084 (.120)	-.071 (.116)	-.021 (.119)	.215* (.110)	-.063 (.105)	.022 (.076)
Black	-.386** (.155)	-.193 (.181)	-.234 (.176)	-.107 (.178)	-.159 (.167)	-.228 (.159)	.042 (.111)
Hispanic	-.232 (.167)	-.367* (.208)	.188 (.202)	-.100 (.207)	-.040 (.192)	-.098 (.183)	.074 (.128)
Temporary Job	-.049 (.102)	-.128 (.124)	-.080 (.120)	-.011 (.122)	.067 (.114)	-.044 (.109)	-.208*** (.075)
Adjusted R Square	.1029	.1078	.0444	.0187	.0195	.0561	.442
Root Mean Sq Error	1.021	1.263	1.225	1.253	1.164	1.111	.805
Number of Observations	946	1006	1006	1006	1006	1006	996

* implies Prob. LT .10 on a two tail test.
** implies Prob. LT .05 on a two tail test.
*** implies Prob. LT .01 on a two tail test.
Standard errors are in parenthesis under the coefficient. Source: Analysis of NFIB survey data.

Table 11
THE EFFECT OF OCCUPATIONAL TRAINING ON YEARLY EARNINGS
A Comparison of Studies

High School Vocational Education

Post 1983 Studies

Methodology

Kang/Bishop (1986)	1981
Women: Business	$1674 (40%)
Trade & Tech.	$ 262 (6%)
Other	$ 882 (22%)
Men: Business	$-192 (-3%)
Trade & Tech.	$1472 (21%)
Other	$2488 (36%)

Campbell et al (1986)	
NLS-1983	$ 933 (17%)
HSB-1983	--- (27%)

Pre-1983 Studies

Meyer (1982)	Avg 73-79	1973
Women: Business	$ 410 (16%)	$ 426
Tech.	$ -72 (-2%)	$ -37
Home Economics	$-248 (-5%)	$ 118
Men: Business	$ 106 (1%)	$ 86
Trade & Ind.	$ 201 (3%)	$ 493
Other Tech.	$ 94 (1%)	$ 491

Methodology

Rumberger/Daymont (1982)		1979
Women	---	(8%)
Men	---	(10%)

CETA Classroom Training

Comparison Group

Bassi et al	
Young Women	$-302
Young Men	$-874
Dickinson et al	
Young Women	$ 117
Young Men	$-565

Supported Work Demonstration

Control Group Methodology

Fraker/Maynard	
Disadv. Youth	$ -18
Women on Welfare	$ 351

Job Corps

Comparison Group

Maller et al.	
First Year	$ 515
Second Year	$ 667
Third Year	$ 652
Fourth Year	$ 787

The Kang/Bishop estimates are based on the quadratic model and assume the individual goes from zero to 4 vocational courses and reduces academic courses from 12 to 8, with the reduction occurring in the following subjects: math, foreign language, science, and social science. The other category of vocational courses in Kang/Bishop includes home economics and exploratory vocational courses. Campbell et al. (1986, 1987) results are a weighted average for all three patterns of participation that combine those who found training related jobs with those who did not. Meyer (1982) and Rumberger/Daymont (1982) results are calculated by multiplying the coefficient on the proportion of courses that is vocational by .33. The CETA estimates are taken from Barnow's (1987, Table 3) review of the literature and are a simple average of results for white and minority youth. The Supported Work result is from Table 5 of Fraker/Maynard (1987). The Job Corps estimate includes both civilian and military jobs and uses non-linear time trends (Maller et al. 1982 p. ix). The estimated effects are reported in current dollars. The dates reported are the year of the earnings data. Since the studies analyze data from different years, comparisons between studies may be influenced by differences in the general level of wages.

Table 12
ASSESSMENTS OF CAREER UTILITY, CHALLENGE AND DIFFICULTY OF HIGH SCHOOL COURSES TAKEN BY SOPHOMORES FALL 1987

COURSE (Percent taking)	Career Utility Very Useful	No use	Challenge A lot	Never	Difficulty Very Diffic.	Very Easy	No Homework
Science (88%)	28%	23%	51%	6%	16%	20%	9%
Math (95%)	47	13	55	7	19	23	8
English (98%)	53	9	36	10	9	31	13
Social Stud.(68%)	18	27	32	9	11	33	11
For. Lang. (51%)	21	22	42	8	14	28	6
Bus/Vocat. (54%)	58	10	34	16	6	54	60
Computer (9%)	53	6	35	10	12	34	42

Source: Longitudinal Survey of American Youth, 10th Grade Fall 1987, The questions were worded as follows: "How useful do you think the course will be to you in your career?", "How much does the ____ course challenge you to use your mind?", "How difficult or easy is the ____ course for you?" and "How many hours of homework do you have for this class in an average week?"

