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The O*NET content model: strengths and limitations

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Abstract This paper describes the Occupational Information Network (O*NET), a relatively recent database containing measures of occupational characteristics produced by the United States Department of Labor as a replacement for the Dictionary of Occupational Titles. O*NET scores cover cognitive, interpersonal, and physical skill requirements, as well as working conditions, and are derived mostly from survey responses of large, representative samples of workers. O*NET's substantive scope and sampling are impressive, but there are also significant gaps and duplication in content. Underlying constructs, item wording, and response options are often vague or overly complex. However, O*NET items have generally sensible correlations with wages, which, along with the richness of the database, ensure O*NET's place among researchers interested in work and labour markets.

Stärken und Grenzen des O*NET-Modells

Zusammenfassung Dieser Artikel beschreibt das Occupational Information Network (O*NET), einen relativ neuen Datensatz des amerikanischen Arbeitsministeriums, der Kennziffern zu den Charakteristika von Berufen enthält und das „Dictionary of Occupational Titles“ ablöst. O*NET umfasst Daten zu den kognitiven, interpersonellen und physischen Kompetenzanforderungen sowie zu den Arbeitsbedingungen. Die Daten stammen zumeist aus großen

und repräsentativen Befragungen von Beschäftigten. Die substanzielle Reichweite und Zusammensetzung des Datensatzes ist beeindruckend, auch wenn er signifikante Lücken und Dopplungen enthält. Die zugrunde liegenden Konstrukte, Frageformulierungen und Antwortmöglichkeiten sind vielfach vage und allzu komplex. Gleichwohl bestehen zwischen den Items in O*NET und den Löhnen im Allgemeinen merkliche Korrelationen. In Verbindung mit der großen Reichweite des Datensatzes bietet dies die Gewähr dafür, dass O*NET ein hoher Stellenwert in der Arbeitsmarkt- und Berufsforschung zukommt.

As the papers in this volume attest, measuring job skill requirements and related job characteristics has always been challenging. One of the earliest and best known sources of direct measures is the Dictionary of Occupational Titles (DOT), a government reference publication produced by the United States Department of Labor's Employment and Training Administration (ETA). ETA has replaced the DOT with the Occupational Information Network (O*NET), which has attracted growing interest but is much less well-known than the DOT. O*NET represents an impressive effort to develop a systematic body of information on occupational characteristics. O*NET has been used in academic studies (e.g., Feser 2003; Hirsch 2005; Krueger and Schkade 2007), and it is likely that interest in O*NET among social scientists studying work and employment will grow, so some understanding of its characteristics as a source of social science data is useful.

The project's principals have published extensive evaluations of the pretest (Peterson et al. 1999; Peterson et al. 2001), but the other background reports and documentation from the O*NET project are somewhat fragmented and the existing record contains notable gaps. There is no published,

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independent evaluation of O*NET comparable to Miller et al.'s (1980) work on the DOT. This paper synthesizes existing published and informally collected information to give researchers an introduction to O*NET. The paper discusses some of O*NET's conceptual strengths and limitations, and presents some empirical analyses of the database's properties to illuminate these issues.

The first section provides a brief description of the DOT as background because its limitations provided the motivation for O*NET. The second section gives a brief description of the development of O*NET. The third section describes the structure of the database and the data collection process. The fourth section discusses some general issues related to O*NET content. The fifth section provides a more detailed evaluation of the measurement properties of O*NET items and scales. A final section presents some concluding observations.

1 Background: the dictionary of occupational titles

The first edition of the Dictionary of Occupational Titles (DOT) was published by the U.S. Department of Labor in 1939 to assist the Employment Service in matching job-seekers to vacant positions during the Depression. Subsequent editions of the DOT appeared in 1949, 1965, and 1977. In 1991 a partial revision of the fourth edition appeared as the final DOT database. In addition to helping the United States Employment Service find jobs for the unemployed, the DOT was also intended as a source of occupational information for career counsellors and students interested in understanding education and training requirements and other demands of different jobs. In her introduction to the final edition of the DOT, the Secretary of Labor, Lynn Martin, noted that it "appears at a time when there is growing recognition of the need for lifetime learning [and] when rapid technological change is making the jobs of current workers more complex than they were even a few years ago..." (United States Department of Labor 1991, p. iii). These sentiments are still relevant today; indeed, they have been voiced continuously in the subsequent two decades.

In addition to narrative job descriptions, the principal content of the DOT is various measures of job skill requirements and other important job characteristics for over 12,000 specific job titles. The DOT rated the level of General Educational Development (GED) and Specific Vocational Preparation (SVP), or job-specific training, required by jobs.

Other important measures rated the cognitive, interpersonal, and physical demands of jobs. This tripartite categorization of worker activities into relations with data, people, and things has been validated in other work, including O*NET, and continues to be a useful category scheme for understanding work requirements (Kohn and Schooler 1983; Peterson et al 1999, pp. 251 ff.).

A large set of measures assessed job requirements in terms of the aptitudes (e.g., manual dexterity), temperaments (e.g., directing others), interests (e.g., artistic), physical demands (e.g., lifting) and environmental conditions (e.g., exposure to chemicals).

The data contained in the DOT was collected by trained job analysts in ETA field offices across the United States based on their observations and interviews at selected job sites. Job analysts visited workplaces on a continuous basis and each new edition of the DOT replaced existing scores with the new scores collected in the intervening period.

Although the DOT was devised primarily to serve practical purposes, social scientists began using the data in the 1960s (Miller et al. 1980, p. 7). Social science use of the DOT grew after Spenner's (1979) seminal work and the large-scale evaluation of the DOT by Miller et al. (1980) sponsored by the National Academy of Sciences, which resulted in the first widely available machine-readable data files with DOT scores linked to standard U.S. Census occupation codes. The crosswalk of more than 12,000 DOT occupation codes to the much smaller set of approximately 450 Census occupation codes permitted researchers to merge DOT scores with standard labour force surveys.

Nevertheless, the DOT was devised by applied psychologists and practitioners for career counselling, not social science research, and the evaluation by Miller et al. (1980) raised a number of questions regarding the quality of the data. They found the DOT over-represented blue-collar manufacturing jobs, the jobs rated were a convenience sample rather than a probability sample, and most ratings in the fourth edition (1977) were simply carried from previous editions, often dating to the 1950s and 1960s without necessarily reevaluating them thoroughly because the scale of the required field visits proved prohibitively time-consuming and costly. Others noted that the DOT scores are occupation averages, which means the measures contain no within-occupation variation (Miller et al. 1980; Attewell 1990; Spenner 1990; Vallas 1990; U.S. Department of Labor 1993, p. 20).

Although some research shows DOT measures perform better than some of the critics suggest (Kohn and Schooler 1983; Handel 2000), the age of the DOT data, nature of the sample, and quality of the measures argued for new and better information on skill requirements and other job characteristics.

2 The development of occupational information network (O*NET)

Responding to methodological criticisms of the DOT and the costs of in-person job analysis, the Advisory Panel for the Dictionary of Occupational Titles (APDOT) was created in 1990

to consider alternatives. APDOT recommended the creation of a new system to replace the DOT, subsequently named the Occupational Information Network (O*NET), which would use standardized surveys of a representative sample of job incumbents instead of job analysts conducting workplace interviews and observations (U.S. Department of Labor 1993; Peterson et al. 1999, pp. 297f.; Peterson et al. 2001).

Intended as an intellectual as well as a methodological break with the DOT, APDOT framed its task in terms of ideas derived from post-industrial and post-Fordist theories. The APDOT report contrasted the Fordist era, when the DOT was developed, to present conditions.

It was a time when mass production largely controlled or limited worker discretion. Jobs were broken into simple tasks that could be filled by low-skilled workers. Layers of managers directed efforts while sophisticated quality control systems caught defects. In describing workers and workplaces, the DOT of the past reflected centralized hierarchical structures and thousands of narrowly defined jobs. As a result, it frequently emphasized manual and manipulative rather than cognitive skill requirements.

Today intense international competition is changing the workplace. The new workplace is characterized by fast-paced product cycles, rapid changes in technology and increased interest in quality and service. To meet these changes, new business arrangements have evolved that encourage faster and more creative action, increased flexibility and closer partnerships with employees and customers. Competition has also increased the pressure for performance.

More flexible and adaptable workforces value teamwork over individual effort and networks and alliances over rigid hierarchies. Flatter organizations decentralize responsibility and create greater employee involvement at all levels. In short, these new high performance workplaces demand new technologies, new workplace structures and new skills (U.S. Department of Labor 1993, p. 13; see also Peterson et al. 1999, pp. 293 f.).

