Occupational Competency As A Predictor of Labor Market Performance

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John Bishop

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John Bishop
Cornell University
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Center for Advanced Human Resource Studies
New York State School of Industrial and Labor Relations
Cornell University
Ithaca, New York 14851-0925
607-255-2742

Former Associate Director: Research
The National Center for Research in Vocational Education

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OCCUPATIONAL COMPETENCY AS A PREDICTOR OF LABOR MARKET PERFORMANCE

Executive Summary

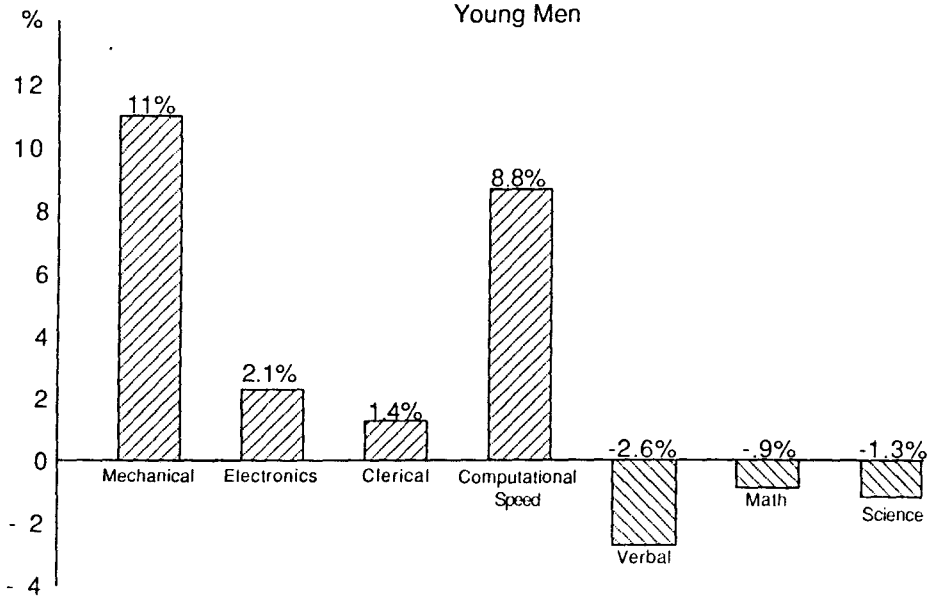
The paper examines the suitability of occupational competency measurement as a device for enhancing the accountability of vocational education programs.

In order for occupational competency tests to be used as program performance measures, they must be demonstrated to be valid predictors of labor market outcomes like earnings and wage rates and of job performance in appropriate occupations. The paper undertakes this task.

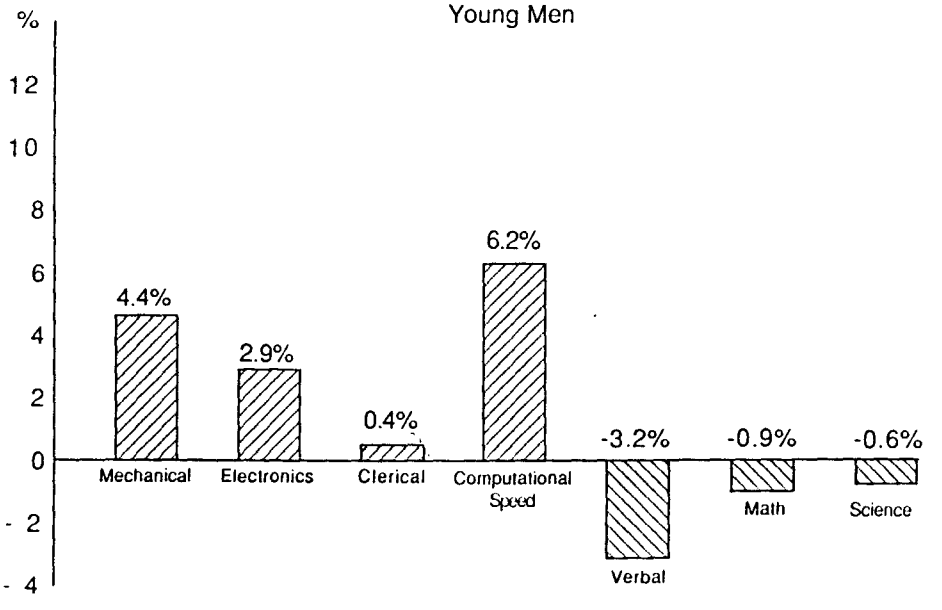
The first section of the paper analyzes the ability of the trade and technical subtests of the Armed Services Vocational Aptitude Battery, or ASVAB to predict short and intermediate term labor market outcomes such as wage rates and earnings of the National Longitudinal Survey's Youth Cohort. Representative findings from this analysis are presented in Figure 1-4. The trade and technical subtests of the ASVAB have very large effects on the wage rates and earnings of young men but have essentially no effects on the wages and earnings of young women. These effects are at least as large 6 years after taking the test as they were in 1980 when the test was taken. The second section of the paper (which is excerpted from another paper titled "The productivity consequences of what is learned in high school") presents evidence that the generic trade and technical competencies measured by the ASVAB also have major impacts on worker productivity in a broad family of military jobs involving the operation, maintenance and repair of complicated machinery and other technically oriented jobs. Since 80 percent of military jobs have close counterparts in the civilian sector, these findings imply that the trade and technical competencies measured by the ASVAB are also highly valid predictors of job performance in most blue collar and craft occupations.

The third section of the paper explores the impact of student participation in vocational education on gains in these generic vocational and academic competencies measured by the ASVAB. The results of this exploratory analysis appear to suggest that the effects of participation in vocational education on these generic skills are small. It appears that most of the effects of vocational education on labor market success do not operate through the generic technical knowledge and skills that the ASVAB subtests measure. This finding is consistent with previous research which has shown that their are

Effect of Competencies
on Earnings, 1984-1985
Young Men

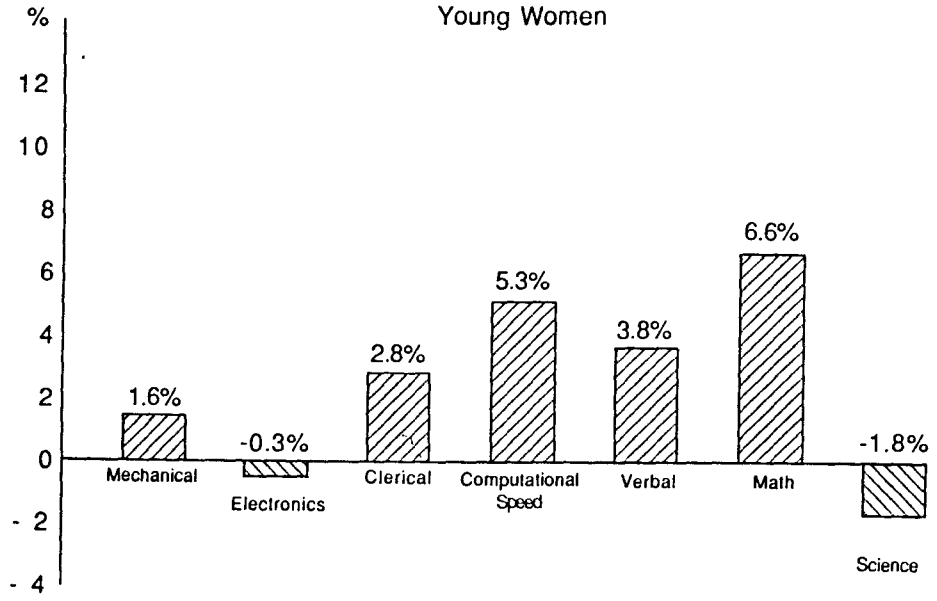


Effect of Competencies
on Wage Rates, 1983-1986
Young Men

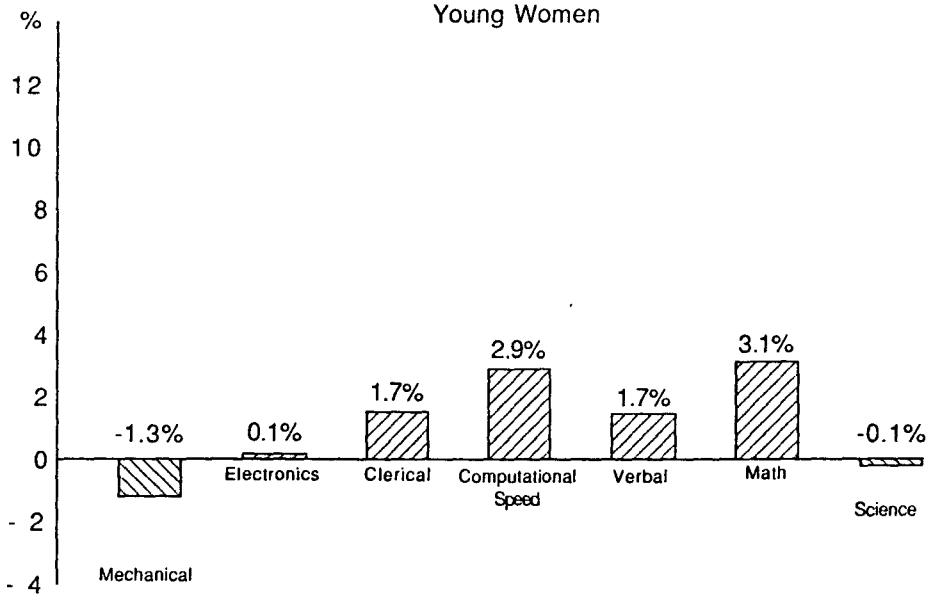


Source: Analysis of NLS Youth data. The figure reports the effect of a one population standard deviation increase in Armed Services Vocational Aptitude Battery subtest while controlling for schooling, school attendance, age, work experience, region, SMSA residence and ethnicity.

Effect of Competencies
on Earnings, 1984-1985
Young Women



Effect of Competencies
on Wage Rates, 1983-1986
Young Women



Source: Analysis of NLS Youth data. The figure reports the effect of a one population standard deviation increase in Armed Services Vocational Aptitude Battery subtest while controlling for schooling, school attendance, age, work experience, region, SMSA residence and ethnicity.

significant economic benefits to vocational education when a student obtains a training related job but essentially no benefits to vocational education if the student does not work in the field studied. Trade and industrial education raises the earnings of its graduates by teaching them skills in a particular occupational cluster and then placing them in one of those occupations. The universe of vocational/technical knowledge being sampled by the mechanical comprehension, auto and shop information and electronics subtests of the ASVAB is much boarder than the objectives of particular trade and technical programs. The result is that even when a program does a good job of teaching the knowledge and skills necessary for its cluster of occupations, it has a much more modest impact on the types of generic technical knowledge that are measured by the ASVAB composites.

Consequently, ASVAB subtests could never be used as the sole or primary indicator of the success of specific vocational programs. The subtests are much too short and superficial to be used as the sole indicator of occupational programs effectiveness. The three subtests combined contain a total of 70 ~~paper and pencil type~~ multiple choice items that are answered in a 39 minute time frame. It might be used, however, in conjunction with more focused assessment instruments developed for particular occupations. For students in the fields of trades and industry and technical occupations, the ASVAB subtests (or specially designed tests similar to them) might be used as indicators of a student's overall competence in the technical arena and as such might provide a way of recognizing which programs do the best job of teaching skills that are useful in a wide variety of mechanical and technical occupations.

The final section of the paper examines the validity and availability of occupationally specific competency tests that can be taken by vocational program completers in secondary and post secondary settings. 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. When occupational competency tests appropriate for the job compete with academic ability tests in predicting job performance measured either by supervisory ratings or actual work samples, the occupational competency tests have about twice as large an effect as ability tests (Hunter, 1983). Since large improvements in job knowledge appear 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 desireable if the student is likely to put the knowledge to use by working in the occupation.

Comprehensive systems of occupational competency testing are now available from a variety of sources: the National Occupational Competency Testing Institute (NOCTI), the Instructional Materials Laboratory at Ohio State University, the New York State Education Department, the Vocational Technical Consortium of States (V-TECS), and the American Association for Vocational Instructional Materials (AAVIM) in Athens, Georgia. Oklahoma is currently validating a set of competency tests keyed to the objectives of its competency based curriculum guides. The great numbers of vendors supplying competency tests means that a federal mandate that states test the competency of their students would not prejudge the issue of what should be taught. Two of the competency testing programs--NOCTI and Oklahoma-- offer inexpensive hands-on-performance tests as one element of their competency testing system.

The state of Pennsylvania has established a **Pennsylvania Skills Certificate** which students may earn by passing both the written and hands-on components of the NOCTI Competency Exams. This certificate program has already stimulated changes in the curriculum. In the first year of testing, students did not do very well on the competency tests for clerical occupations. When causes of the deficiency were examined, it was discovered that the problem was not with the test but the curriculum which had become poorly aligned with current employer needs. The result has been a revision of the office education curriculum. The Pennsylvania's Skills Certificate is an excellent program and federal policy should endeavor to encourage other states to develop similar programs.

The major barrier to implementing performance measurement in vocational education and in other programs has been the unreliability and inappropriateness of the performance measures currently available. Training-related placement rates, currently reported to state departments of vocational education, are not comparable across districts and programs, are subject to manipulation, and suffer from serious nonresponse problems. Tests of generic and specific occupational competency avoid these problems: they are comparable across districts, manipulation can be prevented by developing alternate versions of the test and nonresponse can be easily minimized by making the test a part of the student's final grade in the course. Labor market outcome measures are influenced by environmental factors such as the state of the local economy which educators have no control over; competency test scores are not. The tests are cheap to administer. NOCTI charges only $8.95-$9.50 to supply and score its paper-and pencil exam and the costs of consumable materials for the hands-on performance test are only about $6.00 on average.

There is always a danger that accountability systems based on outcomes will exacerbate existing incentives to cream the eligible population.[8] This can be overcome by devising indicators of program performance which take into account the educational background of the students ~~in a program when~~ at the time they entered vocational education and by offering additional recognition (or larger reimbursements) for success with more challenging students -- the handicapped and those with low test scores or poor marks in junior high school.