ENDNOTES

1. If hiring selections are based entirely on X variables included in the model, unstandardized coefficients are unbiased and simple correction formulas are available for calculating standardized coefficients and validities. Unfortunately, in the civilian sector incidental selection based on unobservables such as interview performance and recommendations is very probable (Thorndike 1949; Olson and Becker 1983; Mueser and Maloney 1987). Consequently, in a sample of accepted applicants for a civilian job, one cannot be confident that these omitted unobservable variables are uncorrelated with the included variables that were used to make initial hiring decisions and, therefore, that coefficients on included variables are unbiased.

2. Because of the concurrent design, the control variables may have been influenced by army experiences so M2 results exaggerate the impact of the new cognitive and non-cognitive variables and underestimate the effect of the ASVAB composites. A validation study using a prospective design confirms this. In longitudinal data where predictor constructs were measured early in the individual's first tour prior to measurement of the criterion constructs, multiple partial Rs are considerably higher for ASVAB composites and other cognitive variables but considerably lower for the dependability and achievement/surgency temperament constructs (Oppler and Peterson 1992).

3. The 500,000 members of the NFIB were stratified by employment and large firms over sampled. Salaried managers in charge of subunits of large publicly owned corporations are not eligible for membership in NFIB, so the sample does not contain data on employment outcomes at large multi-establishment firms. Business owners with no employees in the previous year or who had not hired anyone in the last three years, were asked to check a box and send the questionnaire back completely blank. Five hundred and sixty nine of the returned questionnaires were of this type.

4. In 1985 the mean full time compensation of operatives, craft workers and technicians was approximately $25,000 a year. Studies that measure output for different workers in the same job at the same firm, using physical output as a criterion, can be manipulated to produce estimates of the standard deviation of non-transitory output variation across individuals. It averages about .14 in operative jobs, .28 in craft jobs, .34 in technician jobs, .164 in routine clerical jobs and .278 in clerical jobs with decision making responsibilities (Hunter, Schmidt & Judiesch 1988). Because there are fixed costs to employing an individual (facilities, equipment, light, heat and overhead functions such as hiring and payrolling), the coefficient of variation of marginal products of individuals is assumed to be 1.5 times the coefficient of variation of productivity. Because about 2/3rds of clerical jobs can be classified as routine, the coefficient of variation of marginal productivity for clerical jobs is 30 % [1.5*(.33*.278+.67*.164)]. Averaging operative jobs in with craft and technical jobs produces a similar 30% figure for blue collar jobs. The details and rationale of these calculations are explained in Bishop 1988b.

5. According to the National Assessment of Educational Progress (1988), 93 percent of 17 year olds do not have "the capacity to apply mathematical operations in a variety of problem settings (p. 42)." "In persuasive writing, students had difficulty providing evidence for their points of view....Even in 11th grade, only 28 percent wrote **adequate** or **elaborated** responses to the least difficult persuasive task (1986, p. 9). The 25 percent of the Canadian 18 year olds studying chemistry know as much chemistry as the top 1 percent of American high school graduates taking their second year of chemistry, most of whom are in Advanced Placement classes (International Association for the Evaluation of Educational Achievement, 1988).

Appendix A

Reproduction of Excerpts from
Counselor's Manual for the Armed Services
Vocational Aptitude Battery

Form 14

COUNSELOR'S MANUAL FOR THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY FORM 14

JULY 1984

DoD 1304.12X

Purposes

he ASVAB is a multiple aptitude battery designed for use with students in ırades 11 and 12 and in postsecondary schools. The test was developed to yield :sults that are useful to both schools and the military. Schools use ASVAB test :sults to provide educational and career counseling for students. The military :rvices use the results to identify students who potentially qualify for entry into ıe military and for assignment to military occupational training programs.

.ike other multiple aptitude batteries, the ASVAB measures developed abilities nd predicts what a person could accomplish with training or further education. 'his test is designed especially to measure potential for occupations that require ormal courses of instruction or on-the-job training. In addition, it provides neasures of general learning ability that are useful for predicting performance in .cademic areas.