O*NET sought to avoid the blue-collar manufacturing bias of the DOT and improve measurement of “the increasingly cognitive demands of jobs and the new ways of thinking and managing that focus on quality, variety, speed and customer service” (U.S. Department of Labor 1993, p. 4). A National Academy of Science panel also endorsed the attention given to employee involvement practices in the early version of O*NET (National Research Council 1999, pp. 189, 203 f.).

Another stated goal of O*NET was to gather information relevant to concerns with perceived skills shortages and assist related government initiatives, such as revised educational standards, promotion of apprenticeships, training

programs, and voluntary industry skills standards, as well as the traditional functions of the employment service (U.S. Department of Labor 1993, p. 18, 26 f., 38; Peterson et al. 1999, pp. 9 ff., 300).

The final APDOT report called for new measures that are “accurate, reliable, and valid” and could serve as a basis for rating both job demands and worker abilities in order to improve person-job matching and help policy makers estimate future skill needs more accurately (U.S. Department of Labor 1993, p. 7, 14, 17, 20, 31). It was hoped that the use of survey self-reports would permit ratings to be updated on a regular basis. To facilitate this process, the new system would aggregate occupational categories from over 12,000 titles to less than 1000 occupational units using a slightly modified version of the Standard Occupational Classification system, which would also facilitate linkage to other government labour market data (U.S. Department of Labor 1993).

The APDOT report anticipated that a prototype could be created by 1994 and a final database would be ready by 1996, though later estimates pushed the completion date to 2003 (U.S. Department of Labor 1993, pp. 23 f.; Peterson et al. 2001, p. 481). As a bridge, early versions of O*NET reviewed raw data collected for the DOT in previous decades and recoded them in terms of the new O*NET variables. O*NET began collecting new data from surveys of job incumbents in 2001, replacing the recoded DOT data on a rolling basis until June 2008, when first complete version of O*NET based on original data became available, eighteen years after the APDOT panel was established (U.S. Department of Labor 2005, pp. A-12 f., A-44, A-61).

O*NET resurveys occupations on a continuous basis in a 5-year cycle so another completely new set of ratings became available in 2013. This has great potential utility for researchers interested in capturing within-occupation skill change, which was not possible with the DOT. However, researchers will need to exercise caution because the project is not organized specifically for research purposes and new ratings simply replace old ratings for each set of occupations on a rolling basis rather than updating all ratings for each new edition. In addition, one skills section previously completed by job-holders is now completed by job analysts who make judgment-based ratings using written job descriptions, rather than site visits. The values of these O*NET variables cannot be assumed to be comparable to prior values derived from incumbent self-reports.

3 O*NET data collection and structure

The first complete O*NET cycle produced a database of 239 items across seven surveys mailed to employers for workers to complete and an additional questionnaire assigned

to job analysts because the questions proved too abstract for job incumbents to answer (U.S. Department of Labor 2005, pp. A-4, A-9). The incumbent questionnaires are titled Education and Training, Knowledge, Work Activities, Work Context, Work Styles, and Skills. A small sample of job analysts complete the Abilities questionnaire based on written job descriptions and in 2008 assumed responsibility for the Skills questionnaire from job incumbents, creating a break in this series. These questionnaires cover different but sometimes overlapping substantive domains.¹

To reduce respondent burden, individuals within occupations are randomly selected to receive a subset of questionnaire(s) requiring about a half-hour to complete, rather than completing all surveys.

Responses are averaged across respondents on the assumption that any within-occupation variation represents measurement error, which partly reflects traditional thinking within the guiding discipline of Industrial/Organizational (IO) psychology (Peterson et al. 1999, p. 303; Peterson et al. 2001, p. 485; cf. U.S. Department of Labor 2005, p. A-60). Like the DOT, then, the O*NET database consists of occupation mean values and the original micro-data is not available to researchers. This is a clear drawback to the O*NET database because job-level information on job skill requirements is relatively rare and researchers have been concerned for a long time that occupation-level data may mask important variation within occupations (e.g., Spenner 1990).

In addition to the main surveys, all respondents complete a checklist of representative occupation-specific tasks indicating the tasks that apply to their job.

All respondents also complete a Background questionnaire giving information on personal characteristics and their job, such as age, gender, education, race and ethnicity, tenure, and any limiting physical or mental conditions, among others. Unfortunately, the information from the Background survey is not made publicly available in electronic form, in published tabulations, or even mentioned in numerous background reports consulted for this paper, so the demographic profile of O*NET respondents, the purpose of this information, and the use to which it is put are unclear.

Although there is nothing in principle that prevents the release of individual-level data for research purposes, there have never been plans for such release. This means, for example, that it is not possible to calculate the association between O*NET scores and demographic variables from the Background survey on the basis of microdata.

To draw samples of job incumbents, O*NET staff use data from the U.S. Bureau of Labor Statistics to identify industries that make significant use of the occupations tar-

geted in a data collection cycle and construct a sampling frame of establishments within those industries. Staff contact a random sample of employers and mailed surveys to those agreeing to participate, who then distribute surveys to a random group of employees in the target occupation(s). All employers receive a mix of different questionnaires for each occupation to help ensure the representativeness of data. Respondents receive a prepaid \$ 10 incentive for completing the survey. Spanish-language versions of the surveys are sent to workers who need them as determined by employers and notices accompany all survey packets indicating the availability of Spanish-language versions, though they were not a part of the earliest years of data collection (U.S. Department of Labor 2005, pp.B-18 f., B-27 f.).

According to one estimate, 70 % of eligible establishments agreed to distribute surveys to their employees, of whom 65 % returned completed surveys; response rates have been rising over time due to various efforts to increase them (U.S. Department of Labor 2005, p. A-13, B-28).

Though documentation is not always clear, it appears all O*NET measures are based on at least 15 respondents per occupation and often many more (U.S. Department of Labor 2005, p. B-6). O*NET does not publish information on total sample size, at least not in an easily accessed document, but one staff member estimated that currently approximately 125,000 incumbent questionnaires were collected toward the end of the first round of original data collection (personal communication, customer service staff, National Center for O*NET Development). This would mean there are roughly 31,000 respondents per item because each of the questionnaires is completed by only one-quarter of the sample, and there is an average of 39 respondents per item within each of the 809 occupations in the first complete database. Nevertheless, this calculation should be considered very informal because it is very difficult for a researcher to determine such basic facts about the O*NET sample as total number of respondents and number of respondents per occupation per questionnaire.

O*NET's sampling methodology is a significant improvement over the DOT and even standard household surveys. The sample is large and undoubtedly covers relatively rare occupations with higher reliability than household surveys. Using employers to identify incumbents of different occupations undoubtedly reduces measurement error relative to household surveys, in which occupational classification is based on self-reports that vary greatly in detail and quality (Mellow and Sider 1983; Mathiowetz 1992). Improved occupational assignment, in turn, reduces noise and improves accuracy in the calculation of means for substantive variables (Abraham and Spletzer 2009).

However, the absence of easily accessed summary information about the distribution of respondents by background characteristics makes it difficult to assess how well

¹ For full text of all questionnaires, see <http://www.onetcenter.org/questionnaires.html> (accessed January 23, 2016).

O*NET has succeeded in its efforts to ensure representativeness. Perhaps due to O*NET's applied orientation, an extensive review of published O*NET reports did not turn up any information on the demographic composition of respondents. Therefore, it is not possible to compare the distribution of O*NET respondents with Census population values for age, education, gender, race/ethnicity, and Spanish-language use, although response rates are available by occupation, industry, employer size class, and region (U.S. Department of Labor 2005, Appendix E).

If response rates within occupations are higher for more educated workers, which might be expected from the experience of other surveys, the estimates of mean occupational skill requirements might be higher than the population values. This is an issue for all voluntary surveys, but O*NET does not seem to have considered the issue of demographic representativeness or the use of sampling weights to compensate for any imbalances even though it collects information on individual respondents that would permit identification and correction of any sampling biases.

Because O*NET is a mailout-mailback survey that makes significant literacy demands on respondents, it is likely that responses are skewed to some degree toward the more educated, those with higher cognitive abilities, and citizens and legal residents. Immigrants who speak neither English nor Spanish are effectively outside the universe of respondents, and even Spanish-speakers are likely to be underrepresented, especially undocumented immigrants. Because it samples people through employers, O*NET may also underrepresent various kinds of casual employment, such as temporary workers (National Research Council 1999, p. 203). All of

these influences may impart an upward bias to estimates of job skill requirements relative to true population values and otherwise affect estimated means. However, O*NET does not publish the data necessary to address these issues further.