One of the major benefits of using occupational competency testing to evaluate programs is the diagnostic information that analysis of the test results for individual performance objectives gives teachers and curriculum developers. When accountability systems based on training related placement rates and/or earnings gains (estimated from UI wage record data) signal that an individual program is performing poorly, they do not offer program operators a diagnosis of what is wrong. If placement rates are low, the natural tendency is to redouble placement efforts. While high school vocational education should increase its emphasis on placement into high wage jobs, there is a danger of overdoing this emphasis. If labor market outcomes are the only performance indicators, the placement director may be the only one made "accountable" by the system. The labor market is not so efficient that programs that do a poor job of teaching will inevitably find it impossible to place their graduates in training-related jobs. It would, therefore, appear desireable for occupational competency testing to be a component of state accountability system for vocational education.

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OCCUPATIONAL COMPETENCY AS A PREDICTOR OF LABOR MARKET PERFORMANCE

Vocational education programs funded under the Carl D. Perkins Act must demonstrate compliance with Federal mandates for program participation: target groups such as the physically handicapped and the economically disadvantaged must be served equitably. However, these programs currently are not assessed for their outcomes: funding is not contingent on evidence that program completers fare better in the job market than other students, or that program completers have acquired skills that are clearly linked to subsequent productivity. Because of the success with these types of outcome-based performance measures in other Federal grant-in-aid programs (such as the Job Training Partnership Act), Congress is now interested in possible methods of assessing high school vocational programs in terms of their impact on the earnings and employment experiences of graduates and on their competency and productivity on the job.

Performance measures that link high school course work to subsequent labor market experience and worker productivity are based implicitly on a human capital model: knowledge and skills gained in school are assumed to influence productivity, earnings and employment. However, other factors besides educational achievement may also be significant: for example, completion of a particular high school curriculum, and/or an individual's nonschool experiences, may provide signals to employers of that person's likely future productivity, regardless of his or her specific occupational competency. The question addressed by this paper is whether occupational knowledge is a reliable predictor of intermediate and long term labor market performance and whether tests are available which provide valid measures of occupational competency.

The paper begins by examining a specific battery of vocational and academic competency tests (the Armed Services Vocational Aptitude Battery, or ASVAB) and its ability to predict short and intermediate term labor market outcomes such as wage rates and earnings of the National Longitudinal Survey's Youth Cohort. The second section of the paper (which is excerpted from another paper titled "The productivity consequences of what is learned in high school") examines the impact of the various competencies measured by the ASVAB on job performance in military jobs which closely correspond to civilian jobs. The third section of the paper explores the impact of student participation in vocational education on gains in vocational and academic competency. The final section of the paper examines the current

availability of occupational competency tests that can be taken by vocational program completers in secondary and post secondary settings and the appropriateness of these tests for performance measurement in vocational education.

I. HOW WELL DOES THE LABOR MARKET REWARD THE VOCATIONAL COMPETENCIES MEASURED BY THE ASVAB?

The first task of the study is to determine to what degree the vocational competencies taught by high school vocational programs are rewarded by the labor market. This is accomplished by estimating models predicting the earnings, wage rate and unemployment as a function of competence in various vocational/technical fields while controlling for competence in the academic fields of mathematics, science and language arts, years of schooling, school attendance, ethnicity, age, work experience, marital status and characteristics of the local labor market.

1.1 DATA

The data set for this analysis is the Youth Cohort of National Longitudinal Survey (NLS)--all eight waves from 1979 to 1986. The measures of vocational and academic competence used in the study are derived from the Armed Services Vocational Aptitude Battery (ASVAB), a three hour battery of tests used by the armed forces for selecting recruits and assigning them to occupational specialties. The primary purpose of the ASVAB is to predict the success of new recruits in training and their subsequent performance in their occupational specialty. Its ability to accomplish these objectives has been thoroughly researched and the battery has been periodically modified to incorporate the findings of this research. The ASVAB Manual reports:

> Extensive research demonstrates that the ASVAB composites used in military selection and classification predict performance in training for a variety of military occupations. (Booth-Kewley, 1983; Maier & Truss, 1983; Rossmeissl, Martin & Wing, 1983; Wilbourn, Valentine, & Ree, 1984). For example, validity coefficients for electrical/mechanical equipment repair specialties range from .36 to .74; those for communication specialties range from .36 to .52; those for data processing specialties range from .39 to ,77; and those for clerical and supply specialties range from .53 to .73. These coefficients have been corrected for restriction of range.[1]

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 generalizes quite well to the civilian sector (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)

During the summer of 1980 all members of the NLS Youth sample were asked to take this test and offered a $50 honorarium as an inducement. The tests were successfully administered to 94 percent of the sample. Testing was generally conducted in groups of 5 to 10 persons. The 1980 version of the ASVAB (Form 8A) was administered by staff of the National Opinion Research Corporation according to strict guidelines conforming to standard ASVAB procedures. The Department of Defense which funded this project had Dr. R. D. Bock an authority on educational and psychological testing evaluate the quality of the resulting ASVAB data. He concluded:

> Data from responses of [the NLS Youth Sample] to the ASVAB are free from major defects such as high levels of guessing or carelessness, inappropriate levels of difficulty, cultural test-question bias, and inconsistencies in test administration procedures.[2]

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, Mathematic 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 C.

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 so these subtests are interpreted as indicators of competence in these areas. Appendicies D, E and F provide descriptions of the occupation specific competency examinations (together with sample questions) that have been

developed by the National Occupational Competency Testing Institute and by the states of Ohio and New York to assess the performance of their high school vocational students. By comparing the items included in these specially developed paper and pencil occupational knowledge tests with ASVAB items, it is possible to get a feel for how much overlap there is between the two types of tests. The difference between the tests appears to lie not in the nature of the items but rather in their difficulty and in the breadth of the occupational knowledge universe from which they are drawn. The vocational achievement exams designed for high school students assume the student has studied a particular occupational cluster in some depth under the tutelage of a teacher following the state's curriculum guide for the occupational cluster. The questions consequently ask for more detailed knowledge but from a narrower domain. The ASVAB items are from a broader domain than competency tests for individual occupations and individual items appear to be somewhat more generic. Consequently, the ASVAB subtests should be viewed as measures of knowledge, trainability and generic competence for a broad family of jobs involving the operation, maintenance and repair of complicated machinery and other technically oriented jobs. They do not measure competence in particular occupations like machinist or carpenter.

The analysis enters the electronics subtest and a composite of the mechanical comprehension and auto and shop knowledge subtests separately into the equation. This makes possible comparisons of the effects of the two competencies. Since the electronics subtest is much shorter than the other two tests in combination, it is likely to be a less reliable measure of the true competency in its area. This implies that even if the true impacts of the two competencies are equal the coefficient on the electronics test is likely to be smaller than the coefficients on the mechanical composite.

Competencies that are unique to clerical and retail sales jobs do not appear to be measured by the ASVAB. The ASVAB does contain a speeded clerical checking subtest which is intended for this purpose but validity studies of clerical jobs in the military have found that it does not add to the validity of composites based on verbal, arithmetic reasoning and mathematics knowledge subtests (Wise, Rossmeissl and Oppler, 1987). The clerical checking subtest is included in the analysis but it should not be viewed as a valid predictor of clerical competency.

Two dimensions of mathematical achievement are measured: the speed of doing mathematical computations is measured by the numerical operations subtest and mathematical reasoning ability is measured by a composite of the mathematics knowledge and arithmetic reasoning subtests. Science achievement is indexed by the general science subtest. Verbal achievement is measured by a composite made up of the word knowledge and paragraph comprehension subtests. These seven test composites have all been normalized to have zero mean and unit variance.

Four measures of labor market success are being studied: the log of the hourly wage rate in the current or most recent job, the log of calender 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 calender year).

An extensive set of controls are 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 (EXP_{it}) was derived for January 1 of each year in the longitudinal file. This variable and its square is included in every model as is age and its square. School attendance is controlled by four separate variables. The first variable indicates whether the youth is in school at the time of the interview. The second is a dummy variable indicating whether the youth has been in school since the last interview. The third is a dummy variable indicating whether the student is attending school part time. A positive coefficient is expected on this variable when the other controls for school attendance are entered in the model. The fourth variable is a measure of the share of the calender year that the youth reported attending school derived from the NLS's monthly time log. Years of schooling is 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. Minority status is controlled by a dummy variables for Hispanic and for race. Characteristics of the local labor market 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.

1.2 HYPOTHESES AND ECONOMETRIC SPECIFICATION OF THE MODEL

The objective of the paper is to determine whether the vocational subtests of the ASVAB and by extension other similar paper and pencil tests of generic occupational knowledge are valid early indicators of a youth's short and intermediate term labor market success. This overall objective will be accomplished by testing a series of hypotheses relating to the impact of ASVAB subtest scores on wages, earnings and unemployment. For each hypothesis relating to the three vocational subtests, there is a corresponding hypothesis regarding the impact of the academic subtests. These hypotheses are specified and discussed below.

Main Effects of Test Scores

Hyp. V1: Subtests measuring generic vocational knowledge have positive effects on wage rates and earnings and negative effects on unemployment. Gender is likely to effect which tests are significant predictors of labor market success.

The primary reason for expecting tests of generic vocational knowledge to have positive effects on labor market success is the demonstrated positive effect of vocational course taking on labor market success when the student obtains a job which uses the skills learned in school (Bishop 1988) and the positive effect of content valid job knowledge test scores on supervisory ratings of job performance and work sample measures of worker productivity (Hunter 1983). Since vocational skills appear to payoff only when they are used, the returns to vocational skills are likely to be gender specific. Very few young men work in clerical jobs so the clerical checking subtest is not likely to a very useful predictor of wages and earnings for men. Very few young women have jobs for which knowledge of electronics, mechanical principles, auto mechanics and shop tools are essential, so the electronics and mechanical subtests are not likely to be good predictors of wages and earnings for women.

Hyp. A1: Subtests measuring academic competencies have small and sometimes negative effects on wage rate and earnings in the years immediately following high school graduation.

The reason for expecting the academic subtests to have small and possibly negative effects on labor market success is that analyses of other data sets such as High School and Beyond and NLS Class of 1972 have typically found that academic achievement test scores have small effects on early labor market success (Kang and Bishop 1986; Bishop, Blakemore and Low 1986, Meyer 1982).

One of the reasons this occurs is that vocational skills are more visible to employers than academic skills. Technical skills are easier to assess informally in the interview. Vocational teachers often help their students get jobs and in the process vouch for their competence. In contrast. most employers have little knowledge of job applicants' competence in math, science and reading. A survey of a stratified random sample of 2000 small and medium sized employers who are members of the National Federation of Independent Business found, for example, that aptitude tests had been given to only 3.2 percent of the new hires at these firms and high school transcripts had been obtained for only 13.7 percent of the new hires who had 12 or fewer years of schooling. As a result, the technical skills measured by the electronics, mechanical comprehension and auto and shop knowledge subtests may be better rewarded in the labor market than competence in math and science. These hypotheses are first tested in a model in which the various vocational and academic competencies are assumed to have linear and additive effects on labor market outcomes:

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

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

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

$\underline{V}$ is a vector of test scores measuring competence in three areas: (a) mechanical, auto and shop knowledge, (b) electronics and (c) clerical checking speed.

$\underline{Z}_t$ is a vector of control variables such as age, work experience, schooling, school attendance, region, residence in an SMSA and local unemployment rate, and

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

The rest of the hypotheses to be tested relate to changes over time in the impact of vocational and academic competencies.

Calender Time Interactions

hyp V2: The vocational subtests (which were taken at the end of 1980) should have smaller effects on labor market success in 1985/86 than in 1980/1981. This tendency for the impact of vocational tests to diminish with calender time should occur even when the age of the workers is held constant.

hyp A2: Holding the age of the worker constant, the academic subtests should have smaller effects on labor market success in 1985/86 than in 1980/81.

The first reason for expecting the effect of vocational and academic test scores to diminish with calender time is that competencies and knowledge change over time. The longer the time interval between taking a test and the point at which labor market outcomes are measured, the greater the opportunity for major changes in competencies and the less reliable the early test is as a measure of the individual's current competency level. This decline in reliability should lower the estimated coefficient on the test score. Counteracting this effect, is the possibility of secular trends or cyclical changes in the market return to vocational and academic skills. The payoff to vocational course work appears to be greater in the 1980s than in the 1970s (Bishop, 1988) and this suggests that the return to the vocational competencies measured by the ASVAB subtests may be growing as well. The payoff to years of schooling is also higher in the 1980s than in the 1970s suggesting that the return to academic competencies may also be rising.

To test these hypotheses a composite of the vocational subtests (TV) and a composite of the academic subtests (TA) were defined and then interacted with age deviated from 22, with actual work experience deviated from four years, with years of college and with current status as a student.

$$(2)\ \underline{Y_t} = \underline{a_t A} + \underline{b_t V} + c_t TA + d_t TV + \underline{g_t Z_t} + \underline{u_t}$$

where $c_t = c_{1t}(Age_t\text{-}22) + c_{2t}(Exp_t\text{-}4) + c_{3t}(Student_t) + c_{4t}(Yrs\ of\ College_t)$

$$d_t = d_{1t}(Age_t\text{-}22) + d_{2t}(Exp_t\text{-}4) + d_{3t}(Student_t)$$

Exp_t = Cumulated years of work experience since age 17 as of "t"

$Student_t$ = proportion of the calender year t attending school

When interactions are defined in this way, the main effects coefficients on the seven test scores ($\underline{a}_t$ and $\underline{b}_t$) provide estimates for year t of the effect of the competency on labor market outcomes of 22 year old high school graduates who have had 4 years of real work experience and are not currently students. The coefficients on the interaction of age and the test composites (c_{1t} and d_{1t}) provide estimates of the effect of age on the payoff to academic and vocational competencies while controlling on work experience, years of college and student status. The coefficients on the interaction of work experience with the test composites (c_{2t} and d_{2t}) provide estimates of the effect of work experience on the payoff to academic and vocational competencies while controlling on age and years of college.