The ASVAB can be used for both military and civilian career counseling. Scores rom this test are valid predictors of success in training programs for enlisted nilitary occupations. Through the use of validity generalization techniques, predictions from military validity studies can be generalized to occupations that span most of the civilian occupational spectrum. Although some enlisted occupations are military specific, more than 80% of these occupations have direct civilian occupational counterparts.

Since the ASVAB was first used in high schools in 1968, it has been the subject of extensive research and has been updated periodically. Appendix A contains a brief history of the ASVAB and the various forms that have been used.

Key Features

ASVAB-14, introduced in the 1984-85 school year, contains several key features that were not included in previous forms. These key features include

- **improved usefulness in measuring vocational aptitudes:** In addition to yielding *academic composites* that provide measures of academic potential, ASVAB-14 supplies *occupational composites* that provide measures of potential for successful performance in four general career areas.
- **increased reliability:** Changes in the length and number of subtests have increased the test's reliability without a substantial increase in testing time.
- **nationally representative norms:** ASVAB-14 is normed on a nationally representative sample of 12,000 women and men, ages 16-23, who took the test in 1980.

Content

Subtests

The ASVAB consists of 10 subtests. Eight are power subtests that allow maximum performance with generous time limits. Two subtests are speeded.

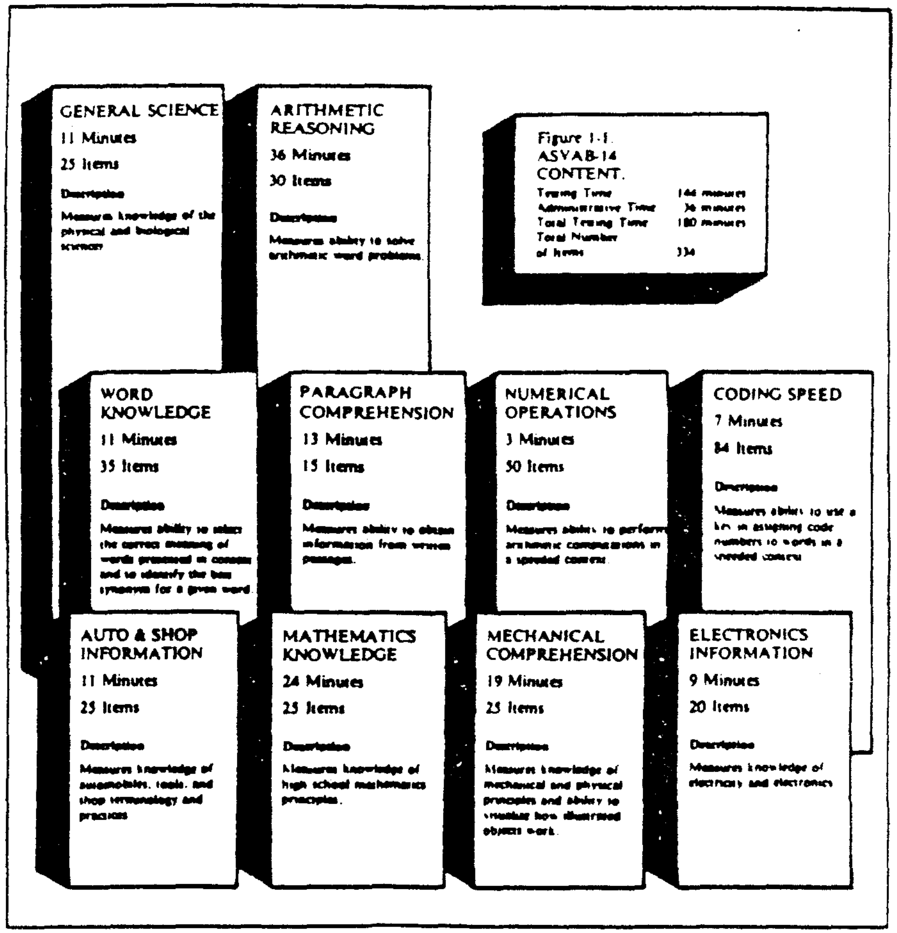
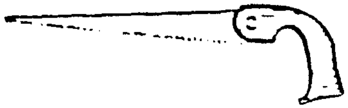


Figure 1-1. ASVAB-14 CONTENT.

Auto & Shop Information

25. A car uses too much oil when which parts are worn?

25-A pistons
25-B piston rings
25-C main bearings
25-D connecting rods



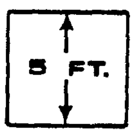
26. The saw shown above is used mainly to cut

26-A plywood
26-B odd-shaped holes in wood
26-C along the grain of the wood
26-D across the grain of the wood

Mathematics Knowledge

7. If x + 6 = 7, then x is equal to

27-A 0
27-B 1
27-C -1
27-D 7/6



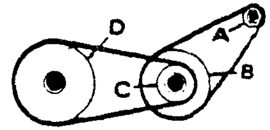
28. What is the area of this square?

