Identification of Technical Aptitude based on Criterion Measures of the U.S. Navy Apprentice Technical Training Program

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SUMMARY

Four out of nine subtests of the Armed Services Vocational Aptitude Battery (ASVAB) are technical knowledge (TK) tests, viz., General Science (GS), Mechanical Comprehension (MC), Auto Shop (AS), and Electrical Information (EI). As measures of technical aptitude the ASVAB TK subtest have severe limitations, namely, the tests (1) represent a rather arbitrary sample from the domain of technical knowledge and skills; (2) measure only technical knowledge (concepts) not technical skills; (3) have only modest predictive utility. In an effort to overcome these limitations this paper presents three studies in which measures of technical aptitude were directly extracted from outcomes of a representative sample of technical training performance.

The purpose of the first study was to test the hypothesis of technical aptitude as a two-dimensional concept. One dimension representing individual differences in disposition to learn conceptual, including factual, knowledge; the other dimension representing individual differences in learning technical skills. Data in this study were the dichotomized post-test scores of eight common modules of the Navy Apprentice Technical Training (A.T.T.) program, which provides basic electricity and electronics training to 21 Navy ratings. Each module was followed by two post-tests, viz., a knowledge test (K-test) and a skill test (S-test). For 16 ratings a sample of 500 recruits was randomly drawn from a database. Estimation of tetrachoric correlations and subsequent tests of factor models was done with Mplus. Based on careful analysis of these 16 variance-covariance matrices, it was concluded that the data could best be described by a two-dimensional independent cluster model - a dimension loading all K-tests and a dimension loading all S-tests. A meta-analysis was performed to arrive at mean estimates (and standard errors) for the parameters of this factor model.

The second study was to investigate how much of the observed score variance of the A.T.T. post-tests reflect the dimensions of a general aptitude for technical training and how much of it is a module-specific training effect – an increase in number of concepts mastered, or an increase in proficiency of a specific skill trained in a particular module. This question was investigated using a structural equations model (SEM) in which the observables (i.e., post-test scores of the A.T.T. modules) were influenced by two latent variables. The first latent variable represents

a general effect (cross-modules effect), either the knowledge dimension or the skill dimension. The second represents the module-specific training effects (i.e., the K-test and S-test of one module). In this way the observed score variance could be decomposed into three components, viz., a general aptitude component, a specific training component and a residue component (including truly unique variance and error variance). It was found that the size of the first two variance components was approximately 20 percent of the observed score variance.

In the third study the CFA model parameters (study 1) were transformed into the item parameters of a two-parameter fully Gaussian latent trait model (i.e., a two-parameter normal (2PN) IRT model). Based on this the person parameters (θ) were estimated in a stratified sample of 10,000 Navy trainees. The study further investigated whether a (2PN) IRT model was adequate for this type of data by investigating whether some critical assumptions of IRT models were met. In particular, it was demonstrated that the measures as indicators of a two-dimensional independent cluster model satisfied the conditions of unidimensionality and local independence. Despite the small number of measures the prediction outcomes were not too deviant from the observed data.