Age and the Payoff to Vocational Competence

hyp V3: Holding calender year constant, the effect of vocational competency test scores on labor market success should be smaller for older workers and for workers with more than average work experience. $d_{1t} < 0$ and $d_{2t} < 0$.

The reason for expecting the effect of vocational competency tests to diminish as a worker ages is that most studies of the effect of course work have found that the large initial effects of vocational course work on wages and earnings diminish as the worker gets older (Meyer 1982; Kang and Bishop 1986). This is what one would expect if vocational courses serve as a signal of occupational competency but the signal has diminishing value as the individual gains post-school work experience. Meyer proposes an alternative explanation. He suggests that new hires who already have training in the occupation have less to learn so their performance and wages improve at a slower rate than the new hires who had no previous relevant training or experience. When, however, skill is defined by a generic occupational competency tests rather than by vocational courses taken, these explanations may not hold. When filling jobs that involve a great deal of on-the-job training, employers may give preference to job seekers who are already partially trained and who have demonstrated their ability to learn the skills required. If this is the way employers behave,

initial skill advantages may be magnified by a positive correlation with opportunities for further training on-the-job and initial rewards for occupational competency might grow with age.

Interactions with Student Status

The next set of hypotheses relate to the effect that being a student has on the payoff to academic and vocational competence. Students working during the summer or part time during the school year generally have a much narrower choice of occupations than young people who have completed their schooling. The high turnover rates and the necessity of scheduling work around school pushes students into occupations which tend not to give scope to the academic and vocational competencies measured by the ASVAB. This implies the following hypotheses:

hyp V4: The return to vocational competencies is less positive for students than for those who have completed their schooling. $d_3 < 0$.

hyp A3: The return to academic competencies is less positive for students than for those who have completed their schooling. $c_3 < 0$.

hyp A4: Among students, high academic competencies are associated with lower earnings.

Young people with strong academic competency are typically faster learners than their peers and are consequently more likely to devote 100 percent of their time to study (eg. attend a college where students to do a great deal of home work). Studies analyzing which students tend to devote the most time to jobs for pay have found that students with

low grades and academic test scores tend to work more than their peers who are doing better in school (Hotchkiss, Bishop and Gardner 1982).

Interactions with Years of College

Academic skills appear to be more critical to job performance in professional and managerial occupations than in blue collar and clerical occupations. This suggests the following hypothesis:

hyp A5: The return to academic competency is larger for college graduates than for high school graduates. $c_{4t} > 0$.

Analyses of the NBER/Thorndike data on men who were in the Air Force during World War II, supports this hypothesis but analyses of other data sets have been more equivocal (Taubman and Wales 1975; Hause 1975; Willis and Rosen 1979).

Age, Experience and the Payoff to Academic Competency

The final set of hypotheses relate to the effects of age and work experience on the return to academic competency.

hyp A6: The return to academic competency grows with the age of the worker. When $c_{2t} = 0$, $c_{1t} > 0$.

Numerous studies have found that the return to academic achievement increases with the age of the worker (Hauser and Daymont 1977; Taubman and Wales 1975). It is not clear, however, why this occurs. One possible explanation is that academic achievement may improve access to jobs offering considerable training and also enable the worker to get more out of the training. If this is the case, one would expect the payoff to academic skills to rise most rapidly for continuously employed workers. If the individual is not working, no such learning will occur, so the payoff to academic achievement will be unaffected by age if experience is controlled. This scenario implies the following hypothesis:

hyp A7: The return to academic competency grows with work experience but not with age when work experience is controlled. When both c_{1t} and c_{2t} are freely estimated, $c_{2t} > 0$ and c_{1t} is not significantly different from zero.

1.3 RESULTS

Main Effects of Test Scores

The results of estimating model 1 are presented in Table 1 through Table 4. Hypothesis V1 is strongly supported. For young men the ASVAB subtests measuring electronics knowledge and mechanical, auto and shop information have large and significant positive effects on wage rates and earnings and negative effects on unemployment. A one standard deviation increase in both of these test scores increases wage rates by 5.9 percent on average and increases log earnings by 13.1 percent on average. This is a very substantial return to achievement in these fields. These subtests had essentially no effect on the labor market success of young women.

The clerical checking subtest had weak positive effects on wage rates of young women and large significant effects on their earnings and unemployment. For young men, doing well on the clerical checking subtest appears to lower unemployment and increase earnings modestly but it has no effect on wage rates.

Hypotheses A1 is supported by the results for young men. Only computational speed has positive effects on labor market success of young men. The other three academic subtests have negative effects on wage rates and earnings and often positive effects on unemployment. In the log earnings models, 20 of 21 coefficients were negative. In the wage rate models, 23 of 24 coefficients were negative. In the unemployment models, 18 of 21 coefficients were positive and 6 were significantly positive at the 5 percent level.

For young women, hypothesis A1 appears to be rejected. Competence in mathematics computation and reasoning had substantial effects on wage rates and earnings of young women. In the wage rate models, 12 of 16 coefficients on the two math tests were significantly positive at the 10 percent level. In the log earnings models, 11 of 14 coefficients were statistically significant at the 5 percent level. A one standard deviation increase in both test scores increased wage rates by 5 to 8 percent and log earnings by about 10 percent.

These are substantial effects. Verbal test scores raised wage rates only 1 percent on average but they increased log earnings by 6.3 percent on average. On the other hand, science test scores had no effect on wage rates and earnings and none of the academic subtests had a consistent effect on the unemployment of young women.

Effects of Calender Time on the Return to Vocational and Academic Competencies

A glance at Tables 1-4 reveals that the passage of time does not appear to be causing the payoff to vocational skills to decrease as was hypothesized. If anything the payoff appears to be growing with the passage of time. However, comparisons of coefficients for 1980 and 1985 in these tables potentially confound four effects: the effect of calender time, the effects of the ageing of the sample, the effects of growing educational attainment and the effects of smaller proportions of the sample being in school. To separate all these influences on the payoff to academic and vocational competencies, it is necessary to examine estimation results for model 2 in which there are explicit interactions between test scores on the one hand and age, work experience, educational attainment and student status. The first model dealing with this problem allows the effect of vocational and academic competencies to depend on level of schooling, age and work experience but assumes that school attendance has no effect on the payoff to competence. The results of estimating model 2.1 with cross equation constraints on the interaction coefficients and c_3 and d_3 set equal to zero are presented in Tables 5 through 9. The estimation technique was seemingly unrelated regression. The second version of model 2 estimated allows the effects of vocational and academic competencies to depend on age, years of college completed and school attendance but not work experience. The results for model 2.2 are presented in Tables 10 through 15. Seemingly unrelated regression was also used to fit this model.

The results clearly contradict our hypotheses (V2 and A2) that when the age, work experience, educational attainment and school attendance of the sample is held constant that wage and earnings impacts of test scores would decline over time. With regard to trends over calender time in the effect of the subtest scores, findings from models 2.1 and 2.2 are essentially the same. For the mechanical/auto/shop knowledge subtest composite, there appears to be no trend in its effect on wage rates of young men and a substantial positive trend in its effects on their earnings. The effect of the electronics subtest on the wage rates of young

men is clearly higher in 1985/86 than in 1981/82. Its effects on earnings appears to be stable over time. The tendency of these two competencies to lower unemployment appears to have grown during the 1980s. The modest positive effect of clerical speed on the earnings of young men appears to have been stable over time. Its impact on male unemployment appears to depend on the business cycle, for it substantially reduced the risk of unemployment during the 1982/83 recession. The effects of clerical speed on the wage rates, earnings and unemployment of young women appears to have grown between 1981 and 1986. **The fact that the payoffs to vocational competency were stable or growing despite the passage of calender time suggests either that the competencies measured by these subtests are reasonably stable over time and/or that the payoff to these skills has been rising over time. These results suggest that the vocational subtests of the ASVAB are good indicators of labor market outcomes in both the short and intermediate term.**

When the age, work experience, educational attainment and school attendance of the sample is held constant, the estimated impacts of the academic subtests appear to be relatively stable over calender time for young men. For young women, the positive effects of the mathematics reasoning and computational speed on wage rates peaked during the 1982/83 recession. Their impacts on earnings appear to be quite stable. The impact of science is consistently negative and appears to be exhibiting no trend. During the 1982/83 recession, high verbal competency reduced the risk of unemployment. The overall effect of verbal competency on earnings appears to be diminishing over time.

Effect of Age and Work Experience on the Payoff to Vocational Skills

Since studies of the effects of course work on wages and earnings have typically found that the payoff to vocational courses tends to decline as time passes after graduating from high school, it was hypothesized (V3) that the payoff to the vocational competencies measured by the ASVAB subtests would decline with age as well. This hypothesis was tested by including interactions between a vocational test composite and age and work experience in the model and constraining the coefficients on these two variables to be equal across all 6 years, 1981 to 1986. The results of this test are presented in Table 9. An alternative way of specifying the interactions is to include an interaction between vocational test scores and student status but to drop the interaction between work experience and

vocational test score. These results are presented in table 14.

For young women, none of the coefficients on interactions of vocational competence with age or work experience are significantly different from zero in either of the two versions of model 2. For young men only one of the 12 coefficients on age or work experience are significantly different from zero at the 10 percent level. Interaction coefficients on age and work experience quite often have opposing signs. In the log earnings model there is a significant coefficient on the age interaction in model 2.1. This result is probably a chance result for the finding is not replicated in the equations predicting earnings in 1985 dollars nor in the age interaction coefficient of the second version of model 2. **These findings further support the earlier conclusion that the ASVAB's electronic, mechanical and auto/shop knowledge subtest scores are good short and intermediate term predictors of labor market success of recent high school graduates.**

Effect of School Attendance on the Payoff to Vocational and Academic Competencies

Being a student appears to have no consistent effect on the payoff to vocational competencies. In the wage rate models, coefficients on the interaction of student status with vocational test scores were not significantly different from zero. There is a statistically significant positive coefficient on the interaction variable in the log earnings equation for males but the coefficient on the same variable in the dollar earnings equations has the opposite sign. Consequently, no great significance should be attached to this result.

Being a student has no significant effects on the wage rate or unemployment effects of academic competency. This result suggests that while the opportunities for employment open to students are generally less attractive wage rates and unemployment are just as contingent on academic competency of students as they are for nonstudents. On the other hand, being a student has strong negative effects on the earnings payoff to academic competency. Hypothesis A4 is strongly supported. A one standard deviation increase in all four academic test scores raises earnings from 1981 to 1985 of 22 year old nonstudents by 5.5 percent for males and by 9.9 percent for women. If, however, the individuals are students the higher test scores are associated with lower earnings: 17 percent lower earnings for male students attending school year round and 10 percent lower earnings for females. It appears that students with high academic test scores choose to spend less time working in the labor

market than students with low academic test scores and that this occurs even after controls are introduced for school attendance (including a dummy for part-time attendance).

This very large negative interaction between academic competency and student status is part of the reason why the main effects of academic test scores were either small or negative in the estimations of model 1 and model 2.1. In the second version of model 2, the main effects coefficients on test scores are characterizing the return to vocational and academic competencies for nonstudents. The payoff to academic competencies for nonstudents is consistently more positive than the payoff for students and nonstudents combined.

Effect of Further Schooling on the Payoff to Academic Competencies

It was hypothesized (A5) that academic competencies would have a more positive effect on the wage rates and earnings of college graduates than of high school graduates. The best test of this hypothesis comes in model 2.2 which contains interactions between academic test scores and student status as well as interactions between test scores and age and years of college completed (see table 14). For young women, the hypothesis appears to be supported by the data. Academic competency has a bigger effect on the wage rates and earnings of young women with a college education than it has on the wages and earnings of women with a high school education. On the other hand, high test scores appear to have a smaller impact on the unemployment of college graduates than on the unemployment of high school graduates. This result appears to be caused by ceiling effects in the linear specification of the unemployment risk model for the main effects of test scores and schooling appear to be quite substantial.

The results are more mixed for males. Years of college has essentially no impact on the wage rate and unemployment impacts of academic test scores.
The earnings payoff to higher academic test scores appears to be significantly lower for college graduates than for high school graduates.

The Effect of Age and Work Experience on the Payoff to Academic Competency

Because it controls for the potentially confounding effects of student status, model 2.2 is the best model for examining the overall impact of age on the return to academic competencies. The findings regarding the effect of age are presented in the third column of

Table 14. The coefficients on the interaction of age with academic test scores are all positive in the wage and earnings regressions and three of them are significantly positive. For male high school graduates not in school, the effect of a one standard deviation higher academic test scores is a 1.7 percent reduction in earnings at age 18, a 5.5 percent increase in earnings at age 22 and a 12.7 increase in earnings at age 26. While the interaction coefficient is not statistically significant, the point estimate derived from estimating model 2.2 imply that for males the wage rate effect of a one SD academic test score differential is 2.0 percent at age 18, 3.7 percent at age 22 and 5.4 percent at age 26.

For female high school graduates who are not students, point estimates imply that a one SD academic test score differential raises earnings by 5.9 percent at age 18, by 9.9 percent at age 22 and by 13.9 percent at age 26. The coefficient on the age interaction with academic test scores is statistically significant in the female wage regression. It implies that a one SD increase in academic test scores lowers the wage rates of young women by 2.1 percent at age 18, increases them by 4.05 percent at age 22 and increases them by 10.2 percent at age 26. These results are consistent with the findings of other studies and clearly support the validity of hypothesis A6.

The final hypothesis, A7, addresses the reasons why the return to academic achievement increases with age. This issue is addressed in Table 9 where the results of estimating model 2.1 are presented. It had been hypothesized that when both age and work experience interactions are included simultaneously in the model that work experience would have a positive effect on the payoff to academic achievement and that age would have no effect. The results presented in columns 3 and 4 of Table 9 clearly contradict this hypothesis. When both interactions appear in the model, work experience has a negative effect on the payoff to academic achievement and age has an enlarged positive effect on the payoff. This would appear to be evidence against the "academic achievement increases the return to on-the-job training" explanation of the tendency of the payoff to academic achievement to rise with age.

