EDUCATIONAL REFORM AND TECHNICAL EDUCATION?

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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]

<u>Success in Training</u>

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:

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

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