4 O*NET content

There are 239 distinct items across all O*NET survey instruments, not counting the Background questionnaire. The Knowledge, Skills, Abilities, and Work Activities questionnaires ask two-part questions about both the Importance and Levels of a given skill or characteristic, such as the item on Negotiation below. These surveys account for 161 items or two-thirds of the total. In principle the different surveys cover different substantive domains, but in practice the division of labour between them is imprecise and the content overlapping. The size of the O*NET database and the looseness of its conceptual structure make it difficult to summarize the content parsimoniously, but Table 1 gives some indication of the major content areas covered by the different surveys.

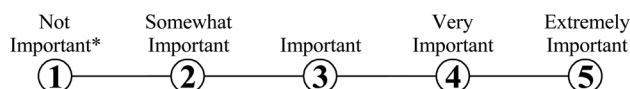
The content is strong in a number of areas. The education and training items are crisp and thoughtful. The response options are detailed, easy for respondents to understand, and expressed in natural units, such as educational degrees and units of time. The only drawback is that information on apprenticeships, which would be interesting to use in conjunction with other data from the U.S. Bureau of Labor Statistics, are not publicly available at least in the downloadable spreadsheet files on the O*NET web site.

Example: O*NET Importance and Level Scales

13. Negotiation

Bringing others together and trying to reconcile differences.

A. How important is NEGOTIATION to the performance of your *current job*?



* If you marked Not Important, skip LEVEL below and go on to the next skill.

B. What level of NEGOTIATION is needed to perform your *current job*?

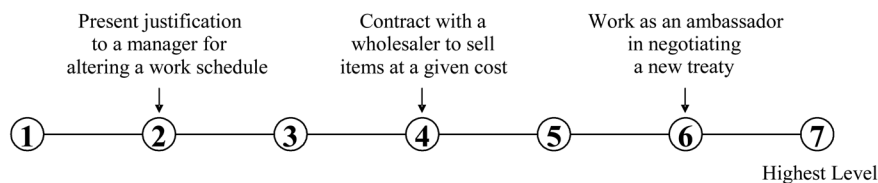


Table 1 O*NET surveys and principal content

Survey	Main content
Education/ training	Required education, related work experience, training
Knowledge	Various specific functional and academic areas (e.g., physics, marketing, design, clerical, food production, construction)
Skills	Reading, writing, math, science, critical thinking, learning, resource management, communication, social relations, technology
Abilities	Writing, math, general cognitive abilities, perceptual, sensory-motor, dexterity, physical coordination, speed, strength
Work activities	Various activities (e.g., information processing, making decisions, thinking creatively, inspecting equipment, scheduling work)
Work context	Working conditions (e.g., public speaking, teamwork, conflict resolution, working outdoors, physical strains, exposure to heat, noise, and chemicals, job autonomy)
Work style	Personal characteristics (e.g., leadership, persistence, cooperation, adaptability)

The Knowledge questionnaire also has a potentially useful set of questions on the extent to which specific academic subjects and functional knowledge are required by all occupations (e.g., medicine, biology, chemistry, physics, foreign language, engineering, mechanical knowledge, clerical, administration and management). Unfortunately, the anchors for the Levels scales have problems in common with most of the other surveys, as discussed below. There is an extensive set of items on interpersonal and problem-solving skills across different instruments. Items on physical and other stressors and hazardous working conditions in the Work Contexts questionnaire are clear and objective, and a rare source of representative data on these important topics.

Unfortunately, although the APDOT report commented explicitly on the need to understand “new technologies, new workplace structures and new skills” (U.S. Department of Labor 1993, p. 13), O*NET’s coverage of the first two domains is weak.

There are items on working with manufacturing technology, but very few relating to information technology and they tend to be too general or ambiguous to be very informative. This is a bit peculiar since one of its goals was to replace the DOT with measures more relevant to the information economy.

Perhaps to fill this gap, O*NET recently began a new Tools and Technology (T2) module, a massive data collection effort that involves sifting through information from occupational information databases, professional associations, vocational education, education/training curricula, and job listings, and consultation with subject matter experts. Most of the data appears to be collected through internet searches (Dierdorff et al. 2006). According to the O*NET

web site, over 32,000 tools and technology are represented in the database, coded into over 18,000 non-duplicative UN Standard Products and Services Codes (UNSPSC). This is a valuable and detailed checklist of specific equipment and software used in different occupations.

However, because the data were not on the incumbent surveys there is no information on the rates of technology use within occupations or the level of knowledge required. A number of occupations might use robots, but the T2 database cannot say whether the proportion of workers within them using robots is 5 % or 95 %. Likewise, while both secretaries and financial analysts may use spreadsheets, there is no way to know whether the software is being used as a simple electronic ledger or to conduct complex financial modelling. The absence of incidence rates and level of complexity is a problem for O*NET’s measures of technology use.

Employee involvement practices are also absent from O*NET, though apparently were included in pretests (Peterson et al. 1999, pp. 147 ff.; Peterson 2001, p. 482). Although there are a few general measures of related ideas, such as job autonomy and group-based work, O*NET is relatively weak on measures of self-directed teams, involvement in quality improvement, and related concepts that are prominent in recent debates on the changing nature of work.

Despite the stated desire to reorient O*NET away from the DOT’s focus on manual occupations (Peterson et al. 1999, pp. 11,16), physical, perceptual, sensory, and psychomotor variables receive some of the most concentrated attention with 38 items. This may reflect O*NET’s reliance on pre-existing job analysis schemes and the understandable desire to assume the DOT’s function in disability determinations (Peterson et al. 2001, pp. 457 ff.). These variables may be useful for measuring changes in physical job demands, such as the declining importance of bodily work (Zuboff 1988), but research indicates that physical job requirements are not strongly related to wages, for example (Rotundo and Sackett 2004, pp. 137 ff.).

Likewise, there are other areas of overlap across surveys. There are four items on mathematics skills, mathematics knowledge, mathematical reasoning, and number facility ($\alpha = 0.92$). In contrast, there is no item on the specific kinds of math used on the job (e.g., algebra, calculus), which might be more helpful to job seekers, educators, and policy planners, as well as researchers. There are items on writing skills, writing comprehension, and written expression, but none on the specific kinds or maximum length of documents read or written on the job. There is an item on “judgment and decision making” and another on “making decisions and solving problems,” and others on freedom to make decisions and frequency of decision-making. There are separate items on dealing with angry people, resolving conflicts, and frequency of conflict situations.

Fig. 1 Percentage distribution of importance and level correlations, by interval

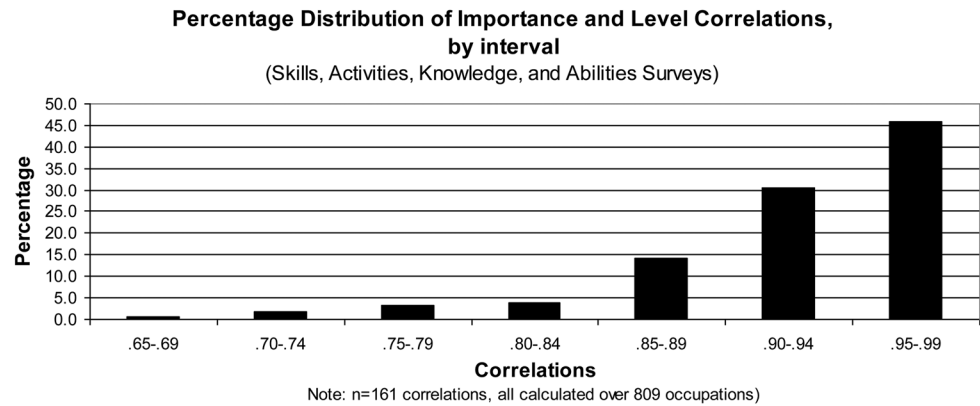
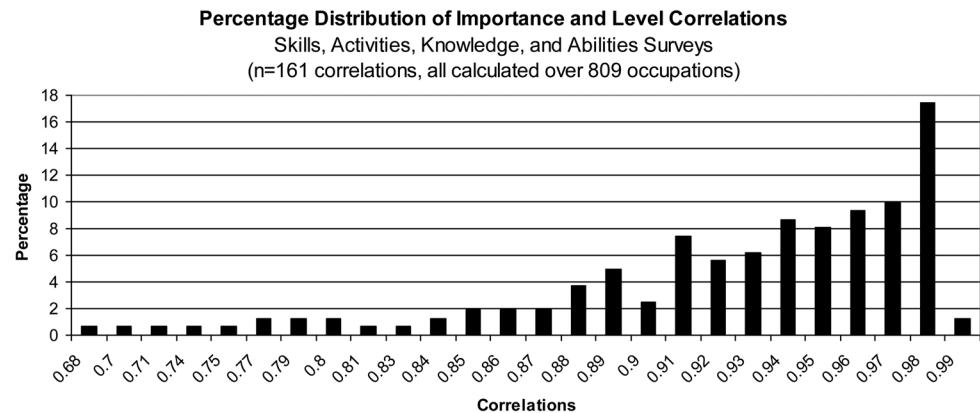


Fig. 2 Percentage distribution of importance and level correlations



There are at least a dozen questions on general cognitive ability ($\alpha=0.97$), such as analytical thinking, critical thinking, analyzing data or information, deductive reasoning, and inductive reasoning.² Although distinctions among these concepts may be clear to psychologists who work with these constructs, they are likely lost on respondents and perhaps even some job analysts rating occupations on the Abilities instrument. Informal inspections of correlations between these items also suggests there may be survey effects, i.e., correlations seem lower between items from different surveys with relatively close meanings compared to correlations between items from the same survey with less similar meanings. In other words, there may be a tendency for respondents to respond in systematic ways to the items within a survey when they belong to the same domain, rather than responding to each item independently.