Since the payoff to academic skills grows with age, the relative payoff to academic and vocational skills will shift as an individual ages. This implies that measures of the short term earnings impact of taking vocational rather than academic courses may (if gains in academic achievement are greater for nonvocational students) overstate the

intermediate and long run benefits of vocational education. Program managers cannot afford to wait 5 or 10 years for evaluations of their program. Consequently, there is a need for predictors of intermediate and long term labor market outcomes which can be obtained immediately at the end of the training program. Measures of competency in both the academic area and in vocational skills have been shown to be valid predictors of future labor market success. Consequently, efforts to measure the performance of vocational education programs should include among the list of performance indicators scores on academic and vocational tests like those contained in the ASVAB.

II. THE IMPACT OF VOCATIONAL COMPETENCIES ON JOB PERFORMANCE

[Excerpted from "The Productivity Consequences of What is Learned in High School"]

Employers are not well informed about the academic competencies of their job applicants. They seldom receive high school transcripts when they request them (only 14 percent of the NFIB sample obtained a high school transcript prior to making a hiring decision) and the transcripts seldom arrive in time to influence the hiring decision. Referrals from high school teachers are also uncommon (about 8 percent of the hires of people with fewer than 12 years of schooling in the NFIB sample) and employment aptitude tests are seldom administered (Bishop and Griffin 1989). Consequently, hiring selections and starting wage rates often do not reflect the competencies and abilities students have developed in school (Bishop 1987b). Instead, hiring decisions are based on easily observable characteristics (such as years of schooling and field of study) that serve as signals for the competencies the employer cannot observe directly. A study of how individual wage rates varied with initial job performance found that when people hired for the same or very similar jobs are compared, someone who is 20 % more productive than average is typically paid only 1.6 % more. After a year at a firm, better producers received only a 4% higher wage at nonunion firms with about 20 employees, and they had no wage advantage at unionized establishments with more than 100 employees or at nonunion establishments with more than 400 employees (Bishop, 1987a).

Employers structure their jobs this way because feasible measures of individual productivity are unreliable and unstable, because workers are reluctant to accept jobs in which the judgement of one supervisor can result in large wage declines and because pay that is highly contingent on performance can weaken cooperation and generate incentives to sabotage others. As a result, the increase in wage rates that results from a student improving his academic achievement is generally much smaller than the actual gain in productivity that results.

If, as seems to be the case, academic achievement is under-rewarded by the labor market, might vocational competencies also be under-rewarded? Or alternatively might the market over-reward vocational competencies? In other words, are the **productivity effects** of the ASVAB subtests measuring trade and technical competence **comparable to the large wage rate effects** that were found in the previous section of the paper? The fact that the

ASVAB subtests assessing electronics/mechanical/auto/shop knowledge are highly valid predictors of success in training for most military jobs might appear to imply that the productivity effects of these competencies are at least as large as the wage rate effects. Since, however, training success is measured by another paper and pencil test, there is a danger that validity coefficients may be biased by common methods bias.

What is needed to address these questions is a data set where ASVAB subtest scores have been related to a hands-on measure of job performance. Maier and Grafton's (1972) study of ASVAB 6/7's ability to predict the armies hands-on measure of job proficiency, the Skill Qualification Test (SQTs) provides such a data set. Maier and Grafton described the SQTs 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.

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) and an appraisal of the program is available in Vineberg and Joyner (1982b).

Correlation matrices relating the ASVAB subtests and SQTs were taken from Appendices A and B in Maier and Grafton (1981). Since recruits are selected into the army and into the various specialties on the basis of the subtest scores and interest variables, the correlation matrices were corrected for restriction of range by Maier and Grafton using procedures described in Dunbar and Linn (1986) and Lord and Novick (1968). 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, all of 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. The results are reported in Table 15. The effects of the four subtests covering the trade and technical field--mechanical comprehension, auto information, shop information and electronics information--are presented in the first four columns of the table. The effects of these subtests 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. The attention to detail subtest (which is similar to the clerical checking subtest in ASVAB 8A) has no effect on performance in clerical jobs and smaller. Clearly the technical competencies being measured by these four ASVAB subtests are important determinants of worker productivity in many civilian jobs.

III. THE IMPACT OF VOCATIONAL EDUCATION ON ASVAB SUBTESTS

The ASVAB subtests measuring competencies in the trade and technical area clearly have a substantial impact on productivity and labor market success of young people. This finding implies that the material being taught in trade and technical courses makes one a more productive worker and is valued by the labor market. For males, in fact, it is more highly valued than the material being taught in English, history and science classes. These findings validate the goals of trade and technical education. An important question remains, however, "Do typical trade and technical programs successfully teach this material?"

It is very difficult to determine the impact of vocational courses on student knowledge of electronics, mechanics and technology. Students who do poorly on paper and pencil tests tend to be attracted to vocational programs. This means that vocational education's effects on technical knowledge cannot be measured without thoroughly controlling for grades, academic ability and a host of other background characteristics. Unfortunately, the NLS contains only a limited number of background variables and early measures of the student's academic ability are available for only a portion of the sample. Even more serious is the problem created by the fact that the indicators of background and early ability are measured with error. If critical control variables are measured with error, all coefficients in the model are biased not just the coefficients on the control variables. Meyer (1988) has shown that when the beginning test score is included as a right hand side regressor in models predicting test score gains, that estimated impacts of vocational education are seriously biased. Using an instrumental variable technique (that cannot be replicated in this data), he shows that the correct coefficient on the lagged test score is approximately zero when a gain score is the dependent variable.

A second limitation on the analysis to follow of the determinants of technical knowledge is the absence of transcript data on the vocational courses taken by the student when in high school. (The author does not have timely access to an NLS data tape containing this information.) This is a problem because when student reports of track have been cross checked against transcripts, it has been 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 likely to influence the development of

technical competence, studies of the impact of vocational education should 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. Given these problems it is clear that a reliable and unbiased estimate of the impact of vocational education on ASVAB subtest scores cannot be obtained from the NLS data that is currently available. What will be done instead is estimate models predicting proxies for subtest specific gain scores. A proxy gain score is defined for each of the ASVAB subtests by subtracting the score (in standardized units) on an early IQ test (taken from high school records) from the ASVAB subtest score also in standardized units. The independent variables for this estimation include the following: a dummy variable equal to one when the respondent reports being or having participated in a high school vocational training program, the share of the 1980 calender year that the youth reported attending school derived from the NLS's monthly time log, age, years of schooling, a dummy for high school graduation, years of college education completed and the date the early test was taken. Minority status is controlled by a dummy variable for Hispanic and two dummy variables for race. Family background was controlled by 8 dummy variables representing the occupation of the respondent's mother and father: father is a manager, mother is a manager, father is a professional, mother is a professional, father is a craft worker, mother is a craft worker, father is a operative/laborer/service worker, and mother is a operative/laborer/service worker. Characteristics of the local labor market are held constant by entering the following variables: dummy variables for the four Census regions, a dummy variable for rural residence and a dummy variable for residence outside an SMSA. Following Meyer (1988), we maintain the assumption that the lagged ability level does not belong in the true model predicting the gain score proxy and estimate the model without including the lagged test score in the estimation.[1]

The results of these estimations are presented in Tables 16 and 17. Self reported status as a vocational student is associated with significantly larger proxy gain scores on all three vocational subtests of the ASVAB for young men and on the clerical speed and computational speed subtests for young women. It does not raise the mechanical and electronics scores of young women. Since young women are generally not found in the trade and industry and technical programs that cover material that may be included on these ASVAB subtests, this pattern of results makes alot of sense.

Vocational education is associated with significantly smaller proxy gain scores on the mathematics reasoning composite for men and in mathematics reasoning and science for women. Being a vocational student appears to have no significant effect on gains in the verbal composite. These estimates of the effect of vocational education on academic subtests are quite similar to the findings of Meyer's (1988) and Bishop's (1985) analysis of High School and Beyond data on test score gains between the sophmore and senior years of high school. The basic finding of all these studies has been that participation in vocational education has only small effects (sometimes positive and sometimes negative) on academic learning. Since the early IQ test is probably quite similar in content to the math, verbal and computational speed subtests the regression results for these subtests are less likely to be biased than the other models.

The source of the potential biases in the vocational subtest models comes from the possibility that the students who enter vocational education are pursuing an already developed interest (eg. in cars) and therefore begin their occupational training already knowing more about the field than other students with the same true early IQ test score. If this phenomenon is important, the coefficients on the dummy for participation in vocational education will be upward biased estimates of the true causal effect of vocational education on technical knowledge and skills. Noting the likely direction of this bias, it is dissappointing that the effects of self-reported participation in vocational education on the three vocational subtests appear to be so small, somewhere between 10 and 20 percent of a standard deviation. One reason for the small coefficients on vocational participation is that only about half of the vocational courses taken by males in high school are in trade and industrial arts. Nevertheless, if one were to multiply the coefficients on the electronics and mechanical composites in the labor market models by an estimate of the effect of trade and industrial education on those test composites (ie. by .1, .2 or even .3 to take account of the mismeasurement of participation in trade and industrial education), the estimated impact on earnings of the gains in generic technical knowledge produced by participation in trade and industrial education would be only one or two percent.

Quite clearly most of the effects of vocational education on labor market success do not operate through the generic technical knowledge and skills that the ASVAB subtests measure. This is also what previous research on the labor market payoffs to vocational

education has found. Two different studies (Campbell, et al. 1986; Rumberger and Daymont 1982) have found that the economic benefits to vocational education occur only when graduates obtain jobs in the field for which they were trained. Table 18 summarizes Campbell, et al.'s analysis of data from the High School and Beyond and the National Longitudinal Survey of Youth.[3] Vocational graduates who obtain a job in an occupation matching their field of training spend about 20 percent more time in the labor force than general track graduates.[4] Their rates of unemployment are about 3 percentage points lower. Vocational graduates working outside their field of training are not significantly more likely to be in the labor force or to be employed than general track graduates.

The third and fourth columns of the table present estimates of the effect of vocational education on current monthly earnings controlling for current and past enrollment in college. High school graduates who took a vocational concentration obtain significantly higher monthly earnings (7 to 8 percent higher) only when their current job is related to their training. When their current job is not related to their training, they do not receive higher wage rates than students who have pursued a general program of study in high school. Students who pursued an academic curriculum in high school did not do better than those pursuing a general curriculum; in one data set they were earning 5% less.

What this research implies is that trade and industrial education raises the earnings of its graduates by teaching them skills in a particular occupational cluster and then placing them in one of those occupations. The universe of vocational/technical knowledge being sampled by the mechanical comprehension, auto and shop information and electronics subtests of the ASVAB is much boarder than the objectives of particular trade and technical programs. The result is that even when a program does a good job of teaching the knowledge and skills necessary for its cluster of occupations, it has a much more modest impact on the types of generic technical knowledge that are measured by the ASVAB composites.

Consequently, ASVAB subtests could never be used as the sole or primary indicator of the success of specific vocational programs. The subtests are much too short and superficial to be used as the sole indicator of occupational programs effectiveness. The three subtests combined contain a total of 70 paper and pencil type items that are answered in a 39 minute time frame. It might be used, however, in conjunction with more focused assessment instruments developed for particular occupations. For students

in the fields of trades and industry and technical occupations, the ASVAB subtests (or specially designed tests similar to them) might be used as indicators of a student's overall competence in the technical arena and as such might provide a way of recognizing which programs do the best job of teaching skills that are useful in a wide variety of mechanical and technical occupations. When, for example, courses such as Principles of Technology, Introduction to Occupations, Business Math, and Manufacturing Systems are required of all vocational students, generic competency tests focusing on the material in these courses would apper to be desireable. This is the strategy currently being pursued by New York State. Inclusion of such tests among the performance indicators for vocational programs will insure that teachers and administrators give priority to the goal of generic technology education. We now turn to a discussion of the types of occupational competency tests that are necessary for performance-based measures of instructional program effectiveness.

IV. IS OCCUPATIONAL COMPETENCY MEASUREMENT FEASIBLE ?

Briefly, the answer to the question posed by the title of this section is **YES**. The growing competency-based vocational education (CBVE) movement has resulted in many states undertaking a comprehensive revision of occupational curricula. These states have described the goals of each occupational training program in terms of competencies and have developed curriculum and criterion-referenced tests appropriate to the task of teaching these competencies. Competency-based vocational education goes by a number of names: performance-based, outcome-based and competency-based. Grant (1979, p.6) has probably provided the most succinct definition of CBVE:

> Competence-based education tends to be a form of education that derives a curriculum from an analysis of a prospective or actual role in modern society and that attempts to certify student progress on the basis of demonstrated performance in some or all aspects of that role. Theoretically, such demonstrations of competence are independent of time served in formal education settings.

Chalupsky et al. describe it as stressing "in depth analysis and continuing adjustment to employment needs, coupled with the collection of student task performance data as an aid in bringing student performance up to standard and for improving learning materials and instructor effectiveness."[5] After surveying CBVE programs, Russell (1978 pp. 55-56) characterized the exemplary programs as achieving or striving to achieve the following:

- Pre-testing students upon entry to determine the skills they already have as well as objectives that need to be achieved
- Allowing each student to proceed to subsequent instruction as soon as performance objectives are attained
- Providing an alternative method of instruction if a student does not achieve a learning task
- Recording students performance as each objective is achieved
- Placing greater emphasis on exit requirements (proficiency) than on entrance requirements
- Assessing students on the basis of competencies, i.e., criterion-referenced testing is used

The objective is to offer students a "success -oriented atmosphere for learning, where success is measured by job-derived standards as opposed to competitive performance among students"(Hirst, 1977, p. 35).

Competency testing is critical to successful implementation of CBVE. It is needed for screening new students for placement, giving credit for previous learning, advancing students when objectives are achieved, identifying remediation needs, certifying areas of competence at graduation and evaluating the effectiveness of instructional programs (Chalupsky 1982). Accountability is, thus, only one of the many objectives of occupational competency testing. Developing these tests and administering them to thousands of students is costly, so it will generally be desireable for the tests to serve multiple objectives (eg. certification, articulation with more advanced training programs and program evaluation).

