

**Obtaining Reliable Job Analysis Information:
A Progress Report from the Work Keys System™: ACT's
Nationwide Program for Improving Workplace Skills**

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Abstract

The reliability of job profiles collected for ACT's Work Keys system, which was first introduced to IPMAAC in 1993, is reviewed. The Work Keys job profiling system, the job analysis system used to establish content validity of the Work Keys assessments, is discussed. Profiles showed strong interrater agreement, with skill levels differing depending on the job and company in which the data was collected. Implications for selection, training, and educational skill standards are discussed.

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This paper presents recent research findings from ACT's Work Keys system, which was first introduced to IPMAAC members in 1993. ACT, Inc. (formerly American College Testing) developed the Work Keys system to improve the nation's workforce. The Work Keys system of job analysis and assessment is used by employers to select new employees and identify training needs among current employees. Work Keys is also used by educators to assess the readiness of high school and technical school students preparing to enter today's "high-tech/high-touch" workplace (McLarty, Nathan, Denning, 1993; Nathan, McLarty, Denning, 1993).

Past presentations to IPMAAC have reported on the development, validity, and adverse impact of the Work Keys assessments; this paper will review the reliability of the Work Keys job profiling system, the job analysis system used to establish the content validity of the Work Keys assessments. A Work Keys job profile, as a job analysis, defines the basic employability skill requirements needed to perform a job effectively (Palmer, Nathan, & Lee, 1994). The basic employability skills used in the profile may include Applied Mathematics, Applied Technology, Listening, Locating Information, Observation, Reading for Information, Teamwork, and/or Writing. Each skill is defined hierarchically in terms of progressively more difficult levels. Profiles become the passing scores on Work Keys assessments when they are used for employee selection, and establish standards for training needs assessment.

In less than five years, over seven hundred human resource professionals, trainers, and workforce development specialists, from colleges, businesses, and government agencies have completed the five-day job profiling training program. Over 1700 job profiles have been collected from these authorized job profilers, for occupations ranging from police officer to secretary to machinist to licensed nurse practitioner.

This paper will present a brief description of the Work Keys job profiling procedure and the five-day job profiling training program, and the recent research findings on the reliability of the Work Keys job profiles and profiling procedure. These results, coupled with previous reports

on the concurrent validity of the Locating Information assessment and the limited adverse impact of Work Keys assessments for many jobs, support the appropriateness of the Work Keys system as an important assessment and training tool.

Reliability is critical to any measurement system. Employers using Work Keys need to know that the job profiling procedure results in reliable information about the skill requirements of jobs. If the procedure results in widely disparate profiles for the same job in the same company, when using different subject matter experts (SMEs), then the profile information will be unreliable, and cannot be used to set passing scores for selection or benchmarks for training.

As noted above, ACT has over 1700 job profiles in its database. Individual profiles can be aggregated to create summary, or "*occupational*" profiles. Many school systems are either currently using, or considering using, Work Keys for their educational standards or skill proficiency targets for students who are about to graduate from high school or technical school. These occupational profiles can provide a basis for establishing these standards or targets. Of course, where resources, technology, and responsibilities differ from company to company or from department to department, skill requirements, and therefore, the job profile, will also differ. Recognizing the distinction between real differences among jobs and erroneous variability is essential for using Work Keys assessments appropriately.

Work Keys Job Profiling Procedure

Each profile is derived from a job analysis process that consists of task analysis and skill analysis. Before becoming authorized to do job profiling, each job profiler receives 38 hours of training led by ACT industrial psychologists. Training covers knowledge of the Work Keys skills, use of a customized computer program required for job profiling, the job profiling procedure used to link Work Keys skills with the task analysis, and a brief overview of important legal implications when tests are used for employee selection. Short lectures, demonstrations, training exercises, and a simulation are all included in the five-day training program. The purpose of this program is to ensure that all profilers understand the job profiling process and the importance of conducting the procedure in a uniform fashion. The job profiling procedure is described below.

