Linking Client Assessment Profiles to O*NET™ Occupational Profiles

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Addendum

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This technical development report contains information based on O*NET™ 98, a prototype whose occupational classification system contains 1,122 occupational units (OUs) based on the Occupational Employment Statistics (OES) classification system.

Since the writing of this report, the O*NET 3.0 database has been developed. The major difference between this database and the O*NET 98 database is its compatibility with the 1998 Standard Occupational Classification (SOC) system.[1] By making O*NET 3.0 compatible with the SOC system, the O*NET 3.0 database now contains 974 O*NET-SOC occupations (the term "occupational unit" is no longer used), which replace the 1,122 O*NET 98 OUs. The O*NET occupations now use the SOC coding system as the basis for the O*NET-SOC occupational codes, instead of the former OES coding structure. These changes account for any differences in codes and/or titles between this report and the current O*NET-SOC structure. Please note that the U.S. Office of Management and Budget has mandated that all federal agencies' occupational classification systems be compatible with the 1998 SOC system.

All O*NET 98 data have been converted to O*NET 3.0 data and verified.

O*NET 3.0 and O*NET OnLine, a Web-based application that allows users to view and use the O*NET 3.0 database, can be accessed via the National Center for O*NET Development's Web site, www.onetcenter.org .

[1] United States Department of Labor, Bureau of Labor Statistics. (1999). *Revising the Standard Occupational Classification System*. Washington, DC: Author.

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Acknowledgments

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Introduction

The Occupational Information Network (O*NET™) Project, part of the U.S. Department of Labor's (DOL) Employment and Training Administration (ETA), has sponsored the development of several **O*NET Career Exploration Tools**. These tools are designed to help clients learn information about themselves that can be used to focus their career search activities. The **O*NET Career Exploration Tools** assist clients in identifying occupations for which they (a) have (or can learn) the necessary knowledges and skills, (b) have the basic interests that characterize people in those occupations, and/or (c) place a high value on work outcomes that the occupations will provide.

To achieve this focused career exploration, clients must be able to accurately and reliably identify their abilities, interests, and/or valued work outcomes. Once clients have gathered information about themselves, they must be directed to occupations that are linked appropriately to the assessment information. The purpose of this report is to describe how client assessment profiles are linked to O*NET Occupational Unit profiles.

O*NET Career Exploration Tools

O*NET has developed five career exploration tools designed to help clients assess important pieces of vocational and career information:

(1) **O*NET Ability Profiler**—measures nine abilities related to job performance. The assessment is group-administered via paper-and-pencil and uses computerized scoring.

(2) **O*NET Interest Profiler**—measures six vocational interests (i.e., Realistic, Investigative, Artistic, Social, Enterprising, and Conventional: R-I-A-S-E-C; cf. Holland, 1985, 1997). The assessment is self-administered via paper-and-pencil and is self-scored.

(3) **O*NET Computerized Interest Profiler**—measures six vocational interests (i.e., R-I-A-S-E-C interests). The assessment is self-administered via computer and uses computerized scoring.

(4) **O*NET Work Importance Locator**—measures six important work values (Achievement, Independence, Recognition, Relationships, Support, and Working Conditions) identified in the Theory of Work Adjustment (cf. Dawis & Lofquist, 1984; Dawis, Lofquist, & Weiss, 1968; Lofquist & Dawis, 1969; Weiss, Dawis, England, & Lofquist, 1964).[2] The assessment is self-administered via paper-and-pencil and is self-scored.

(5) **O*NET Work Importance Profiler**—measures 21 important work outcomes (needs) related to six work values. The assessment is self-administered via computer and uses computerized scoring.

[2]In the Theory of Work Adjustment, the six work values were labeled Achievement, Autonomy, Status, Altruism, Safety, and Comfort, respectively.

Each of the assessment tools described above yields several scores for the client. These scores define the client's *score profile*. Clients can identify occupations to explore using the score profile generated for them from a single **O*NET Career Exploration Tool**, or they can combine score profiles generated from multiple **O*NET Career Exploration Tools**.

O*NET Occupations

O*NET has developed an occupational classification system that contains 1,122 occupations or Occupational Units (OUs). The OUs, which were developed during DOL's transition from the *Dictionary of Occupational Titles (DOT*; U.S. Department of Labor, 1991*),* represent a refinement of the Occupational Employment Statistics (OES) occupational classification structure. Although the majority of OUs are one-to-one translations of OES occupations, others are sub-groupings created by giving consideration to the similarity of the work content, education, and training requirements of the DOT occupations that composed the original OES occupations. The OUs are further categorized into five Job Zones on the basis of the amount of education, training, and/or experience each OU requires. Job Zones are ordered according to increasing levels of education, training, and/or experience, such that Job Zone 1 contains the OUs requiring the least preparation, and Job Zone 5 contains those OUs requiring the most preparation (Oswald, Campbell, McCloy, Rivkin, & Lewis, 1999).