Accountability is easier to implement in the context of CBVE, particularly at the classroom instruction level. "Vocational teachers who conduct competency-based programs...are in a good position to appraise their instruction by focusing on its products..." (Erickson, 1979, p. 257). **However, a competency-based approach to teaching is not essential to the use of competency testing as a program evaluation tool. Accountability driven competency testing can be implemented in vocational programs which have not adopted any of the elements of the CBVE approach to instruction. Consequently, a federal requirement that states test the competency of their vocational students and use the results of these tests in their accountability systems would not force states and districts to adopt the CBVE approach to instruction.**

4.1 VALIDITY

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 19. 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 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. 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. This places them in a metric that is roughly comparable to the ASVAB subtest scores analyzed in section 3. 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. Nevertheless, it would appear that vocational programs have substantially larger effects (in the test score SD metric) on competency in the occupation being studied than on the academic and vocational subtests of the ASVAB.[7]

When occupational competency tests appropriate for the job compete with academic ability tests in predicting job performance measured either by supervisory ratings or actual work samples, the occupational competency tests have about twice as large an effect as ability tests (Hunter, 1983). Since large improvements in job knowledge appear 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 desireable if the student is likely to put the knowledge to use by working in the occupation.

4.2 AVAILABILITY

Comprehensive systems of occupational competency testing are now available from a variety of sources: the National Occupational Competency Testing Institute (NOCTI), the Instructional Materials Laboratory at Ohio State University, the New York State Education Department, the Vocational Technical Consortium of States (V-TECS), and the American Association for Vocational Instructional Materials (AAVIM) in Athens, Georgia. Oklahoma is currently validating a set of competency tests keyed to the objectives of its competency based curriculum guides. These tests are being used within the state and will be made available to vocational educators in other states when norms are available. For more information write to the Oklahoma Occupational Testing Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074. Detailed descriptions of these testing programs can be found in Appendices D through G and a resource guide available from AAVIM developed by the National Center for Research in Vocational Education (1988).

The great numbers of vendors supplying competency tests means that a federal mandate that states test the competency of their students would not prejudge the issue of what should be taught. Fifty-seven different tests are available from NOCTI--some very narrow in focus and others quite broad (eg. General Office). New York State has

developed tests evaluating student achievement in required generic courses such as Principles of Technology and Introduction to Occupations. V-TECS has developed a test item bank which states and local districts can access to develop tests which are tailored to the state's curriculum and the needs of the local community.

Two of the competency testing programs--NOCTI and Oklahoma-- offer inexpensive hands-on-performance tests as one element of their competency testing system. The fact that hands-on tests are available is particularly important because exclusive reliance on paper-and-pencil tests for program evaluation and competency certification would, in my opinion, be undesirable. Since occupational competency is more than just knowledge of facts, multiple-choice exams are not, by themselves, a satisfactory assessment of occupational competence. Competence is the ability to apply knowledge to particular real life situations, diagnose practical real world problems and get the job done, and hands-on performance tests are essential if it is to be fairly evaluated. Many vocational programs now give their graduates a competency profile which describes and certifies the individual student's skills. Many students use these profiles as credentials when they seek work in the field. One of the benefits of increasing the number of states that use competency testing for accountability purposes is that it is likely to stimulate an increase in the use of competency tests to certify students' achievements. Vocational students would then have the option of including their ratings on the occupational competency tests on their competency profiles. This would both motivate them to work hard at developing their occupational competency and at the same time enhance their ability to compete for better jobs.

The state of Pennsylvania has established a **Pennsylvania Skills Certificate** which students may earn by passing both the written and hands-on components of the NOCTI Competency Exams. A description of the program is provided in Exhibit 1. Where possible the local Craft Advisory Committee is being recruited to serve as judges for the hands-on performance test. This certificate program has already stimulated changes in the curriculum. In the first year of testing, students did not do very well on the competency tests for clerical occupations. When causes of the deficiency were examined, it was discovered that the problem was not with the test but the curriculum which had become poorly aligned with current employer needs. The result has been a revision of the office education curriculum (J.

COMMONWEALTH OF PENNSYLVANIA
OFFICE OF THE GOVERNOR
HARRISBURG

Of Pennsylvania's many natural resources, our students are the most important. They are tomorrow's work force, the foundation of our economic future. It is essential, therefore, that all students reach their full potential in basic knowledge and job-related skills.

The Pennsylvania Skills Certificate recognizes high achievement by vocational students. It offers students a chance to demonstrate their abilities through a fair and carefully-prepared examination.

I urge all vocational students to prepare for and to take the tests for the Pennsylvania Skills Certificate. Not only can it reward your own achievement, but it shows everyone the importance of vocational-technical education. The Pennsylvania Skills Certificate tells employers, parents, and co-workers that you are qualified and able to perform today's jobs as well as tomorrow's.

Robert Casey
Governor

WHAT OCCUPATIONAL COMPETENCY TESTS WILL BE AVAILABLE?

Accounting/Bookkeeping
Agriculture Mechanics
Appliance Repair
Architectural Design
Audio-Visual Communications
Auto Body
Auto Diesel Mechanics
Automotive Specialist
Baking
Building Construction Occupations
Building Trades Maintenance
Business Data Processing
Cabinetmaking
Carpentry
Child Care Services
Civil Technology
Clothing & Textiles Management and Production
Commercial Art
Communications Electronics
Computer & Information Sciences
Construction Masonry
Dental Assisting
Diesel Engine Mechanics
Diversified Occupations
Electrical Construction and Maintenance
Electrical Occupations
Electrical Technology
Electromechanical Technology
Electronic Technology
Food Production, Management and Service
Forestry Products & Processing
General Drafting & Design
General Office
General Secretarial
Graphic Arts
Health Assisting
Heating
Heating & Air Conditioning
Heavy Equipment Maintenance & Repair
Home Health Aide
Horticulture
Industrial Electricity
Machine Trades
Marketing & Distribution
Mechanical Drafting
Medical Assisting
Metalworking & Fabrication
Nursing Assisting
Painting & Decorating
Plumbing
Production Agriculture
Sheet Metal
Small Engine Repair
Upholstering
Warehousing Services
Welding

Pennsylvania Skills Certificate

PSC

Commonwealth of Pennsylvania
Robert P. Casey, Governor

Department of Education
Thomas K. Gilhool, Secretary

What is the Pennsylvania Skills Certificate ?

WHAT IS THE PENNSYLVANIA SKILLS CERTIFICATE?

The Pennsylvania Skills Certificate is a special award created by the Pennsylvania Department of Education to recognize high achievement by Vocational Education students.

To receive the certificate, you must be enrolled in an approved program at your school. Also, you must show that you have mastered the knowledge and skills required for an occupation.

HOW WILL YOU BENEFIT?

Having the Pennsylvania Skills Certificate can help you get a good job in your chosen field.

The Pennsylvania Skills Certificate tells employers that you can do the job.

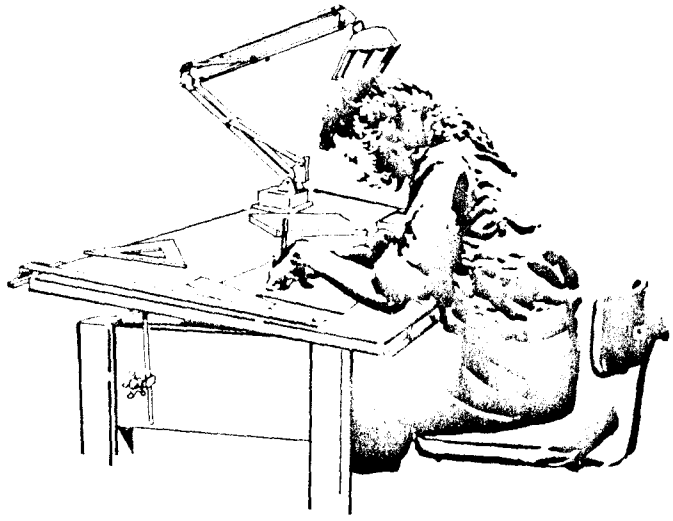
WHY IS IT NEEDED?

Jobs in Pennsylvania are becoming more technical and competitive. That makes it extremely important for you to study hard and make the most of your talents as you prepare to enter the work force.

It is just as important for you to prove your strengths. That way you can find the best job, for you, in the field of your choice.

HOW WILL IT BE EARNED?

You will be able to take the tests for the Pennsylvania Skills Certificate in the Spring of your senior year. To earn the Skills Certificate, you must pass both a written test and a test of how well you can perform job skills. You must demonstrate entry-level job competencies and graduate from an approved program in vocational training.



WHAT TYPE OF TEST WILL BE USED?

You will take a written test and a test of your work skills.

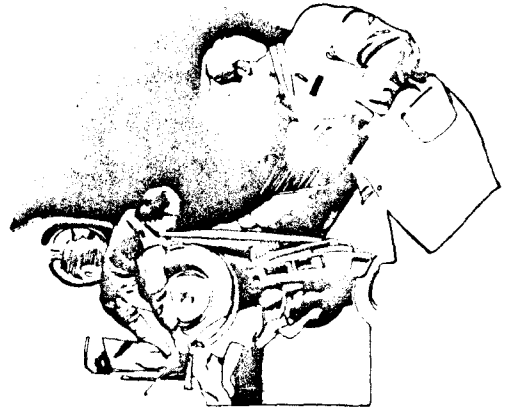
The written test covers factual knowledge, technical information, your understanding of principles, and your ability to solve problems related to your vocational training.

The performance test will consist of work assignments designed to judge your knowledge of skills required to do the job. You will be in the laboratory, shop, or clinical setting you use during your training. In some cases your performance will be judged by the local Craft Advisory Committee.

HOW WILL THE TESTS BE ADMINISTERED AND SCORED?

You will take the tests in your school. The school will obtain tests directly from the National Occupational Competency Testing Institute (NOCTI).

NOCTI will score the tests and provide the results and rankings. Statewide rankings will be reported to the Department of Education. Your individual score will determine your eligibility for the Pennsylvania Skills Certificate. You will receive the Skills Certificate from the Pennsylvania Department of Education.



Cullen, 1988). The Pennsylvania's Skills Certificate is an excellent program and federal policy should endeavor to encourage other states to develop similar programs.

4.3 MEASURING PROGRAM PERFORMANCE FAIRLY AND INEXPENSIVELY

The major barrier to implementing performance measurement in vocational education and in other programs has been the unreliability and inappropriateness of the performance measures currently available. Training-related placement rates, currently reported to state departments of vocational education, are not comparable across districts and programs, are subject to manipulation, and suffer from serious nonresponse problems. Tests of generic and specific occupational competency avoid these problems: they are comparable across districts, manipulation can be prevented by developing alternate versions of the test and nonresponse can be easily minimized by making the test a part of the student's final grade in the course. Labor market outcome measures are influenced by environmental factors such as the state of the local economy which educators have no control over; competency test scores are not. The tests are cheap to administer. NOCTI charges only $8.95-$9.50 to supply and score its paper-and pencil exam and the costs of consumable materials for the hands-on performance test are only about $6.00 on average.

There is always a danger that accountability systems based on outcomes will exacerbate existing incentives to cream the eligible population.[8] This can be overcome by devising indicators of program performance which take into account the educational background of the students in a program when they entered vocational education and by offering additional recognition (or larger reimbursements) for success with more challenging students -- the handicapped and those with low test scores or poor marks in junior high school. One approach that could be considered is to base state reimbursement of the local vocational education costs on the number of completers not the number of students and on the difference between competency test scores of graduates and a prediction of those test scores based on educational background variables such as freshman year grades and test scores. Under such a system, teachers and counselors would face incentives to recruit/admit into vocational education every student they feel they can help.

Performance indicators measuring the value added of individual vocational programs would not be all that difficult to devise and implement. When the school submitted its examination results to the State Department of Education for grading, it could also be asked to provide the data on the educational background of each student. The information requested might include courses taken, special education diagnosis if any, parent's education and occupation, eligibility for Title I services, and junior high or freshman year grades and standardized test scores. The State Department of Education would conduct a simple regression analysis of this data and generate a predicted competency test score for each student taking the test. The mean difference between the actual and predicted competency test scores would be the basis for assessing the effectiveness of individual vocational programs. The absolute levels of achievement of program completers would be reported, of course, but attention would be directed at the value added measures. Staff at the State Department of Vocational Education would prepare these statistics and brief the school board and the vocational advisory committees. These briefings would also provide information on other performance indicators such as completion rates, earnings gains based on UI wage record data and training related placement rates and offer comparative data on the performance of similar districts in the state. The school board and advisory committees would be encouraged to use the statistics to identify individual programs that require improvement.

One of the major benefits of using occupational competency testing to evaluate programs is the diagnostic information that analysis of the test results for individual performance objectives gives teachers and curriculum developers. When accountability systems based on training related placement rates and/or earnings gains (estimated from UI wage record data) signal that an individual program is performing poorly, they do not offer program operators a diagnosis of what is wrong. If placement rates are low, the natural tendency is to redouble placement efforts. While high school vocational education should increase its emphasis on placement into high wage jobs, there is a danger of overdoing this emphasis. JTPA is sometimes accused of placing too much emphasis on short term placement rates and insufficient emphasis on the quality of the training. If labor market outcomes are the only performance indicators, the placement director may be the only one made "accountable" by the system. The labor market is not so efficient

that we can count on programs that do a poor job of teaching being unable to market their graduates. It is important, therefore, that occupational competency tests be a component of every state's accountability system for vocational education.

FOOTNOTES

1. U.S. Military Entrance Processing Command. Counselor's Manual for the Armed Services Vocational Aptitude Battery, Form 14. July, 1984.

2. R. D. Bock & R. J. Mislevy. Profile of American youth: Data quality analysis of the Armed Services Vocational Aptitude Battery. Chicago, IL: National Opinion Research Center, 1981.

3. These estimates of the effects of vocational education were derived from Table 14 and 16 of Campbell et al (1986) by calculating a weighted average of the coefficients on concentrator, limited concentrator and concentrator/explorer seperately for those with and without a training related job. Academic program category is defined by the courses taken on the transcript. The regressions included controls for the following: sex, minority status, handicapped, limited English proficient, test scores, grade point average, family background, attitudes, past and present college attendance, employment during high school, aspirations in 8th grade, region, rural/urban. The estimates for 1985 are taken from Table 7 of Campbell et al., 1988. The analysis of HSB data contained additional controls for presence of a spouse or child, absenteeism and discipline problems in high school. The monthly earnings models controlled for labor market experience and tenure on ones current job. The HSB model of monthly earnings also contained controls for occupation.