Task Analysis

A trained job analyst generates an initial task list based on information from the Dictionary of Occupational Titles (1991), existing job descriptions, training and procedural manuals, etc. The analyst then presents this initial task list to a panel of SMEs who add, delete, consolidate, and/or change the task descriptions until the list of tasks accurately depicts their job as it is performed in their company. After editing the initial task list, the SMEs rate each task according to the "Importance" of the task to overall job performance, using a six-point scale ranging from "0" ("This task is not performed") to "5" ("This task is extremely important to the job I perform"). They also rate the tasks on "Relative Time Spent," the amount of time spent performing this task compared to that spent on other tasks, which is also rated on a six-point scale ranging from "0" ("This task is not performed") to "5" ("I spend a very large amount of time performing this task compared to that spent on other tasks"). The average Importance rating is multiplied by the average Relative Time Spent rating to obtain a "Criticality" rating. The tasks are then rank-ordered according to their Criticality ratings. Finally, the SMEs review the Criticality ratings in order to pare the list down to the tasks most critical to their jobs. Normally, this process involves removing the least critical tasks and making any necessary revisions to the remaining task descriptions. Once the SMEs are satisfied with the task list, the task analysis phase of job profiling is completed.

Skill Analysis

This final task list is then used in the skill analysis phase of job profiling. The SMEs work with each Work Keys skill separately. The SMEs are presented with the definition for one Work Keys skill and they are asked to identify the tasks which require that skill on the job. The analyst continues the process by presenting a detailed description of one level of the skill to the SMEs. This description consists of a definition of what employees should be able to do at that level (the materials taken from the test specifications for the assessment that measures the skill) and two examples of work at that level. The SMEs review one skill level at a time. For each skill level reviewed, SMEs are asked to judge whether the level of that skill used in their job is lower than, about the same, or higher than the skill level being reviewed. The SMEs continue

with this process until they come to a consensus regarding the level of the skill required for the job as a whole. They will always see at least three levels, the level they feel is appropriate for their job, one level below, and one level above, so that they can be sure they are choosing the correct level. This skill analysis procedure is repeated for each Work Keys skill. The final product of this profiling process is a document listing the most critical tasks an individual in the job must perform and, for each relevant skill area, the level of that skill required for the job.

When profiling is conducted for use in selection and promotion decisions (versus, for example, training or education goals), this process is repeated by at least one other independent group of SMEs and, depending on the number of employees in the job classification being profiled, possibly by more than two groups. When the results of the various groups are not the same, a panel of representatives from all the groups will convene to discuss and define the requirement.

The comprehensive and systematic analysis of jobs is consistent with the requirements for job analysis described in the "Uniform Guidelines on Employment Selection Procedures" (Equal Employment Opportunities Commission, Civil Service Commission, Department of Labor, & Department of Justice, 1978). Adherence to these requirements helps ensure that Work Keys instruments meet the content validity requirements for a test when that test is used to screen job applicants. Because job profiling is based on the same metric as the assessments, the skill analysis conducted by the SMEs also establishes the passing score on the Work Keys assessments for their job. Evidence that the job profiling procedure results in reliable and accurate skill requirements for jobs is critical for establishing the content validity of the Work Keys assessments in specific situations, and the viability of the Work Keys system in general.

Overview of Research Study

A job profile results from a job analysis of one particular job in one particular company. By design, if different groups of SMEs for the same job in a particular company arrive at different skill ratings, they are compelled to meet in order to arrive at a consensus. As a consequence, there will be no variance in the final skill ratings (i.e., the job profile). However, the results from each session of SMEs prior to this final reconciliation are retained. Therefore, it

is feasible to examine the consistency with which different groups of SMEs arrive at the same skill ratings. Any discrepancies in the profiles established by the different groups will be evident in the session results.

In addition to examining the results of replications contributing to a single job profile, one could also examine the issue of reliability by looking at groups of profiles for the same job titles. It is hypothesized that the variance between job titles should be larger than the variance within each job title. That is, job profiles for the jobs within the same job titles (DOT titles) should be more similar than those for jobs with different jobs titles. For example, the profiles for Maintenance Mechanic should not vary as much from company A to company Z as would those of Maintenance Mechanic, Secretary, and Shipping and Receiving Clerks.