In short, the individual surveys contain much that is useful but also seem to have been constructed with less coordination than desirable, resulting in both duplication and

gaps in content. In other cases, the underlying construct of interest is itself unclear, which is considered further in the following section.

5 Measurement: O*NET items and scales

O*NET items from the four surveys with two-part questions raise three kinds of concerns: the distinction between Importance and Levels, construct definition and question wording, and response scale anchors.

5.1 Importance and levels

The Knowledge, Skills, Abilities, and Work Activities questionnaires contain 161 two-part items that ask respondents the importance of the characteristic for their job (e.g., decision making) and, if at least somewhat important, the level of the characteristic needed for their job. By contrast, the Work Context questionnaire uses mostly frequency, time spent, and other conventional response scales, such as not important/extremely important and none/a lot. The Education and Training questionnaire uses degree obtained and required times as response options.

²The full list is (1) analytical thinking; (2) critical thinking; (3) analyzing data or information; (4) deductive reasoning; (5) inductive reasoning; (6) processing information; (7) complex problem solving; (8) updating and using relevant knowledge; (9) active learning; (10) thinking creatively; (11) fluency of ideas; and (12) category flexibility.

Analyses of pretest data indicated that Importance and Level items are so highly correlated ($r=0.95$) as to be largely redundant, but O*NET made no changes to this aspect of the questionnaires (Peterson et al. 1999, pp. 61, 290 f., 302). Analyses of current O*NET data confirms that the Importance and Level items are largely redundant. When Importance and Level scores are correlated across the full sample of 809 occupations for all 161 questions using this format, the mean correlation is 0.92 and the median is 0.94 (author's calculations). Approximately 19% of the correlations are 0.98 or above, and only 15% are below 0.88. Figures 1 and 2 present the full percentage distribution of the correlations in banded intervals and by individual value, respectively. It is unfortunate that the evident redundancy of these two sets of scales across 161 items coexists with the under-representation of content on information technology and employee involvement.

5.2 Construct definition and question wording

Specialists in the design of survey research agree that best practice argues for survey questions that are phrased clearly, avoid jargon, and measure a single, well-defined concept or construct, a property known as unidimensionality (Tourangeau et al. 2000, pp. 23ff., 61). Many O*NET items violate these principles. There are numerous examples of vague, complex, jargon-laden, potentially confusing, and multi-barrelled items that bundle more than one concept into the same question. Even the definitions used to clarify questions are often long and complex. Points along the Levels scales are anchored by behavioural examples that have their own problems, discussed in the next section.

For example, one item asks the extent to which jobs require "Identifying Objects, Actions, and Events," which is defined as

Identifying information by categorizing, estimating, recognizing differences or similarities, and detecting changes in circumstances or events.

Testing an automobile transmission apparently involves a relatively low level of this construct, while determining the reaction of a virus to new drug represents a relatively high level. (The questionnaire text for this and the following examples are reproduced in the Appendix).

Other examples include:

- Estimating the Quantifiable Characteristics of Products, Events, or Information

Estimating sizes, distances, and quantities; or determining time, costs, resources, or materials needed to perform a work activity

- Judging the Qualities of Objects, Services, or People

Assessing the value, importance, or quality of things or people

- Systems Evaluation

Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system

These and other O*NET items presume a single, easily-rated dimension, but the questions arguably encompass many complex and difficult to rate dimensions. Some, such as "systems evaluation", "critical thinking" and "active learning" use behavioural science jargon that is likely to be unfamiliar and unclear to many lay respondents.

The anchoring examples do not necessarily clarify matters. For Systems Evaluation the anchors are determining why a coworker was unable to complete a task on time (Level 2), understanding why a client is unhappy with a product (Level 4), and evaluating the performance of a computer system (Level 6). It is not at all clear that this item measures a single, clearly defined construct.

Job analysis techniques often derive general constructs from factor analyses of many specific items and it appears that the O*NET surveys try to skip the use of concrete items and ask respondents to rate their jobs directly on the higher-order constructs. Given the difficulty even many social scientists have making substantive sense of the factors resulting from exploratory factor analyses, this does not seem a promising approach for surveys completed by lay people.

Variables on the Abilities questionnaire seem particularly prone to this problem. Questions originally intended for completion by job incumbents carry names like "fluency of ideas", "category flexibility", "speed of closure" and "rate control". The instrument contained so many technical terms that it was assigned to job analysts to complete rather than workers once final data collection began (Donsbach et al. 2003). The Skills questionnaire, which was completed by workers in O*NET's first 5-year cycle, was also transferred to job analysts in 2008 because of the cognitive difficulties its items created for respondents.

The APDOT panel recommended that "information should be presented in an easily understood format with a minimum of technical jargon" (U.S. Department of Labor 1993, p. 23). Lead project staff seemed generally satisfied that this goal was met.

[Survey items] differ from technical definitions, however, in that each skill is defined in simple English... In creating the O*NET questionnaires, every effort was made to write the descriptor definitions and anchors at

no more than an eighth-grade reading level (Peterson et al. 1999, p. 57, 243).

However, following the pretest, the conclusion from expert reviews, cognitive interviews, and focus groups was that survey questions were often “hard to understand, interpret, and answer” (Hubbard et al. 2000, p. 11). “Focus group participants sometimes found the right-side (example) anchors to be of limited utility in making a rating judgment about their job” (Hubbard et al. 2000, p. 14). Survey questions used difficult vocabulary, overlong sentences, and complex concepts that assumed knowledge and were difficult for respondents to relate to their own jobs (Hubbard et al. 2000, p. 11).

The task of answering such an item requires a fair level of verbal ability (to understand the words presented), cognitive sophistication (to conceptualize these novel concepts), and abstract thinking (to generalize from their own experiences to make judgments about people who they imagine might do their job). Respondents must also be sufficiently familiar with questionnaires to easily project their mental representation onto a rating scale that is itself complex and difficult to understand.

Most of the questions refer to high level abstractions of everyday activities. This makes it hard to (1) understand what the question is asking about and (2) retrieve and combine information to formulate an answer. This can result in unreliable and invalid answers. It is likely that high levels of education—higher than high school—are necessary, due to the extensive vocabulary used in these instruments (Hubbard et al. 2000, pp. 12 f.).

In short, answering many of the O*NET questions often appears to be a very complex judgment task. Survey research indicates that when survey questions present respondents with a complex task they are more likely to answer in a pragmatic fashion using heuristics based on their general views of the subject rather than responding to the particular content of the items as intended by researchers (Krosnick 1999, pp. 547 ff.). In other words, it is unlikely that all of the item ratings reflect independent judgments along distinct dimensions; answers to groups of items may reflect a response set.

5.3 Level scale anchors

The Knowledge, Skills, Abilities, and Work Activities surveys use Level of complexity scales that range from 1 to 7. In addition, O*NET staff assign a score of zero when respondents report a trait is not important for their job on the preceding Importance scale. The Levels scales are anchored

at three points with specific examples to give respondents common benchmarks in assigning scores to their jobs. The intent is to improve consistency across respondents and increase the objectivity of the ratings.