4. The occupation of the current or most recent job is matched against field of training to define training relatedness. One has to be in the labor force at least one week during the year to be in a training related job, so the association between the two reflects both directions of causation. Since almost all individuals in the sample had been in at least one job since completing school, this is not likely to be a serious source of bias.

5. Albert Chalupsky, Linda Phillips-Jones and Malcolm Danoff, "Competency Measurement in Vocational Education," Washington, DC: American Institutes for Research, 1981. pg. 5.

7. This occured because (1) occupational competency tests assess a field of knowledge which untrained individuals have little exposure to, (2) the curriculum the students studied in the time interval was well alligned with the content of the occupational competency test but not with the ASVAB and (3) the domain of knowledge assessed occupational competency tests is narrower than that assessed by the ASVAB. Test of generic technical competence do not inevitably yield small before-after differences. The tests keyed to New York State's Principles of Technology and Introduction to Occupations curriculum probably have large before after differences.

8. Since most teachers prefer to teach intelligent, well-behaved, motivated students, there will always be pressure to cream -- that is, to recruit the most able and screen out those with learning or attitude problems. Program and teacher reputations tend

to be more influenced by absolute levels of student achievement -- cars repaired, houses well constructed, and good jobs obtained--than by value added -- saving individuals who were headed for failure.

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Table 1
Effect of Competencies on Log Wage Rate

	Mechanical	Electronic	Clerical Speed	Comp. Speed	Math	Verbal	Science	R^2	N
Males									
1986	.053***	.030**	.006	.064***	-.007	-.022	-.009	.264	4272
	(4.16)	(2.34)	(.52)	(5.75)	(.51)	(1.50)	(.62)		
1985	.055***	.021	.004	.064***	.007	-.015	-.005	.270	4206
	(4.34)	(1.64)	(.35)	(5.84)	(.57)	(1.02)	(.39)		
1984	.035***	.038***	.007	.070***	.005	-.018	-.016	.239	4527
	(2.76)	(2.91)	(.66)	(6.37)	(.43)	(1.22)	(1.19)		
1983	.044***	.022*	.004	.068***	-.025	-.036***	.017	.243	4401
	(3.52)	(1.69)	(.40)	(6.72)	(2.01)	(2.52)	(1.31)		
1982	.035***	.019	.007	.041***	-.014	-.011	-.010	.220	4477
	(2.77)	(1.43)	(.62)	(3.84)	(1.16)	(.79)	(.75)		
1981	.030**	.003	-.001	.050**	-.001	-.008	-.023	.238	3881
	(2.37)	(.20)	(.11)	(4.65)	(.11)	(.54)	(1.71)		
1980	.030**	.022	-.011	.039***	-.025**	-.007	-.024*	.225	3552
	(2.34)	(1.62)	(.99)	(3.49)	(2.01)	(1.78)			
1979	.025*	(.011)	.003	.030**	.004	-.002	-.026	.248	2249
	(1.60)	(.65)	(.23)	(2.21)	(.26)	(.14)	(1.58)		
Female									
1986	-.003	.009	.028***	.024**	.027*	.027*	.011	.275	4080
	(.15)	(.65)	(2.61)	(2.04)	(1.95)	(1.70)	(.77)		
1985	-.032**	.018	.030***	.021*	.042***	.027*	.003	.256	3965
	(1.97)	(1.31)	(2.87)	(1.83)	(3.11)	(1.76)	(.24)		
1984	-.004	.013	.008	.037***	.048***	+.003	-.002	.231	4159
	(.22)	(.99)	(.81)	(3.25)	(3.59)	(.19)	(.13)		
1983	.007	-.022	.009	.042***	.044***	.011	-.011	.205	4054
	(.44)	(1.71)	(.91)	(3.84)	(3.44)	(.75)	(.08)		
1982	.018	-.001	.015	.038***	.020	.003	-.017	.184	4037
	(1.15)	(.05)	(1.54)	(3.54)	(1.61)	(.22)	(1.25)		
1981	.001	.020	.006	.030***	.002	.016	-.005	.190	3481
	(.06)	(1.57)	(.60)	(2.81)	(.15)	(1.11)	(.35)		
1980	-.028*	.001	.017	.025**	.018	-.014	.029*	.150	3173
	(1.68)	(.05)	(1.62)	(2.06)	(1.31)	(.88)	(1.91)		
1979	.008	.006	.002	.038**	.002	.008	-.023	.236	2075
	(.39)	(.35)	(.14)	(2.51)	(.10)	(.40)	(1.23)		

Model contains no interactions of Test scores with age, work experience and years of schooling.

Table 2
Effect of Competencies on Log Earnings

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science	R^2	N
Males									
1985	.111***	.022	.002	.119***	-.038	.018	.018	.358	4521
	(5.31)	(1.04)	(.14)	(6.55)	(1.79)	(.76)	(.80)		
1984	.097***	.017	.016	.089***	-.002	-.012	-.020	.372	4564
	(4.65)	(.80)	(.92)	(4.90)	(.11)	(.52)	(.00)		
1983	.045**	.080***	.028	.111***	-.013	.021	-.031	.376	5004
	(2.16)	(3.74)	(1.60)	(6.21)	(1.66)	(.91)	(1.41)		
1982	.080***	.048	.013	.133***	-.036	-.008	-.020	.416	4954
	(3.79)	(2.23)	(.73)	(7.33)	(1.77)	(.35)	(.91)		
1981	.079***	.063***	.019	.111***	-.053	-.004	-.035	.400	4574
	(3.67)	(2.81)	(1.03)	(6.01)	(2.54)	(.15)	(1.49)		
1980	.107***	.051	.042**	.087***	-.009	-.052**	-.078***	.392	3955
	(4.84)	(2.13)	(2.25)	(4.49)	(.42)	(2.04)	(3.22)		
1979	.079***	.041	.017	.082***	-.034	-.058	-.023	.380	3411
	(3.45)	(1.63)	(.86)	(4.11)	(1.57)	(2.19)	(.91)		
Female									
1985	.004	-.026	.021	.053***	.064***	.041	.010	.328	3888
	(.12)	(1.10)	(1.12)	(2.59)	(2.64)	(1.48)	(.40)		
1984	.022	.011	.038**	.057***	.053**	.073	-.040	.377	3893
	(.78)	(.46)	(2.06)	(2.79)	(2.22)	(2.69)	(1.57)		
1983	.023	.002	.058***	.085***	.052**	.046	-.009	.333	4139
	(.81)	(.10)	(3.09)	(4.11)	(2.14)	(1.64)	(.34)		
1982	-.013	-.008	.035*	.053**	.064***	.105***	-.047*	.344	4101
	(.46)	(.33)	(1.88)	(2.55)	(2.71)	(3.71)	(1.82)		
1981	-.024	-.011	.039*	.021	.059***	.118***	-.040	.332	3843
	(.82)	(.44)	(1.87)	(1.01)	(2.47)	(4.19)	(1.51)		
1980	.029	-.009	.042**	.084***	.036	.038	-.036	.333	3409
	(1.00)	(.39)	(2.21)	(3.99)	(1.52)	(1.32)	(1.35)		
1979	.045	.029	.048**	.097***	-.023	.021	-.002	.333	2886
	(1.47)	(1.12)	(2.44)	(4.43)	(.94)	(.71)	(.08)		

Model contains no interactions of Test scores with age, work experience or education.

Table 3
Effects of Academic and Vocational Competencies
on Earnings

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science	R^2	N
Male									
1985	1104***	271	278	1240***	-99	-57	-193	.350	4900
	(4.47)	(1.09)	(1.34)	(5.85)	(.40)	(.21)	(.74)		
1984	1087***	238	.88	1034***	-11	-179	-3	.350	5007
	(5.00)	(1.08)	(.48)	(5.54)	(.05)	(.74)	(.01)		
1983	726***	607***	313**	1053***	-139	-222	-182	.367	5642
	(4.17)	(3.42)	(2.14)	(7.05)	(.81)	(1.14)	(.98)		
1982	814***	338**	278***	926***	-304*	-306*	-180	.354	5742
	(5.01)	(2.05)	(2.04)	(6.64)	(1.92)	(1.69)	(1.04)		
1981	650***	332**	330***	655***	-360**	-77	-279*	.355	5237
	(4.29)	(2.13)	(2.60)	(5.07)	(2.43)	(.45)	(1.72)		
1980	632***	324**	219*	493***	-207	-110	-429	.343	4543
	(4.73)	(2.30)	(1.95)	(4.28)	(1.58)	(.72)	(2.96)		
1979	465***	115	38	458***	-376***	-229	100	.320	3836
	(3.63)	(.84)	(.35)	(4.15)	(3.09)	(1.58)	(.73)		
Female									
1985	-28	-157	238*	439***	808***	105	37	.405	5150
	(.14)	(.96)	(1.88)	(3.22)	(4.79)	(.57)	(.21)		
1984	90	45	160	442***	655***	199	-152	.440	5254
	(.54)	(.33)	(1.52)	(3.89)	(4.67)	(1.30)	(1.04)		
1983	203	102	275***	541***	541***	178	-137	.371	5712
	(1.26)	(.78)	(2.71)	(4.94)	(4.06)	(1.20)	(.97)		
1982	172	36	158*	306***	446***	337**	-53	.359	5773
	(1.16)	(.31)	(1.69)	(3.03)	(3.67)	(2.47)	(.41)		
1981	186	3	324***	181**	321***	416***	-244**	.346	5384
	(1.41)	(.03)	(3.86)	(1.99)	(2.95)	(3.40)	(2.10)		
1980	105	61	268***	310***	139	249**	-123	.330	4758
	(.91)	(.65)	(3.71)	(3.91)	(1.48)	(2.36)	(1.22)		
1979	370***	-215**	280***	276***	-80	173*	-14	.320	4024
	(3.33)	(2.34)	(3.99)	(3.57)	(.88)	(1.67)	(.14)		

Table 4
Effects of Academic and Vocational Competencies
on Unemployment

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science	R^2	N
Male									
1985	-.9	-1.6**	-.9	.1	.4	-.3	1.3**	.207	4459
	(1.50)	(2.47)	(1.68)	(.22)	(.67)	(.40)	(1.99)		
1984	-1.6**	-.8	.2	-.8	.2	-.5	.2	.228	4523
	(2.37)	(1.24)	(.29)	(1.45)	(.25)	(.73)	(.22)		
1983	-.6	-.5	-1.3**	-1.0	-.9	-.9	.3	.212	4888
	(.82)	(.66)	(2.03)	(1.52)	(1.23)	(1.10)	(.36)		
1982	-1.5*	-1.1	-2.1***	-.7	-2.1***	.2	1.2	.200	4835
	(1.91)	(1.38)	(3.20)	(1.06)	(2.77)	(.27)	(1.42)		
1981	-1.6**	-.9	-1.3**	-1.0	-1.2	-.2	1.5	.180	4761
	(2.13)	(1.15)	(2.07)	(1.47)	(1.64)	(.28)	(1.81)		
1980	-1.7**	.4	-1.6**	-1.6**	-1.6**	1.6*	-0.1	.163	4305
	(2.1)	(.46)	(2.38)	(2.31)	(2.0)	(1.71)	(.14)		
1979	-1.6	-.1	-1.1	-2.2***	-.5	2.2**	-.5	.177	3057
	(1.93)	(.07)	(1.44)	(3.05)	(.63)	(2.27)	(.59)		
Female									
1985	.8	-.1	-.7	.5	-.5	1.7**	-.3	.203	4223
	(.98)	(.22)	(1.26)	(.84)	(.78)	(2.2)	(.40)		
1984	1.3	.2	-1.7***	.5	-.7	-1.5*	-.7	.216	4285
	(1.39)	(.3)	(3.07)	(.83)	(.92)	(1.82)	(.88)		
1983	1.3	.4	-.7	-.8	-.9	-2.7***	-.0	.216	4446
	(1.39)	(.57)	(1.16)	(1.24)	(1.14)	(3.12)	(.03)		
1982	1.6*	1.9**	-.2	-1.2*	-1.5*	-3.1***	-.9	.223	4442
	(1.71)	(2.38)	(.35)	(1.82)	(1.88)	(3.34)	(1.03)		
1981	2.5**	1.4*	-1.2*	1.1	-1.0	-2.2***	.1	.209	4380
	(2.57)	(1.76)	(1.92)	(1.59)	(1.26)	(3.72)	(.15)		
1980	1.8*	1.3	-1.6	-.2	-1.7**	-1.9**	-.4	.181	3982
	(1.76)	(1.59)	(2.47)	(.29)	(2.08)	(2.0)	(.40)		
1979	.6	2.3**	-1.4**	-1.9**	-1.5	-2.0*	.1	.168	2914
	(.57)	(2.53)	(1.99)	(2.43)	(1.64)	(1.88)	(.12)		

Table 5
Effect of Competencies on Log Wage Rate
(at Age 22 with 4 years of work experience)

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science
Male							
1986	.033	.042**	.000	.063***	-.004	-.030	-.014
	(1.55)	(2.20)	(.00)	(4.00)	(.23)	(1.45)	(.73)
1985	.047**	.006	.002	.068***	-.010	-.007	-.010
	(2.48)	(.36)	(.22)	(4.45)	(.53)	(.37)	(.55)
1984	.023	.027	.002	.068***	-.010	-.002	-.009
	(1.29)	(1.50)	(.16)	(4.47)	(.58)	(.10)	(.50)
1983	.032*	.027	.002	.076***	-.028	-.040**	.018
	(1.83)	(1.52)	(.32)	(5.11)	(1.60)	(2.09)	(1.01)
1982	.050***	.017	-.011	.047***	-.006	-.032	.010
	(2.70)	(.93)	(.72)	(3.00)	(.33)	(1.59)	(.50)
1981	.037**	.002	-.011	.060***	-.004	-.023	-.017
	(2.07)	(.10)	(.79)	(4.19)	(.21)	(1.24)	(.95)
Female							
1986	.024	.011	.020	.021	-.005	-.005	-.004
	(.87)	(.57)	(1.23)	(1.25)	(.23)	(.20)	(.18)
1985	-.022	.027	.033**	-.001	.018	-.016	.006
	(.90)	(1.42)	(2.15)	(.07)	(.94)	(.74)	(.31)
1984	.003	.021	.008	.031*	.030*	-.032	-.007
	(.14)	(1.17)	(.56)	(1.94)	(1.67)	(1.50)	(.38)
1983	.006	-.034**	-.003	.054***	.039**	-.003	.002
	(.30)	(1.99)	(.20)	(3.64)	(2.28)	(.16)	(.08)
1982	.011	.002	.012	.038***	.048***	-.005	-.040**
	(.54)	(.14)	(.94)	(2.75)	(2.95)	(.29)	(2.32)
1981	-.011	.028*	.003	.021	.009	.027	-.012
	(.50)	(1.75)	(.25)	(1.56)	(.56)	(1.41)	(.70)

Estimates based on model 2 using seemingly unrelated regression. It contains interactions for academic test scores with age, experience and years of college and interactions of vocational test scores with age and experience.