Method

Sample

A total of 1193 job profiles were collected between March, 1993, and December, 1996, the time period of this study. Each job profile is specific to a company. However, since profiles with the same DOT title can come from different companies and different profilers, the same DOT title can have different profiles, depending on the specific requirements of each job within each company or location, and because of differences between profilers. In addition, each profile might contain different Work Keys skills due to each company's decision to include subsets of skills in its job analysis; that is, a profile for one job might include skill levels for Reading for Information, Applied Mathematics, and Listening whereas a profile for another job with the same job title might include skill levels for only Reading for Information and Applied Mathematics.

Altogether, the 1193 profile have been collected from 191 authorized profilers from 428 companies in 32 states. Each job profile is assigned a *Dictionary of Occupational Titles* (DOT) job title by the job analyst (authorized job profiler) and verified by the ACT I/O Psychologist staff. The 1193 job titles are classified into 472 DOT titles. Each profile can be the result of one profiling session (N = 1044; 87.5%), or of more than one session (N = 149; 12.5%). Profiles in the latter category comprise Subset A (see Table 1) for an analysis on the agreement of results

from multiple sessions contributing to the same job profile provided by the same analyst for the same company. Our interest was in the *sessions* contributing to the profiles, not the individual profiles. Further, of the 472 DOT titles, twenty DOT titles that had ten or more profiles, a total of 354 jobs, were included in Subset B (see Table 1) which was used in our analyses of the consistency of job profile results for DOT titles. Only the final results of the profiles were included in the subset, that is, the results from sessions contributing to each profile were not included.

Analyses

In our first analysis we looked at the agreement between profiles obtained by the same analyst for the same job in the same company, but with different SMEs. Results from the 149 profiles in which more than one group of SMEs participated (i.e., Subset A) were analyzed, and the percentages of profiles with no difference between groups, with one-level differences, and with two-level differences or more were calculated.

In our second set of analyses we looked at the consistency of skill level requirements within job titles using Subset B. First, we used ANOVA to examine the mean differences among skill levels for different jobs. A significant F between jobs would indicate that the variability of skill levels between DOT titles was greater than the variability found within DOT titles, which indicates that regardless of who collected the data or which company provided the data, in general, skill levels vary reliably from job to job.

Our next analysis examined the consistency of the skill levels required *within* each job title. To do this, we calculated an estimate of the within-job-title (within-group) reliability using an adaptation of the within-group interrater reliability equation provided by James, Demaree, and Wolf (1982):

$$r_{wg(L)} = 1 - (s_{Xj}^2 / \sigma_{EU}^2)$$

where $r_{wg(L)}$ is the within-group interrater reliability for a group of K profiles on a single DOT title Xj , s_{Xj}^2 is the observed variance on Xj , and σ_{EU}^2 is the variance on Xj that would be expected if all judgments were due exclusively to random measurement error. Where $r_{wg(L)}$, our estimate of reliability, is greater than .70, it meets the minimally accepted standards of reliability. The

greater the consistency within DOT titles, the more robust (i.e., generalizable) will be the recommendations that educators and trainers can make about the work-readiness of students and trainees, respectively.

Results

Descriptive statistics for the skill ratings of three Work Keys skill areas used in this research, Applied Mathematics, Locating Information, and Reading for Information, are presented in Table 1. Only a subset of the profiles were established using more than one session (N = 149, 12.5% of the sample); the remainder, all based on one session of SMEs per profile, could not be included in this study.

The data strongly support the agreement of profiles established by different SME groups for the same job in the same company. As seen in Table 2, of the 134 jobs whose profiles included Applied Mathematics, 132 (89.8%) were no more than one level from initial agreement; of these 109 (74.2%) recommended identical skill levels. Of the 116 jobs whose profiles included Locating Information, 115 (99.1%) were no more than one level from initial agreement, and 82 (70.7%) recommended identical skill levels. Finally, of the 134 jobs whose profiles included Reading for Information, 128 (95.5%) were no more than one level from initial agreement, and 92 (68.6%) recommended identical skill levels.

Next, the profiles were examined to determine if the variance between job titles was larger than the variance within each job title. Since the data set is one that accumulated naturally (not by experimental design) and produced unequal cell sizes, the majority of the job titles have few cases (profiles). Therefore, a subset of job titles that included ten or more profiles (shown as Subset B in Table 1) was identified for this analysis; this subset consists of a total of 20 distinct DOT titles. The job titles are Chemical Operator II, Chemical Operator III, Customer Service Representative, Electrician, Electronics Assembler, Electronics Technician, General Supervisor, Hand Packager, Injection-Molding-Machine Tender, Machine Packager, Machine Operator I, Machine Operator II, Machinist, Maintenance Mechanic, Material Handler, Numerical Control Machine Operator, Quality Control Technician, Secretary, Shipping & Receiving Clerk, and

Stores Laborer.