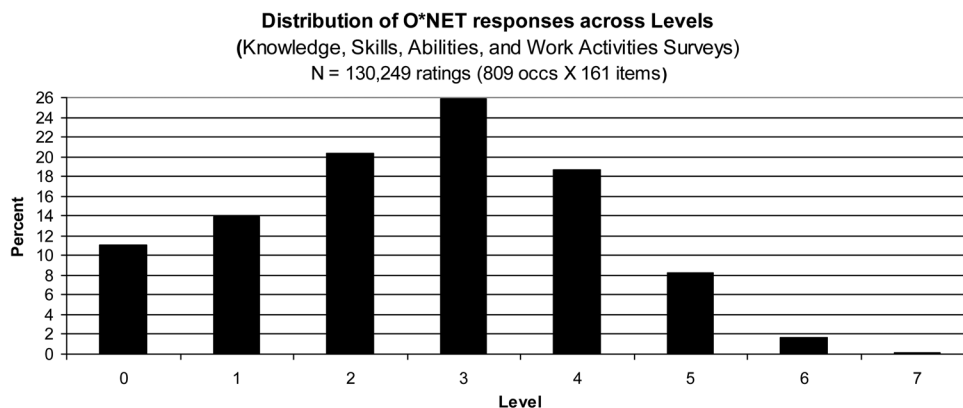
However, the behavioural anchors have three potential drawbacks: violation of the equal interval assumption, extreme anchoring and scale truncation, and questionable overall helpfulness of the anchors.

1. It is not obvious that the anchors divide the scales into equal intervals. The item on speaking skill is anchored by three behavioural examples at Levels 2, 4, and 6: explaining tourist attractions, interviewing applicants, and arguing a legal case before the U.S. Supreme Court (see Appendix). On its face, the level of speaking skill required for the middle anchor seems much closer to the first task than the third task, yet the survey asks respondents to treat the behaviours as marking off equally-spaced ranges of the construct.
2. There is also a systematic and rather puzzling tendency to use extreme examples to anchor level 6, which is one level below the maximum scale value. Level 6 anchors include writing a legal brief challenging a federal law, creating a new technology for producing industrial diamonds, judging the value of recently discovered ancient art, and maintaining information on orbital satellites (see Appendix). Another Level 6 anchor, estimating the amount of natural resources beneath the world's oceans, is not obviously a job responsibility for any occupation. Other Level 6 anchors, such as arguing a case before the Supreme Court, negotiating a treaty as an ambassador, and designing a new personnel system for the Army, are performed by a tiny fraction within their respective occupations. Even if one were to grant that respondents in other jobs could relate their tasks to these highly occupation-specific anchors, they would cover a very small fraction of the workforce. If these behaviours are one level below their respective scale maxima, one wonders how many jobs could possibly qualify for the maximum ratings.

Indeed, only 81 of the 130,249 ratings (809 occupations times 161 items) or 0.06% of ratings are between 6.50 and 7 (author's calculations). It seems likely that respondents almost never use the maximum scale value, probably because the Level 6 anchors tend to be so extreme. Scores at Level 6 (occupational means between 5.50 and 6.49 inclusive) are only slightly more common, representing 1.68% of all ratings. Thus, out of 130,249 ratings, approximately 1.75% is 5.5 or above.

The designers of O*NET seemed unaware of potential problems with the anchors, such as scale compression. While they acknowledged that individual anchors might have idiosyncratic effects, “It is difficult, however, for us to

Fig. 3 Distribution of O*NET responses across levels



believe that the chosen anchors plausibly could have serious, systematic effects” (Peterson et al. 1999, p. 244).

The rest of the distribution of ratings across levels shows good variation (see Fig. 3). However, O*NET creates potential confusion among respondents by offering response options that are then precluded by the choice of extreme examples for Level 6 anchors. Most survey researchers try to prevent compression of the response distribution to capture as full and detailed range of variation as possible. O*NET truncates its own scales unnecessarily by discouraging respondents from using the top two scale values and generates puzzlement among researchers and, one suspects, respondents, as well.

- At the most general level, it is not clear that O*NET’s behavioural anchors make the rating task easier than an unlabelled or less complexly labelled scale, such as the Importance scales. Because the anchors are so occupation-specific, respondents may have problems relating their own job tasks to them and locating themselves on the scale. For example, the item on “Documenting/Recording Information” assumes people know how much documentation is required for a crime scene investigation and can judge their own job’s paperwork requirements relative to this anchor point (see Appendix). This is not to endorse the Importance scales over the Level scales because in principle the concept of level of complexity or trait intensity is more meaningful than importance. However, it is quite possible that respondents are relying more on the numerical part of the Level scale than on the anchors, which are highly occupation-specific, often esoteric, and would seem to present a complex judgment task for respondents, who would need to relate these examples to their own particular job.

5.4 Implications

Despite the limitations of the O*NET items and scales, there is reason to believe *a priori* that the O*NET rankings con-

tain useful information. Research on occupational prestige scales within sociology shows that when respondents are asked to sort occupational titles without further instructions, they rank them in a manner consistent with other surveys asking respondents to rank occupations in terms of their prestige (Kraus et al. 1978). Prestige scores, in turn, correlate strongly with objective data on occupational earnings and education levels (Hauser and Warren 1997). Respondents who are trying to make sense out of ambiguous or confusing tasks will supply their own meanings or best guesses in such situations. Therefore, it would not be surprising if O*NET respondents provided broadly reasonable ratings of their jobs even if both the question wording and behavioural anchors were somewhat confusing and distracting. Respondents undoubtedly use the ranking implicit in the numerical scale as a guide if nothing else. Averaging ratings over respondents within occupations also reduces the influence of idiosyncratic rating behaviours. The high reported response rates, including low rates of item non-response, also suggest that the O*NET instruments have face validity, though the reassignment of the Skills questionnaire from incumbents to analysts because of respondent confusion over the instrument also argues for caution. The greater reliability of O*NET’s occupational coding also improves the reliability of its occupational skill scores.

Indeed, according to one test O*NET items show reasonably strong criterion validity. When O*NET items are correlated with wages the measures often perform well. Table 2 shows descriptive statistics for bivariate correlations between individuals’ wages and O*NET occupation-level scores, after O*NET data were appended to individual-level records in the Current Population Survey (2005) ($n_{cps} = 223,011$). The first row for all measures can be compared to the second row for the four surveys using the anchors and Importance-Level format (Knowledge, Skills, Abilities, Work Activities). The average correlation with wages is 0.19 for all items and 0.23 for those from the four surveys with anchors. While not all correlations are high, 40.2% of all ratings and 48% of ratings from the four surveys are greater than 0.30 (not shown). When

Table 2 Correlations between wages and O*NET items

	Mean	SD	N
All	0.19	0.23	239
Four surveys	0.23	0.23	161
Data	0.37	0.12	63
People	0.24	0.16	30
Things	-0.05	0.17	79
Management	0.37	0.07	22
Other	0.24	0.16	42

N number of correlations. The four surveys in the second row are Knowledge, Skills, Abilities, and Work Activities. Correlations produced by merging O*NET ratings onto microdata from the Current Population Survey outgoing rotation group files (2005) ($n=223,011$)

one considers that wages may not be a suitable criterion for all O*NET variables, these aggregate results seem reasonable.

Indeed, the results are in some cases even stronger when the correlations are disaggregated by subject. The items reflecting involvement with data and management tasks correlate 0.37 with wages on average and many are higher. Items relating to interpersonal tasks and skills correlate 0.27 with wages on average. Correlations for involvement with things, sensory-motor, and other physical tasks cluster around zero, with a significant number of negative values. The correlations for data-related and management tasks are not only larger, they are also more consistently related to wages (see Fig. 4). Another three items measuring job autonomy correlate 0.37 with wages on average (not shown). The residual category in the last row of Table 2

refers to questions dealing with personality traits, double-barrelled items, and other topics.

Table 3 shows the full set of 239 correlations in the order they appear on the different O*NET questionnaires. The absolute and relative magnitudes of many of the individual correlations appear reasonable, but others less so and argue for further analysis (e.g., wages correlate 0.38 with requirements for near vision ability and 0.46 with email use, but only 0.27 with programming skills). Needless to say, multivariate analyses might alter conclusions drawn from Tables 2 and 3.

Nevertheless, despite various exceptions, it appears that the implications of O*NET's limitations for the validity of its measures are smaller than might be expected, at least based on this initial analysis.