For the wage models the system weighted R^2 is .132 and the degrees of freedom are 12746. For the female wage models the system weighted R^2 is .130 and the degrees of freedom are 11330.

Table 6
Effect of Competencies on Log Earnings
(at Age 22 with 4 years of experience)

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science
Male							
1985	.125***	.021	.038*	.069***	-.035	-.045*	-.039
	(4.91)	(.87)	(1.96)	(3.44)	(1.43)	(1.65)	(1.57)
1984	.101***	.049**	.008	.070***	-.018	-.049*	-.020
	(4.28)	(2.07)	(.40)	(3.61)	(.76)	(1.89)	(.83)
1983	.037	.071***	.036*	.102***	-.041*	-.022	-.046*
	(1.54)	(2.93)	(1.84)	(5.02)	(1.73)	(.83)	(1.84)
1982	.072***	.044*	.003	.136***	-.044*	-.037	-.036
	(2.81)	(1.71)	(.13)	(6.34)	(1.75)	(1.30)	(1.34)
1981	.059	.048	.011	.113***	-.054**	-.047	.022
	(2.19)	(1.81)	(.51)	(5.10)	(2.07)	(1.61)	(.79)
Female							
1985	.002	.001	.038	.022	.076	-.008	-.038
	(.06)	(.04)	(1.57)	(.89)	(2.52)	(.24)	(1.22)
1984	.015	.029	.027	.042*	.043	.021	-.057*
	(.44)	(1.06)	(1.23)	(1.78)	(1.56)	(.65)	(1.96)
1983	.027	-.014	.030	.070***	.042	-.034	-.044
	(.81)	(.52)	(1.35)	(2.87)	(1.50)	(1.03)	(1.47)
1982	-.022	.024	-.020	.055**	.031	.033	-.048
	(.61)	(.84)	(.86)	(2.19)	(1.07)	(.96)	(1.54)
1981	-.044	-.010	.035	-.002	.059**	.057	-.057
	(1.17)	(.35)	(1.48)	(.09)	(2.01)	(1.62)	(1.85)

Estimates based on model 2.1 using seemingly unrelated regression. It contains interactions for academic test scores with age, experience and years of college and interactions of vocational test scores with age and experience.

For the models of male earnings the weighted R^2 was .224, and the number of degrees of freedom = 15116. For the Female models the weighted R^2 = .209 and the number of degrees of freedom = 11046.

Table 7
Effect of Competencies on Earnings (1985)
(at Age 22 with 4 years of experience)

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science
Male							
1985	1155***	313	411*	1137***	-568	-602*	-323
	(3.83)	(1.08)	(1.73)	(4.73)	(.20)	(1.87)	(1.09)
1984	1210***	298	113	1035***	121	-577**	-171
	(4.51)	(1.13)	(.52)	(4.72)	(.46)	(1.98)	(.63)
1983	787***	610***	429**	1026***	-43	-629**	-268
	(3.41)	(2.69)	(2.31)	(5.43)	(.19)	(2.51)	(1.14)
1982	871***	328	423**	980***	-55	-632**	-253
	(3.74)	(1.45)	(2.28)	(5.21)	(.25)	(2.53)	(1.09)
1981	770***	350	369**	742***	-49	-394*	-210
	(3.33)	(1.65)	(2.10)	(4.23)	(.23)	(1.66)	(.97)
Female							
1985	-83	-239	297**	438***	722***	248	-140
	(.34)	(1.28)	(1.96)	(2.83)	(3.68)	(1.15)	(.72)
1984	114	-116	172	513***	559***	239	-221
	(.55)	(.72)	(1.33)	(3.86)	(3.32)	(1.29)	(1.31)
1983	76	-158	102	586***	529***	145	-206
	(.38)	(1.01)	(.81)	(4.50)	(3.25)	(.81)	(1.25)
1982	-53	-55	-60	464***	432***	333*	-56
	(.27)	(.37)	(.51)	(3.76)	(2.80)	(1.96)	(.36)
1981	-80	-161	143	306***	398***	468***	-182
	(.42)	(1.16)	(1.26)	(2.70)	(2.71)	(2.93)	(1.28)

Estimates based on model 2.1 using seemingly unrelated regression. It contains interactions for academic test scores with age, experience and years of college and interactions of vocational test scores with age and experience.

For male earnings the weighted R^2 is .192; and the degrees of freedom is 20456. For female earning the weighted R^2 is .227 and the degrees of freedom is 22506.

Table 8
Effect of Competencies on Unemployment
(at Age 22 with 4 years of experience)
(in %)

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science
Male							
1985	-1.4*	-1.0	-1.1*	.4	-1.6**	.4	1.6**
	(1.93)	(1.41)	(1.94)	(.79)	(2.33)	(.56)	(2.28)
1984	-1.3*	-.2	-.4	-.8	-.5	-.4	.4
	(1.91)		(.63)	(1.39)	(.77)	(.46)	(.56)
1983	-.3	-.5	-1.6*	-.5	-1.8**	.0	1.1
	(.30)	(.61)	(2.25)	(.67)	(2.20)	(.04)	(1.26)
1982	-.4	-.9	-1.7**	.4	-.21**	.6	1.9**
	(.43)	(.97)	(2.29)	(.47)	(2.43)	(.66)	(2.03)
1981	.0	-1.3	-.3	-.7	-1.2	.7	1.3
	(.08)	(1.47)	(.44)	(.94)	(1.4)	(.73)	(1.39)
Female							
1985	.5	0.0	-1.0*	.3	-2.3***	-1.2	-.4
	(.55)	(.02)	(1.73)	(.48)	(3.28)	(1.46)	(.61)
1984	.9	.2	-1.9***	-.2	-1.4*	-1.3	-.5
	(.97)	(.23)	(3.20)	(.28)	(1.80)	(1.52)	(.51)
1983	.7	-.2	-1.1*	-1.3*	-.3	-2.0**	.4
	(.76)	(.31)	(1.75)	(1.91)	(.43)	(2.20)	(.45)
1982	.9	1.8**	-.6	-1.5***	-.9	-2.1**	-.1
	(.86)	(2.17)	(.92)	(2.02)	(1.03)	(2.13)	(.11)
1981	2.2*	.7	-.4	-1.0	-.9	2.0*	1.0
	(1.94)	(.80)	(.60)	(1.30)	(1.00)	(1.93)	(1.13)

Estimates based on model 2.1 using seemingly unrelated regression. It contains interactions for academic test scores with age, experience and years of college and interactions of vocational test scores with age and experience.

For male unemployment system weighted R^2 is .126 and degrees of freedom are 16556. For female unemployment the system weighted R^2 is .121 and the degrees of freedom are 14181.

Table 9
Effects of Age, Work Experience and College
on the Payoff to Academic and Vocational Competency

	Vocational Composite times		Academic Composite times		
	Age	Work Exper.	Age	Work Exper.	Years of College
Male					
Log Wage	-.0022	.0085	.0160**	-.0180*	.0002
	(.30)	(.89)	(2.09)	(1.88)	(.03)
Log Earnings	-.0190**	.0039	.0478***	-.0384***	-.0314***
	(2.20)	(.37)	(4.75)	(3.47)	(3.72)
Earnings ($)	26	-4	401***	-269**	-155
	(.28)	(.04)	(3.98)	(2.46)	(5.35)
Unemployment (%)	-.53**	1.00***	.17	.55*	.59**
	(2.06)	(3.18)	(.61)	(1.75)	(2.49)
Female					
Log Wage	-.0040	.0048	.0211***	-.0069	.0089
	(.44)	(.41)	(2.63)	(.69)	(1.62)
Log Earnings	-.0008	-.0159	.0353	-.0281	-.0012
	(.05)	(.85)	(2.54)	(1.67)	(.13)
Earnings ($)	-13	-79	107*	40	140**
	(.18)	(.85)	(1.71)	(.56)	(2.53)
Unemployment (%)	-.04	.06	-.11	1.35***	1.00***
	(.12)	(.15)	(.35)	(3.80)	(4.39)

Results of estimating model 2.1 with cross equation constraints on interactin coefficients and proportions of year in school interactions coefficients set to zero.

Table 10
Effects of Academic and Vocational Competencies
on Log Wage Rates
(22 yr. old High School Graduates Not in School)

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science
Male							
1986	.034	.045**	.002	.062***	-.008	-.031	-.014
	(1.57)	(2.36)	(.13)	(3.90)	(.40)	(1.46)	(.76)
1985	.047**	.007	.003	.067***	-.010	-.006	-.010
	(2.44)	(.39)	(.23)	(4.41)	(.56)	(.31)	(.52)
1984	.020	.027	.003	.068***	-.008	.001	-.007
	(1.13)	(1.51)	(.19)	(4.48)	(.46)	(.04)	(.40)
1983	.028	.026	.004	.077***	-.024	-.036*	.021
	(1.60)	(1.49)	(.30)	(5.17)	(1.36)	(1.88)	(1.18)
1982	.044**	.016	-.013	.049***	.001	-.025	.013
	(2.45)	(.85)	(.84)	(3.13)	(.06)	(1.30)	(.70)
1981	.030*	-.001	-.014	.063***	.006	-.015	-.012
	(1.78)	(.03)	(1.03)	(4.45)	(.33)	(.80)	(.68)
Female							
1986	.036	.015	.025	.021	-.005	-.001	-.007
	(1.29)	(.76)	(1.52)	(1.26)	(.27)	(.06)	(.33)
1985	-.014	.030	.037**	-.001	.018	-.014	.006
	(.58)	(1.59)	(2.39)	(.04)	(.92)	(.65)	(.30)
1984	.011	.024	.011	.032**	.031*	-.031	-.007
	(.49)	(1.32)	(.71)	(2.02)	(1.70)	(1.41)	(.35)
1983	.012	-.032*	-.001	.056***	.040**	-.003	.004
	(.57)	(1.87)	(.07)	(3.77)	(2.35)	(.15)	(.20)
1982	.015	.005	.015	.040***	.051***	-.004	-.039**
	(.78)	(.30)	(1.18)	(2.89)	(3.18)	(.23)	(2.23)
1981	-.007	.030*	.006	.022	.014	.030	-.010
	(.37)	(1.93)	(.46)	(1.63)	(.89)	(1.63)	(.58)

Estimate of model 2.2 with cross equation constraints on interactions with competency composites and interactions with coefficients on work experience interactions set to zero.

Table 11
Effect of Academic and Vocational Competencies
on Log Earnings
(22 yr. old High School Graduates Not in School)

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science
Male							
1985	.111***	.014	.030	.077***	-.023	-.029	-.028
	(4.29)	(.56)	(1.53)	(3.84)	(.95)	(1.06)	(1.12)
1984	.087***	.042*	-.000	.079***	-.002	-.031	-.008
	(3.64)	(1.78)	(.02)	(4.03)	(.07)	(1.17)	(.32)
1983	.021	.065***	.029	.111***	-.019	-.002	-.032
	(.88)	(2.65)	(1.50)	(5.51)	(.81)	(.09)	(1.25)
1982	.057**	.037	-.004	.148***	-.018	-.015	-.019
	(2.28)	(1.43)	(.21)	(6.89)	(.71)	(.52)	(.72)
1981	.041	.040	.002	.126***	-.019	-.018	-.001
	(1.53)	(1.52)	(.11)	(5.72)	(.72)	(.61)	(.04)
Female							
1985	.001	-.000	.040	.026	.078***	.010	-.033
	(.03)	(.02)	(1.64)	(1.02)	(2.58)	(.28)	(1.05)
1984	.021	.027	.030	.047**	.050*	.040	-.051*
	(.59)	(.99)	(1.36)	(1.97)	(1.80)	(1.20)	(1.74)
1983	.036	-.009	.035	.076***	.051*	-.018	-.035
	(1.06)	(.34)	(1.59)	(3.13)	(1.85)	(.53)	(1.16)
1982	-.011	.029	-.011	.063**	.049	.053	-.037
	(.31)	(1.03)	(.48)	(2.54)	(1.72)	(1.56)	(1.19)
1981	-.029	-.005	.045**	.007	.086***	.081**	-.046
	(.82)	(.16)	(1.99)	(.27)	(2.98)	(2.39)	(1.50)

Estimate of model 2 with cross equation constraints on interactions with competency composites and interactions with coefficients on work experience interactions set to zero.