The finding that variability in skill levels is greater between jobs with different job titles than it is between jobs within the same job title is evidence that skill levels do not vary equally across all jobs, and that skill levels vary reliably depending on differences between the job titles to a greater degree than they vary depending on differences between organizations. This is important information for schools or trainers wanting to use summary profiles as education or training targets.

The ANOVA analysis of Subset B, is shown in Table 3. The results indicate that job title, that is, differences in skill levels across job titles, accounts for a larger source of variance in the ratings of Applied Mathematics ($MS_{\text{between jobs}} = 10.32$, $MS_{\text{within jobs}} = 0.88$, $F = 11.71$, $p < .05$, $R^2 = 0.40$, $\omega^2 = 0.36$), Locating Information ($MS_{\text{between jobs}} = 2.86$, $MS_{\text{within jobs}} = 0.52$, $F = 5.49$, $p < .05$, $R^2 = 0.26$, $\omega^2 = 0.21$) and Reading for Information ($MS_{\text{between jobs}} = 7.31$, $MS_{\text{within jobs}} = 0.64$, $F = 11.39$, $p < .05$, $R^2 = 0.39$, $\omega^2 = 0.36$) than did the variability in skill levels within job titles. That is, the same levels of Applied Mathematics, Locating Information, or Reading for Information skills do not hold for all the jobs in question. For example, higher levels of each of these skills are required for the Chemical Operator jobs (on average, Level 5), than for the Machine Operator jobs (Level 4). In other words, although these skills are needed by employees in all of the jobs profiled, there appears to be reliable differences in skill level requirements from job to job.

However, while we found reliable differences in skill level requirements from job to job, we did not find reliable estimates of skill levels within each job title. Using James et al.'s estimate of the intra-class correlation coefficient, the intra-class correlation coefficients for Applied Mathematics, Locating Information, and Reading for Information, were .33, .65, and .36, respectively. In other words, for any one job title, the level of skill needed can vary. While educators may want to use summary data to estimate skill requirements for counseling students about job requirements, employers cannot simply “look up” a skill level and use that as their passing score on a Work Keys assessment. They need to conduct a thorough job analysis to determine which skill levels are required for jobs in their own companies especially if the

information is used for administrative decisions with respect to their employees.

Discussion

In conducting this research, we looked at two prerequisites for establishing the reliability of the Work Keys job profile results. First, consistency between different groups of SMEs rating the same job in the same organization, was found. The Work Keys job profiling training and structured job analysis procedure do appear to result in skill level ratings with a large degree of agreement from one group of raters to another. Just as assessors in an assessment center must reconcile differences found by different assessors for the same job candidate, Work Keys profilers reconcile differences in skill level requirements for the same job in the same company from profiling session to profiling session. Profilers bring together SMEs from each group to resolve the differences between skill level recommendations. However, it is reassuring to know that data collected so far shows that the need to reconcile is rare, and when differences do occur, they are small.

On the other hand, our investigation of the consistency in skill level requirements within a job title found mixed results. While we found significant differences in skill requirements from one job title to another, considerable variability in skill level requirements was still found within each job title, particularly for mathematics and reading. These differences could be due to differences in technology, work design, or other factors unique to each company; in other words, they reflect *real* differences in jobs from company to company. It is also possible that these differences are due to the skill or ability of the individual job profiler. At this time, we are not able to separate these two effects. We will need sufficiently large numbers of profiles from the same profilers for the same jobs to test this hypothesis. However, as human resource professionals familiar with job analysis, we did not find these results surprising; specific tasks of a job and the skill requirements needed to perform those jobs can differ depending on the company, technology in place, and work design.