6 An alternative approach

Although O*NET is useful one might ask if there might be a better approach to measuring job skill requirements. O*NET sought to create a common language for describing worker and job requirements to improve person-job matching and help policy makers estimate future skill needs more accurately (U.S. Department of Labor 1993, p. 7,14, 17, 20,31; Peterson et al. 1999, p. 18). However, the level scales have an arbitrary metric that make direct comparisons between job characteristics and worker traits difficult. The rating scales may be useful for comparisons across jobs and over time, but they do not have an absolute meaning or

Fig. 4 Percentage distribution of correlations between O*NET measures and mean occupational wages

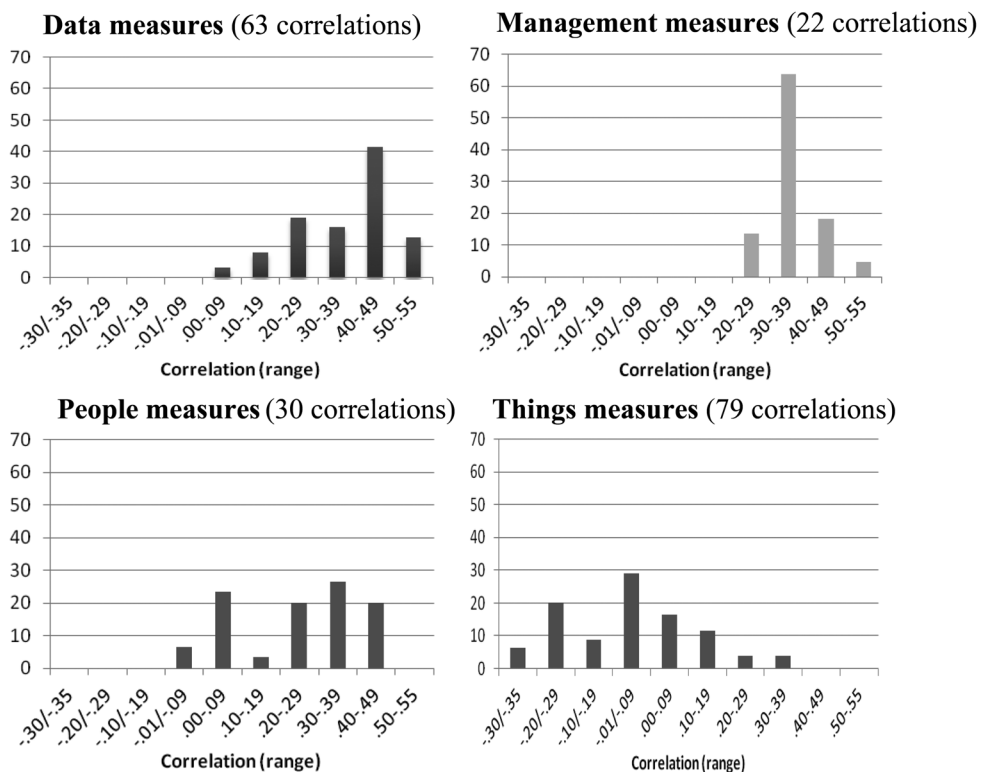


Table 3 Correlations between Wages and O*NET Variables

Variable	<i>r</i>
Education, training	
Job zone	0.53
Education required	0.49
Related job experience	0.44
Class training	0.26
OJT	0.29
Work Styles	
Achievement	0.44
Persistence	0.43
Initiative	0.39
Leadership	0.32
Cooperation	0.08
Concern for others	0.03
Social orientation	0.04
Self-control	0.01
Stress tolerance	0.20
Adaptability	0.29
Dependability	0.20
Attention to detail	0.28
Integrity	0.27
Independence	0.29
Innovation	0.34
Analytical thinking	0.49
Skills	
Reading comprehension	0.44
Active listening	0.43
Writing	0.43
Speaking	0.42
Mathematics	0.38
Science	0.23
Critical thinking	0.45
Active learning	0.43
Learning strategies	0.32
Monitoring	0.44
Social perceptiveness	0.31
Coordination	0.42
Persuasion	0.42
Negotiation	0.43
Instructing	0.34
Service orientation	0.28
Complex prob. solving	0.52
Operations analysis	0.29
Technology design	0.28
Equipment selection	0.13
Installation	0.12
Programming	0.27
Quality control analysis	0.32
Operations monitoring	0.13
Operation and control	0.13
Equipment maintenance	-0.06
Troubleshooting	0.19
Repairing	-0.03
Systems analysis	0.41
Systems evaluation	0.42

Table 3 (continued)

Variable	<i>r</i>
Judgment, decision making	0.48
Time management	0.44
Management of financial resources	0.36
Management of material resources	0.34
Management of personnel resources	0.38
Work Activities	
Getting information	0.45
Identifying objects, actions	0.34
Monitoring processes, materials	0.32
Inspecting equipment,	0.04
Estimating quantifiable characteristics	0.39
Judging the qualities of objects	0.44
Evaluating information for compliance	0.44
Processing information	0.46
Analyzing data or information	0.52
Making decisions, solving problems	0.51
Thinking creatively	0.46
Updating, using relevant knowledge	0.51
Developing objectives and strategies	0.48
Scheduling work and activities	0.46
Organizing, planning work	0.49
Perform general physical activities	-0.17
Controlling machines, processes	-0.05
Handling and moving objects	-0.22
Working with computers	0.39
Operating vehicles, devices, equipment	0.00
Drafting, laying out, and specifying	0.20
Repairing, maintain mechanical equip.	-0.03
Repairing, maintaining electronic equip.	0.08
Documenting information	0.39
Interpreting meaning of information	0.48
Communicating with supervisors, peers	0.46
Communicating outside organization	0.41
Establishing interpersonal relationships	0.36
Assisting and caring for others	0.07
Selling or influencing others	0.27
Resolving conflicts and negotiating	0.36
Performing for public	-0.02
Coordinating work of others	0.38
Developing and building teams	0.39
Training and teaching others	0.32
Guiding, directing subordinates	0.37
Coaching, developing others	0.35
Providing consultation to others	0.48
Performing admin. activities	0.38
Staffing organizational units	0.33
Monitoring, controlling resources	0.35
Knowledge	
Admin. and management	0.34
Clerical	0.27
Economic and accounting	0.25
Sales and marketing	0.15
Customer, personal service	0.20
Personnel, human resources	0.32

Table 3 (continued)

Variable	<i>r</i>
Production and processing	0.09
Food production	-0.28
Computers and electronics	0.41
Engineering and technology	0.26
Design	0.26
Building and construction	0.14
Mechanical	0.07
Mathematics	0.40
Physics	0.23
Chemistry	0.07
Biology	0.18
Psychology	0.24
Sociology and anthropology	0.22
Geography	0.19
Medicine and dentistry	0.12
Therapy and counseling	0.20
Education and training	0.33
English language	0.43
Foreign language	0.06
Fine arts	0.09
History and archeology	0.16
Philosophy and theology	0.19
Public safety and security	0.14
Law and government	0.38
Telecommunications	0.27
Communications, media	0.34
Transportation	0.08
Abilities	
Oral comprehension	0.49
Written comprehension	0.52
Oral expression	0.45
Written expression	0.50
Fluency of ideas	0.46
Originality	0.45
Problem sensitivity	0.43
Deductive reasoning	0.51
Inductive reasoning	0.50
Information ordering	0.46
Category flexibility	0.46
Mathematical reasoning	0.41
Number facility	0.35
Memorization	0.26
Speed of closure	0.33
Flexibility of closure	0.38
Perceptual speed	0.24
Spatial orientation	-0.09
Visualization	0.26
Selective attention	0.25
Time sharing	0.10
Arm-hand steadiness	-0.21
Manual dexterity	-0.27
Finger dexterity	0.06
Control precision	-0.10
Multilimb coordination	-0.20

Table 3 (continued)

Variable	<i>r</i>
Response orientation	-0.08
Rate control	-0.07
Reaction time	-0.08
Wrist-finger speed	-0.20
Speed of limbs	-0.22
Static strength	-0.25
Explosive strength	-0.01
Dynamic strength	-0.20
Trunk strength	-0.31
Stamina	-0.25
Extent flexibility	-0.31
Dynamic flexibility	-0.24
Gross body coord.	-0.28
Gross body equilibrium	-0.12
Near vision	0.38
Far vision	0.19
Visual color discrimination	0.14
Night vision	-0.06
Peripheral vision	-0.09
Depth perception	0.05
Glare sensitivity	-0.05
Hearing sensitivity	0.11
Auditory attention	0.03
Sound localization	-0.07
Speech recognition	0.24
Speech clarity	0.37
Work Contexts	
Face-to-face discussions	0.32
Public speaking	0.26
Telephone conversation	0.31
Electronic mail	0.46
Written letters and memos	0.38
Contact with others	0.07
Work with a work group or team	0.21
Deal with external customers, public	0.06
Coordinate or lead others	0.29
Responsible for health and safety	-0.04
Responsible for work outcomes	0.22
Conflict situations	0.18
Dealing with angry people	-0.04
Dealing with violent people	0.00
Indoor work, environment controlled	0.17
Work not environmentally controlled	0.02
Work outdoors exposed to weather	-0.03
Work outdoors under cover	0.00
Work in open vehicle	-0.06
Work in an closed vehicle	0.13
Physically close to others	-0.20
Sounds and noise uncomfortable	-0.07
Very hot or cold temperatures	-0.14
Bright or inadequate light	-0.05
Contaminants	-0.16
Cramped work space	-0.10
Whole body vibration	-0.02