28-A 1 square foot
28-B 5 square feet
28-C 10 square feet
28-D 25 square feet

Mechanical Comprehension

29. Which post holds up the greater part of the load?

29-A post A
29-B post B
29-C both equal
20-D not clear



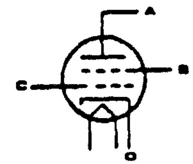
30. In this arrangement of pulleys, which pulley turns fastest?

30-A A
30-B B
30-C C
30-D D

Electronics Information

31. Which of the following has the least resistance?

31-A wood
31-B iron
31-C rubber
31-D silver



32. In the schematic vacuum tube illustrated, the cathode is element

32-A A
32-B B
32-C C
32-D D

Key To The Sample Test Items

1.	B	17.	B
2.	D	18.	A
3.	B	19.	C
4.	C	20.	D
5.	C	21.	E
6.	D	22.	E
7.	D	23.	C
8.	C	24.	B
9.	C	25.	B
10.	B	26.	B
11.	A	27.	B
12.	C	28.	D
13.	D	29.	A
14.	D	30.	A
15.	B	31.	D
16.	E	32.	D

General Science

1. **An eclipse of the sun throws the shadow of the**
   - 1-A moon on the sun
   - 1-B moon on the earth.
   - 1-C earth on the sun
   - 1-D earth on the moon

2. **Substances which hasten chemical reaction time without themselves undergoing change are called**
   - 2-A buffers.
   - 2-B colloids
   - 2-C reducers.
   - 2-D catalysts.

Arithmetic Reasoning

3. **How many 36-passenger busses will it take to carry 144 people?**
   - 3-A 3
   - 3-B 4
   - 3-C 5
   - 3-D 6

4. **It costs $0.50 per square yard to waterproof canvas. What will it cost to waterproof a canvas truck cover that is 15′ x 24′?**
   - 4-A $ 6.67
   - 4-B $ 18.00
   - 4-C $ 20.00
   - 4-D $180.00

Word Knowledge

5. **The wind is <u>variable</u> today.**
   - 5-A mild
   - 5-B steady
   - 5-C shifting
   - 5-D chilling

6. **<u>Rudiments</u> most nearly means**
   - 6-A politics.
   - 6-B minute details.
   - 6-C promotion opportunities.
   - 6-D basic methods and procedures.

[illegible] **hold burglaries can be attributed to unlocked windows or doors. Crime is the result of opportunity plus desire. To prevent crime, it is each individual's responsibility to**
   - 7-A provide the desire.
   - 7-B provide the opportunity
   - 7-C prevent the desire.
   - 7-D prevent the opportunity

[illegible] **that every attempt is made to conserve it. For instance, on one oasis in the Sahara Desert the amount of water necessary for each date palm tree has been carefully determined.**

How much water is each tree given?
   - 8-A no water at all
   - 8-B water on alternate days
   - 8-C exactly the amount required
   - 8-D water only if it is healthy

Numerical Operations

9. **3 + 9 =**
   - 9-A 3
   - 9-B 6
   - 9-C 12
   - 9-D 13

10. **60 ÷ 15 =**
   - 10-A 3
   - 10-B 4
   - 10-C 5
   - 10-D 6

Coding Speed

KEY

bargain 8385	house 2859	owner 6227
chin 8930	knife 7150	point 4703
game 6456	music 1117	sofa 9645
	sunshine 7489	

QUESTIONS	A	B	C	D	E
11 game	6456	7150	8385	8930	9645
12. knife	1117	6456	7150	7489	8385
13 bargain	2859	6227	7489	8385	9645
14 chin	2859	4703	8385	8930	9645
15. house	1117	2859	6227	7150	7489
16 sofa	7150	7489	8385	8930	9645
17. owner	4703	6227	6456	7150	8930

	A	B	C	D	E
18 music	1117	2859	7489	8385	9645
19 knife	6227	6456	7150	7489	8485
20 sunshine	4703	6227	6456	7489	8930
21 chin	1117	2859	4703	7150	8930
22. sofa	4703	6227	7150	8485	9645
23. bargain	2859	6456	8385	8930	9645
24 point	1117	4703	6227	6456	7150