Ultimately, the accuracy of a job profile cannot be directly tested, but can only be inferred. Like performance measures, job analyses suffer from a “criterion problem”; there is no

accepted criterion for establishing the accuracy of a job analysis. These results, coupled with (a) previous findings of the concurrent validity study of the use of the Locating Information assessment for predicting the success of civil service clerical workers (Lee, McLarty, Robie, Reichert, Edwards, and Tozer, 1995), and (b) the limited adverse impact of Work Keys assessments for many jobs (Nathan, 1995), begin to build support for the appropriateness of the Work Keys system as an important selection and screening tool.

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Table 1

Frequency Statistics of Work Keys Skill Levels

 Total Number of Jobs = 1193

	Mean	Median	Mode	Range	Min.	Max.	Var.	Standard Deviation
Applied Mathematics	4.42	4	4	4	3	7	1.54	1.24
Locating Information	4.44	4	4	3	3	6	0.74	0.86
Reading for Information	4.45	4	5	4	3	7	1.09	1.04

Subset A

Total Number of Jobs = 149

Applied Mathematics	4.12	4	3	4	3	7	1.25	1.12
Locating Information	4.29	4	4	3	3	6	0.59	0.77
Reading for Information	4.10	4	4	4	3	7	0.83	0.91

Subset B

Total Number of Jobs = 20

Applied Mathematics	4.44	4	4	4	3	7	1.28	1.13
Locating Information	4.44	4	4	3	3	6	0.63	0.79
Reading for Information	4.58	5	5	4	3	7	1.11	1.05

Table 2

Frequency and Percentage of Session Results that were Identical (0), One-Level Off (± 1), and Two-Levels Off (± 2)

N = 149	Applied Mathematics	Locating Information	Reading for Information
0	109 (74.15%)	82 (55.78%)	92 (62.58%)
± 1	23 (15.65%)	33 (22.45%)	36 (24.49%)
± 2	2 (1.36%)	1 (0.68%)	6 (4.08%)
Not Included In Profile	13 (8.84%)	31 (21.09%)	13 (8.84%)

Table 3

ANOVA: Sources of Variance in Job Profiles

Total Number of Jobs = 354
 Total DOT Titles = 20

	DF	Sum of Squares	Mean Square	F	p level
<u>Applied Mathematics</u>					
Job Title	19	195.99	10.32	11.71	<.05
Error	334	294.33	0.88		
Total	353	490.32			
<u>Locating Information</u>					
Job Title	19	54.44	2.86	5.49	<.05
Error	334	157.60	0.52		
Total	353	212.05			
<u>Reading for Information</u>					
Job Title	19	138.93	7.31	11.39	<.05
Error	334	216.32	0.64		
Total	353	355.25			

Table 3 (continued)

ANOVA: Sources of Variance in Job Profiles

Total Number of Jobs = 354

	Applied Mathematics		Locating Information		Reading for Information	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Chemical Operator II	4.50	0.97	5.10	0.88	4.90	0.32
Chemical Operator III	5.30	1.06	5.22	0.83	5.00	1.00
Customer Service Representative	4.38	0.96	4.59	0.62	4.87	0.74
Electrician	5.61	1.09	4.94	0.68	5.29	0.92
Electronics Assembler	3.86	0.69	4.38	0.52	4.00	0.82
Electronics Technician	5.90	1.10	4.67	0.71	5.40	0.84
General Supervisor	4.54	0.93	4.73	0.65	4.82	0.60
Hand Packager	3.50	0.85	3.60	0.70	3.78	0.83
Injection-Molding-Machine Tender	3.60	0.70	3.70	0.82	4.10	0.74
Machine Packager	3.42	0.58	3.95	0.58	3.55	0.63
Machine Operator I	4.00	0.83	4.14	0.73	3.96	0.77
Machine Operator II	4.05	0.91	4.32	0.75	4.21	0.79
Machinist	5.27	1.42	4.80	0.92	4.33	1.00
Maintenance Mechanic	5.16	0.99	4.81	0.74	5.16	0.77
Material Handler	3.81	0.87	4.19	0.66	3.95	0.86
Numerical Control Machine Operator	5.25	1.06	4.82	0.98	4.43	1.09
Quality Control Technician	5.27	1.19	4.90	0.57	4.91	0.83
Secretary	4.39	0.88	4.29	0.75	5.03	0.90
Shipping & Receiving Clerk	3.68	0.85	4.13	0.76	3.67	0.70
Stores Laborer	3.40	0.70	3.89	0.33	3.60	0.70