Table 3 (continued)

Variable	<i>r</i>
Exposed to radiation	0.09
Exposed to disease	-0.01
Exposed to high places	0.00
Hazardous conditions	-0.02
Hazardous equipment	-0.02
Exposed to minor burns	-0.25
Sitting	0.31
Standing	-0.33
Climbing ladders, etc.	-0.04
Walking or running	-0.35
Kneeling, crouching, etc.	-0.25
Keeping balance	-0.29
Using hands with tools	-0.28
Bending or twisting body	-0.34
Repetitive motions	-0.34
Common safety equip.	-0.09
Specialized safety equip.	0.02
Serious mistake possible	0.24
Decisions' results	0.36
Decisions have impact	0.27
Freedom to make decisions	0.40
Automated job	0.08
Very exact is important	0.24
Repetitious activities	0.00
Freedom to set tasks	0.37
Competitive job	0.29
Meet strict deadlines	0.27
Keep pace set by machine	-0.18
Regular schedule	-0.04
Hours per week	0.39

O*NET ratings merged onto the Current Population Survey outgoing rotation group files (2005)

(*n*~216,000). Correlations listed according to order on O*NET questionnaires.

external referent. Likewise, abstract factor scores built from several such variables (e.g., Peterson et al. 1999, pp. 251 ff.) use arbitrary rather than natural units. There are usually no commensurate person measures to which they can be compared directly to test for possible mismatch.

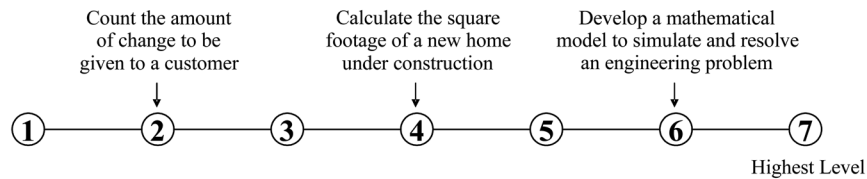
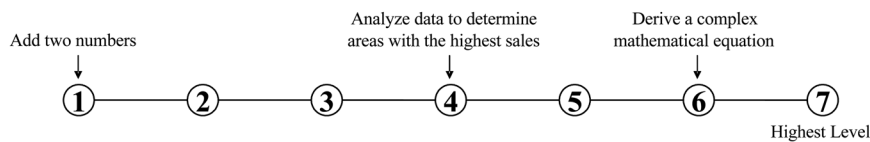
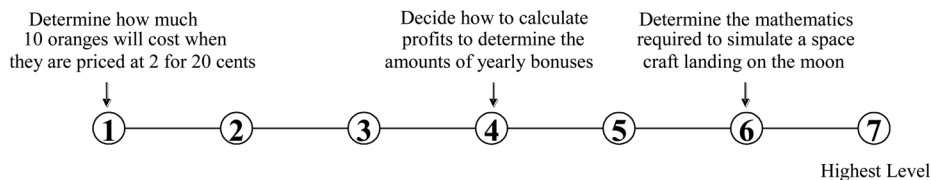
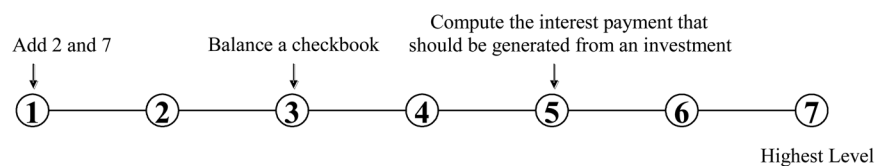
One of the principles of Item Response Theory is to array both items and subjects on the same scale. This same property would be desirable for measures of job characteristics; they should use the same units as measures of person characteristics. For example, one can easily compare O*NET's measure of occupational educational requirements with the educational attainment of the labour force because jobs and persons are measured in a common, natural unit, i.e., degree levels. By contrast, it is not easy to know whether workers are well matched with jobs on dimensions measured with the 0–7 Level scales because there are no corresponding person measures that use these yardsticks. This limits the usefulness of such items for individual employment coun-

selling, public policy planning for education and training, and research on the congruence or mismatch between the distributions of the nation's workforce characteristics and the jobs available. If people and jobs are not measured on the same or equivalent scales, they cannot be compared.

Explicit scaling is an alternative approach that would address this and some of the other problems described above. Explicit scaling involves questions and response options that are objective, concrete, correspond directly to the target of interest, and have absolute meanings for respondents. Questions are phrased in terms of facts, events, and behaviours, rather than attitudes, evaluations, and holistic judgments. Items are general enough to encompass the wide range of jobs within the economy, but sufficiently concrete that they have stable meanings across respondents. Response options use natural units when possible and discriminate a wide range of levels to avoid floor and ceiling effects. Rating scales, vague quantifiers, and factor scores, which have arbitrary metrics and lack specific or objective referents, are a last resort. The exhibit on the following page contrasts O*NET's items on mathematics with those from the author's survey of Skills, Technology, and Management Practices (STAMP), which used explicit scaling principles (see Handel 2008 and this issue for more detail on the implementation of explicit scaling in STAMP). The alternative questions are clear and objective, correspond to person measures, and are well aligned with policy-relevant school curriculum categories.

Items constructed using an explicit scaling approach would be expected to have high face validity and ease of use (unlike the O*NET Abilities and Skills questionnaires), and to produce less measurement error because there is less room for subjective interpretation and self-enhancing biases. Because of their more direct correspondence to the target phenomenon or concept, such measures have greater external or ecological validity. They are more meaningful outside the context of a particular survey instrument because of their greater faithfulness to some observable, real-world condition or concept. Their strength is their verisimilitude.

While absolute or externally meaningful scales can be difficult to construct for some job characteristics, O*NET also missed opportunities to construct more objective measures of math, reading, writing, physical demands, technology skills, and employee involvement, among others. For example, O*NET measures of physical demands could have been greatly improved if the project had produced more objective measures aligned with policy by collaborating with other disciplines, such as ergonomics and occupational health, and other government agencies, such as the National Institute for Occupational Safety and Health, Occupational Safety and Health Administration, and the Social Security Administration's Division of Disability Research.

O*NET Math Items (Importance scales deleted)**5. Mathematics****Using mathematics to solve problems.****B. What level of MATHEMATICS is needed to perform *your current job*?****14. Mathematics****Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.****B. What level of knowledge of MATHEMATICS is needed to perform *your current job*?****11. Mathematical Reasoning****The ability to choose the right mathematical methods or formulas to solve a problem.****B. What level of MATHEMATICAL REASONING is needed to perform *your current job*?****13. Number Facility****The ability to add, subtract, multiply, or divide quickly and correctly.****B. What level of NUMBER FACILITY is needed to perform *your current job*?**

STAMP Math Items

At your job, do you:

- use addition or subtraction
- use multiplication or division
- do math using fractions, decimals, or percentages
- use simple algebra to solve for unknown values
- use more advanced algebra to solve complex equations
- use geometry or trigonometry
- use probability and statistics, such as correlations and regressions
- use calculus or other advanced mathematics

Conclusion

The Occupational Information Network (O*NET) was designed to replace the *Dictionary of Occupational Titles*, which was difficult to update and had generated numerous questions regarding sampling strategy, content coverage, and measurement strategy. O*NET improves upon the DOT in its sample size, sampling methods, and content coverage. Nevertheless, questions and issues regarding the sample, content, and measurement approach remain.

1. The representativeness of the worker sample with respect to basic demographic information, such as education, gender, race, and ethnicity, is unknown even though O*NET collects this information on its Background survey. It is possible that over-representation of more educated workers because of the survey's cognitive burden biases estimates of skill demands upward, but this remains a hypothesis in the absence of the necessary data and analysis.
2. O*NET's coverage of certain content areas, such as technology and employee involvement practices, is too sparse, while other content is redundant. This redundancy does not seem to reflect design but rather a lack of coordination in the construction of a very long battery of items across multiple instruments.
3. Four of the main O*NET surveys contain substantial redundancy between the Importance and Level scales; correlations between these scores within items are generally around 0.90 or above. Respondent burden could be reduced and important content on technology and workplace practices created by removing the Importance portion of these items.
4. Many of the items themselves are vague, overly complex, and jargon-laden. O*NET has recognized this fact implicitly in transferring responsibility for completing the Abilities and Skills questionnaires from incumbents to job analysts, who receive written information on the occupations they rate but do not make workplace site visits.
5. The anchors for the seven-point Level scales often violate the equal interval assumption, can be difficult to relate to occupations other than the ones from which

they are drawn, and typically assign extreme anchors for Level 6, consistently discouraging respondents from using the upper end of O*NET's own chosen scale range.