Table 12
Effects of Academic and Vocational Competencies
on Earnings (1985)
(22 yr. old High School Graduates Not in School)

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science
Male							
1985	1253***	315	460*	1233***	-.000	-412	-224
	(4.16)	(1.10)	(1.94)	(5.14)	(.00)	(1.29)	(.76)
1984	1285***	335	149	1117***	229	-416	-608
	(4.86)	(1.28)	(.70)	(5.12)	(.88)	(1.44)	(.25)
1983	856***	646***	471***	1100***	133	-528**	-144
	(3.58)	(2.89)	(2.58)	(5.88)	(.59)	(2.15)	(.62)
1982	933***	364	462**	1065***	166	-547**	-101
	(4.23)	(1.64)	(2.56)	(5.74)	(.75)	(2.24)	(.44)
1981	816***	400*	419**	817***	235	-279	- 47
	(3.80)	(1.92)	(2.47)	(4.73)	(1.11)	(1.22)	(.22)
Female							
1985	12	-156	362**	486***	794***	331	- 87
	(.05)	(.84)	(2.42)	(3.17)	(4.07)	(1.57)	(.45)
1984	223	- 60	235*	527***	.650***	279	-165
	(1.09)	(.38)	(1.88)	(4.02)	(3.90)	(1.56)	(.99)
1983	199	- 84	161	605***	621***	117	-127
	(1.03)	(.55)	(1.36)	(4.75)	(3.88)	(.68)	(.78)
1982	60	6	7	469***	575***	313*	16
	(.33)	(.05)	(.07)	(3.92)	(3.84)	(1.93)	(.10)
1981	00	-107	207**	299***	603***	479***	-103
	(.00)	(.81)	(2.00)	(2.74)	(4.29)	(3.21)	(.74)

Estimate of model 2.2 with cross equation constraints on interactions with competency composites and interactions with coefficients on work experience interactions set to zero.

Table 13
Effects of Academic and Vocational Competencies
on Unemployment
(22 yr. old High School Graduates Not in School)

	Mechanical	Electronic Knowledge	Clerical Speed	Computation Speed	Math	Verbal	Science
Male							
1985	-1.57**	-1.19*	-1.21**	.39	-1.37	.19	1.57**
	(2.15)	(1.73)	(2.12)	(.68)	(1.97)	(.24)	(2.22)
1984	-1.73**	- .53	- .60	-.86	- .40	-.58	.34
	(2.44)	(.75)	(1.05)	(1.46)	(.57)	(.74)	(.47)
1983	- .81	- .91	-1.89***	-.52	-1.80**	.22	1.00
	(.97)	(1.07)	(2.73)	(.73)	(2.15)	(.24)	(1.13)
1982	-1.08	-1.31	-2.06***	-.43	-2.16***	.48	1.75
	(1.24)	(1.48)	(2.85)	(.57)	(2.48)	(.49)	(1.89)
1981	- .80	-1.82**	- .81	- .78	1.33	.57	1.14
	(.89)	(2.04)	(1.11)	(1.06)	(1.51)	(.58)	(1.23)
Female							
1985	.12	- .15	-1.20**	.22	-1.95**	-1.73**	- .53
	(.14)	(.21)	(2.12)	(.38)	(2.72)	(2.13)	(.73)
1984	.48	.03	-2.10***	- .32	-1.22	-1.97**	- .60
	(.51)	(.04)	(3.56)	(.51)	(1.61)	(2.27)	(.76)
1983	.28	- .45	-1.30**	-1.53**	- .41	-2.71***	.17
	(.29)	(.56)	(2.11)	(2.26)	(.51)	(2.95)	(.20)
1982	.39	1.53*	-.85	-1.76**	-1.17	-2.81***	- .34
	(.38)	(1.85)	(1.30)	(2.44)	(1.37)	(2.86)	(.37)
1981	1.57	.38	- .70	-1.29*	-1.34	-2.73***	.79
	(1.43)	(.44)	(1.02)	(1.73)	(1.49)	(2.67)	(.84)

Estimate of model 2.2 with cross equation constraints on interactions with competency composites and interactions with coefficients on work experience interactions set to zero.

Table 14
Determinants of the Payoff to
Academic and Vocational Competency

	Vocational Competence times		Academic Competence times		
	Age	Student	Age	Student	Yrs. of College
Males					
Log Wage Rate	.0026 (.47)	.0030 (.15)	.0043 (.75)	-.0222 (1.11)	.0045 (.77)
Log Earning Rate	-.0115 (1.43)	.1205*** (2.83)	.0180** (2.10)	-.224*** (4.85)	-.0173** (1.98)
Earnings	10 (.12)	-597 (1.62)	159* (1.81)	-1425*** (3.65)	-221** (2.54)
Unemployment	-.32 (.72)	-.35 (.13)	1.47** (2.94)	3.55 (1.21)	-.33 (.53)
Females					
Log Wage Rates	-.0038 (.54)	-.0350 (1.54)	.0154** (2.46)	-.0265 (1.22)	.0150*** (2.65)
Log Earnings	-.0070 (.58)	.0168 (.29)	.0098 (.87)	-.204*** (3.65)	.0177* (1.83)
Earnings	-63 (.95)	-115 (.37)	8 (1.09)	-2044*** (7.27)	.310*** (5.49)
Unemployment	.06 (.24)	2.96* (1.83)	.56** (2.24)	-.76 (.49)	.79*** (3.33)

Results of estimating model 2.2 with cross equation constraints on interaction coefficients and work experience interaction coefficient set to zero.

Table 15
Effect of Competencies on
Job Performance (SQT)

	Mechanical Comprehension	Auto Info	Shop Info	Electr. Info	Attention to Detail	Comp. Speed	Word Know	Arith Reasoning	Math Know	Science	R^2
Skilled Technical	.092***	.017	.132***	.174***	.024	.031	.215***	.062**	.121***	.057*	.548
(1324)	(3.07)	(.58)	(4.28)	(5.09)	(1.12)	(1.17)	(6.77)	(1.96)	(3.76)	(1.83)	
Skilled Electronic	.086	.098	.246***	.045	.084*	-.013	-.004	-.021	.261***	.072	.426
(349)	(1.30)	(1.49)	(3.64)	(.60)	(1.81)	(.22)	(.06)	(.30)	(3.67)	(1.05)	
General (Const) Maintenance	-.004	.082**	.117***	.121***	.043*	.068***	.066*	-.101***	.441***	.134***	.592
(879)	(.11)	(2.34)	(3.25)	(3.05)	(1.76)	(2.19)	(1.80)	(2.73)	(11.70)	(3.67)	
Mechanical Maintenance	.042	.314***	.206*	-.089	.055	.235**	-.004	-.068	.061	.096	.412
(131)	(.38)	(2.88)	(1.84)	(.71)	(.72)	(2.43)	(.03)	(.59)	(.52)	(.85)	
Clerical	-.068	.087***	-.030	.065	.015	.085**	.118***	.241***	.206***	.064	.425
(830)	(-1.59)	(2.05)	(-.69)	(1.33)	(.50)	(2.24)	(2.61)	(5.33)	(4.46)	(1.44)	
Operators & Food	.109*	.179***	.062	.100**	.050	-.037	.061	.114*	.106**	.076*	.414
(814)	(2.50)	(4.11)	(1.39)	(2.02)	(1.62)	(.96)	(1.33)	(2.47)	(2.25)	(1.66)	
Combat	.147***	.060***	.080***	.058***	.048***	.035**	.069***	.070***	.139***	.070***	.358
(5403)	(8.28)	(3.38)	(4.42)	(2.86)	(3.82)	(2.23)	(3.71)	(3.74)	(7.29)	(3.82)	
Field Artillery	.059	.047	.030	.134**	.088**	-.009	.000	.186***	.230***	.061	.422
(534)	(1.10)	(.89)	(.56)	(2.21)	(2.33)	(.19)	(.01)	(3.28)	(3.99)	(1.10)	

Re-Analysis of Maier & Grafton's (1981) data on the ability of ASVAB 6/7 to predict Skill Qualification Test (SQT) scores. The correlation matrix was corrected for restriction of range by Maier & Grafton.

Table 16
Determinants of Competency Gains
Young Men

	Mechanical	Electronic	Clerical Knowledge	Comp. Speed	Math Speed	Verbal	Science	Level Early Test
Vocational Student/Grad	.203***	.119**	.101*	-.013	-.101**	.013	.058	-.152***
	(3.46)	(2.06)	(1.65)	(.21)	(2.02)	(.26)	(1.08)	(2.70)
Currently a Student	-.193**	-.121	-.222	-.134	+.161	.034	.011	.358***
	(2.37)	(1.51)	(2.60)	(1.55)	(2.32)	(.48)	(.15)	(4.60)
Yrs of High School	.085**	.083**	.069*	.148***	.070**	.135***	.083***	.174***
	(2.51)	(2.50)	(1.95)	(4.11)	(2.42)	(4.54)	(2.68)	(5.39)
Yrs of College[1]	-.209***	-.167***	-.038	-.142***	-.009	-.185	-.083**	.153
	(5.07)	(4.10)	(.88)	(3.23)	(.26)	(5.08)	(2.18)	(.54)
Age	.125***	.118***	.054***	.037	.057***	.087***	.082***	-.067***
	(6.37)	(6.07)	(2.59)	(1.76)	(3.44)	(5.05)	(4.52)	(3.56)
Hispanic	-.126	-.063	.389***	.335***	.076	.111	-.043	-.414***
	(1.42)	(.73)	(4.16)	(3.53)	(1.00)	(1.41)	(.53)	(4.84)
Black	-.335	-.165***	.116*	.137**	-.035	-.059	-.164***	-.703***
	(5.61)	(2.82)	(1.85)	(2.16)	(.69)	(1.12)	(3.00)	(12.29)
Parents Occup.[2]	-.36	-.29	-.38	-.41	-.15	-.36	-.39	.73
Time Since First Test	-.026***	-.030***	-.024***	-.024***	-.023***	-.025***	-.023***	.022***
	(3.19)	(3.72)	(2.83)	(2.81)	(3.38)	(3.51)	(3.07)	(2.85)
R^2	.142	.104	.072	.051	.072	.077	.059	.354

Source: Models predicting the difference between standard ASVAB subtest scores and standardized scores on an academic aptitude test taken many years earlier. Besides the variables included in this table, the model included controls for region, residence in a rural area, residence in a non metropolitan area, high school diploma and parents occupation.

1. T statistics and *'s indicating significance are for a test of the hypothesis that the coefficient on years of college is different from the coefficient on years of high school.

2. The occupational effect presented in this row is the difference between the gain for young women with two parents from professional occupations and young women whose parents were both operatives, laborers or service workers.

Table 17
Determinants of Competency Gains
Young Women

	Mechanical	Electronic	Clerical Knowledge	Comp. Speed	Math	Verbal	Science	Level of Early Test
Vocational Student/Grad	.028	-.045	.164***	.105*	-.095**	-.022	-.134***	-.127**
	(.57)	(.86)	(2.59)	(1.78)	(2.09)	(.48)	(2.72)	(2.39)
Currently a Student	-.120*	-.106	-.169**	-.090	.183***	-.000	.051	.276***
	(1.80)	(1.50)	(1.98)	(1.13)	(3.00)	(.01)	(.78)	(3.87)
Yrs of High School	-.041	-.014	.086**	.093**	.028	.117***	.040	.143***
	(1.29)	(.42)	(2.11)	(2.47)	(.96)	(4.05)	(1.27)	(4.20)
Yrs of College[1]	-.068	-.065	-.032**	-.004**	.091*	-.014***	-.033**	+.272
	(.73)	(1.31)	(2.49)	(2.01)	(1.88)	(3.90)	(2.12)	(.11)
Age	.112***	.133***	.114***	.065***	.054	.097***	.121***	-.101***
	(7.04)	(7.89)	(5.55)	(3.39)	(3.70)	(6.62)	(7.61)	(6.42)
Hispanic	-.014	-.040	.345***	.172*	.029	-.029	.032	-.473***
	(1.82)	(.48)	(3.43)	(1.83)	(.40)	(.41)	(.40)	(5.62)
Black	.128**	.139**	.134**	.186***	.028	.011	.106**	-.774***
	(2.46)	(2.52)	(1.49)	(2.98)	(.58)	(.22)	(2.05)	(13.84)
Parents Occup.[2]	-.11	-.20	-.40	-.33	-.03	-.22	.00	.63
Time Since First Test	-.036***	-.038***	-.050***	-.051	-.041	-.040	-.045	.042***
	(5.15)	(5.23)	(5.61)	(6.11)	(6.38)	(6.33)	(6.57)	(5.65)
R^2	.092	.099	.092	.061	.091	.095	.075	.345

Source: Models predicting the difference between standard ASVAB subtest scores and standardized scores on an academic aptitude test taken many years earlier. Besides the variables included in this table, the model included controls for region, residence in a rural area, residence in a non metropolitan area, high school diploma and parents occupation.

1. T statistics and *'s indicating significance are for a test of the hypothesis that the coefficient on years of college is different from the coefficient on years of high school.

2. The occupational effect presented in this row is the difference between the gain for young women with two parents from professional occupations and young women whose parents were both operatives, laborers or service workers.

Table 18

THE ECONOMIC EFFECT OF VOCATIONAL EDUCATION

(Relative to Graduates Who Pursued a General Curriculum)

OUTCOMES

Groups In Comparison to General Curriculum	Labor Force Participation (age 20)	Unemployment (age 20)	Monthly Earnings (age 20)	Monthly Earnings (age 19-26)
Vocational Grads				1985
Training Related	20%***	-3*	7%**	8%**
Not Training Related	2%	1	3%*	-5%
Academic Grads	-9%***	1	-5%*	0%

Source: Table 14 and 16 of Campbell, Basinger, Dauner, and Parks, Outcomes of Vocational Education for Minorities, the Handicapped and the Poor. The classification of students into vocational, academic and general was based on the high school transcript. A graduate was in a training related job when the occupation matched (liberally defined) the field for which he/she trained. Results reported are averages of coefficients on concentrator, limited concentrator and concentrator explorer. For the labor force participation model the value presented in the table are the estimated coefficients divided by the mean labor force participation rate. Coefficients from regressions predicting the log of monthly earnings have been multiplied by 100 to approximate percentage impacts. The regressions included controls for the following: sex, minority status, handicapped, limited English proficient, test scores, grade point average, family background, attitudes, past and present college attendance, employment during high school, aspirations in 8th grade, region, rural/urban. The fourth column reports analyses of NLS data. Taken from Table 7 of Campbell et al., 1988b. The first 3 columns are based on HSB data and contain additional controls for presence of a spouse or child, absenteeism and discipline problems in high school. The monthly earnings models control for labor market experience and tenure on ones current job. The HBS model of monthly earnings also contained controls for occupation. The average significance level of the coefficients are indicated by the number of stars. *** is significant at the .01 level using a two tail test. ** is significant at the .05 level. * is significant at the .10 level.

Table 19
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).