6. Given the complexity of the information processing tasks involved, it is likely that respondents answer many questions pragmatically and heuristically, based on their general views of the apparent meaning of the questions and scales, rather than based on the precise, particular or intended meaning of the items and anchoring examples.

Despite these concerns, in the aggregate, 40% of O*NET's 239 items correlate moderately or moderately strongly with wages and the figure is 48% for the items from the four surveys using the Importance and Level format, suggesting reasonable criterion validity, though individual correlations often have unexpected absolute and relative magnitudes.

However, while many O*NET measures seem to function reasonably well, the data would be more interpretable if the items and response options were more objective. Explicit scaling is one alternative approach. O*NET is now widely used in career counselling and related fields, which is a tribute to the project's efforts. Presumably, many of its intended users find it useful. However, the O*NET content model is ponderous and unnecessarily flawed, posing problems of interpretability for workers completing the surveys and probably for job seekers, as well.

For researchers, O*NET presents opportunities but also challenges. The very size of the database is daunting and requires attention in selecting variables. The Importance scales are redundant and can probably be ignored without great loss of information. Many variables have ambiguous or fuzzy meanings and the reasonableness of basic descriptive results should always be checked before proceeding to take the meaning at face value. The O*NET project itself could make the database more useful to researchers by publishing basic sampling data from the background survey, clearly archiving each quinquennial version of the database, and making available to researchers the original survey microdata for secondary data analysis.

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7 Appendix

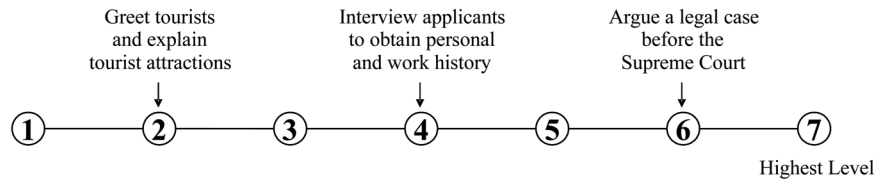
Representative O*NET items

(Importance scales deleted to conserve space)

3. Speaking

Talking to others to convey information effectively.

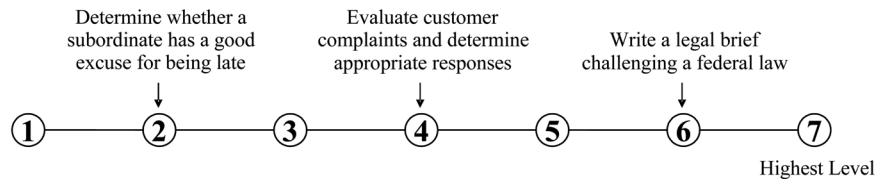
B. What level of SPEAKING is needed to perform *your current job*?



7. Critical Thinking

Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.

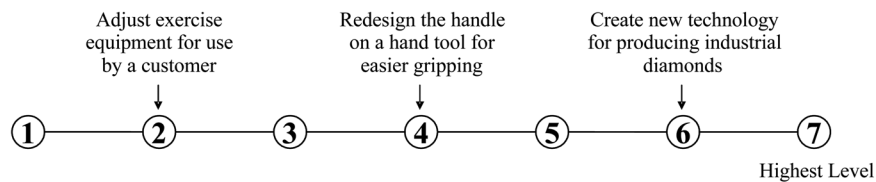
B. What level of CRITICAL THINKING is needed to perform *your current job*?



19. Technology Design

Generating or adapting equipment and technology to serve user needs.

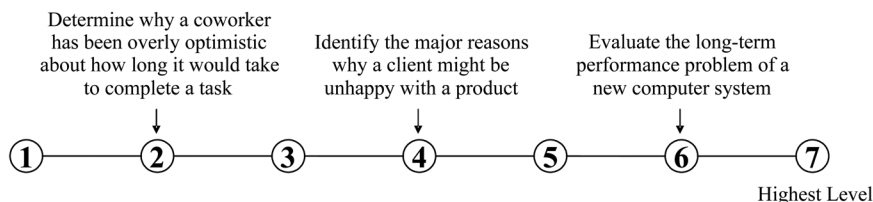
B. What level of TECHNOLOGY DESIGN is needed to perform *your current job*?



30. Systems Evaluation

Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.

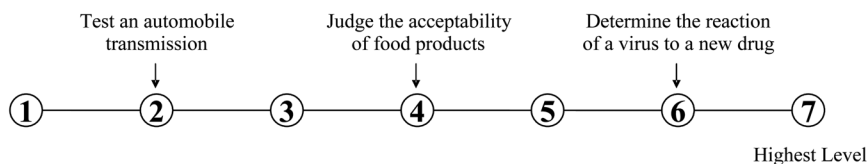
B. What level of SYSTEMS EVALUATION is needed to perform *your current job*?



2. Identifying Objects, Actions, and Events

Identifying information by categorizing, estimating, recognizing differences or similarities, and detecting changes in circumstances or events.

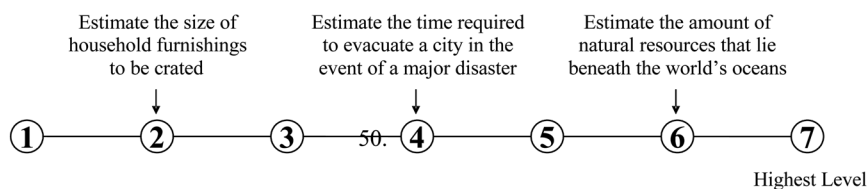
B. What level of IDENTIFYING OBJECTS, ACTIONS, AND EVENTS is needed to perform *your current job*?



5. Estimating the Quantifiable Characteristics of Products, Events, or Information

Estimating sizes, distances, and quantities; or determining time, costs, resources, or materials needed to perform a work activity.

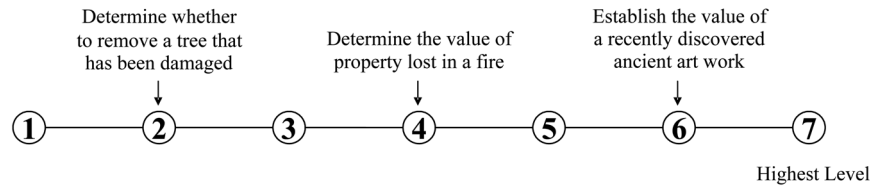
B. What level of ESTIMATING THE QUANTIFIABLE CHARACTERISTICS OF PRODUCTS, EVENTS, OR INFORMATION is needed to perform *your current job*?



6. Judging the Qualities of Objects, Services, or People

Assessing the value, importance, or quality of things or people.

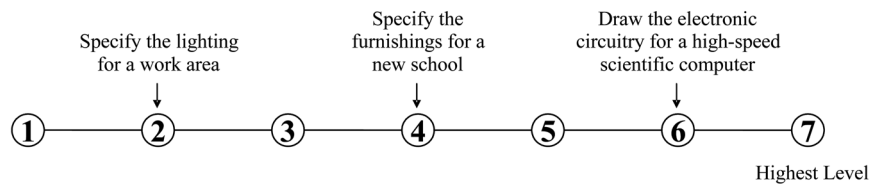
B. What level of JUDGING THE QUALITIES OF OBJECTS, SERVICES, OR PEOPLE is needed to perform *your current job*?



21 Drafting, Laying Out, and Specifying Technical Devices, Parts, and Equipment

Providing documentation, detailed instructions, drawings, or specifications to tell others about how devices, parts, equipment, or structures are to be fabricated, constructed, assembled, modified, maintained, or used.

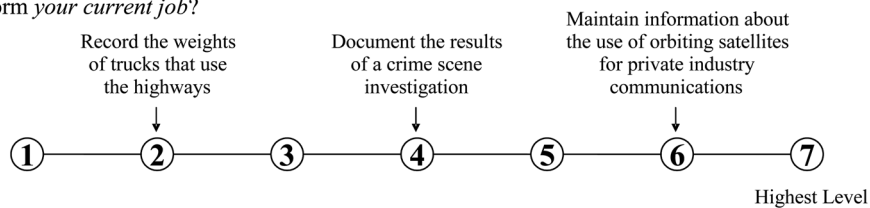
B. What level of DRAFTING, LAYING OUT, AND SPECIFYING TECHNICAL DEVICES, PARTS, AND EQUIPMENT is needed to perform *your current job*?



24. Documenting/Recording Information

Entering, transcribing, recording, storing, or maintaining information in written or electronic/magnetic form.

B. What level of DOCUMENTING/RECORDING INFORMATION is needed to perform *your current job*?



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