The O*NET OUs have been assigned information needed to directly link the occupations with the **O*NET Career Exploration Tools**.[3] Each OU has a specific score profile that corresponds to (a) ability information measured by the **O*NET Ability Profiler**, (b) interest information measured by the **O*NET Interest Profiler** and **O*NET Computerized Interest Profiler**, and (c) work values information measured by the **O*NET Work Importance Locator** and **O*NET Work Importance Profiler**. For a description of the development of this occupational information, see *Generation and Use of Occupational Ability Profiles for Exploring O*NET Occupational Units, Vols. I-II* (McCloy, Campbell, Oswald, Rivkin, & Lewis, 1999), *Development of Occupational Interest Profiles for O*NET Occupations* (Rounds, Smith, Hubert, Lewis, & Rivkin, 1999), and *Determining the Occupational Reinforcer Patterns for O*NET Occupational Units, Vols. I-II* (McCloy, Waugh, Medsker, Wall, Rivkin, & Lewis, 1999a).

[3]The assigned occupational information can be used to link a variety of career exploration tools, in addition to those developed by O*NET. For a listing of other types of information assigned to each OU, see the *O*NET 98: Data Dictionary* (U.S. Department of Labor, 1998).

Linking Assessment Results to Occupations

A primary goal of the **O*NET Career Exploration Tools** is to identify the set of occupations (i.e., O*NET OUs) that best correspond to a client's abilities, interests, and/or work values. To meet this goal, a procedure is needed that compares a client's assessment results from one or more of the O*NET tools (e.g., **O*NET Ability Profiler**, **O*NET Computerized Interest Profiler**) to OU-specific information related to the tool(s) the client elects to utilize. The OUs with score profiles that most closely correspond to the client's score profile should qualify as suggested candidates for the client's career exploration. The following sections discuss how client/OU profile correspondence was characterized for the purposes of identifying an algorithm for determining profile similarity. The sections describe the correspondence algorithms developed for the following situations: (a) clients using a single O*NET tool, and (b) clients using multiple tools.

Clients Using a Single Tool

For clients using a single **O*NET Career Exploration Tool**, a matching procedure was needed to compare a client's score profile generated from one tool (e.g., **O*NET Ability Profiler**) with the related occupation score profile of each O*NET OU. In addition, where possible, the procedure needed to help the client identify the occupations that constitute a "strong" match with his or her assessment information. Due to the variety of score profiles produced by the **O*NET Career Exploration Tools** (e.g., 2 reliable interest scores versus 21 reliable work need scores), as well as the varying presence of computerized scoring associated with each tool, several matching procedures were required.

O*NET Interest Profiler (paper-and-pencil)/O*NET Work Importance Locator

A simple matching procedure was necessary for these two tools. The client hand-scores both of these tools, precluding a correspondence algorithm that would require complicated mathematical calculations. Also, the fact that clients look up occupations in a score report by hand also points to the need for a very simple procedure. Finally, although both of the tools yield a total of six scores, only the top two scores for the Work Importance Locator provide reliable information to the client, restricting the amount of information available for inclusion in a matching procedure.

For these tools, the matching procedure emphasizes both the client's and the occupations' *highest* or *primary* score, rather than the entire score profile. Occupations are sorted into categories based on the highest score in their profile. The OUs are sorted into one of six interest areas (Realistic, Investigative, Artistic, Social, Enterprising, or Conventional) and into one of six work value areas (Achievement, Independence, Recognition, Relationships, Support, and Working Conditions).[4] For either exploration tool, the client is directed to identify the area (i.e., either interest or work value) with the highest score and begin

[4]To provide clients with a variety of occupations to explore within each area, some occupations are included in a particular area based on the second highest score in their profile, and, in a few cases, based on their third highest score. Therefore, the total number of occupations listed in the score report for both the **O*NET Interest Profiler** and **O*NET Work Importance Locator** exceeds 1,122.

exploring occupations within that area.[5] Clients have the option to explore the occupations located in the area with their second highest score should they be unsatisfied with those within their highest area.

O*NET Computerized Interest Profiler/O*NET Work Importance Profiler

A more complex matching procedure could be employed with these two tools. Although the instruments are self-administered, both are scored by computer rather than by the client. This allows for an almost unlimited array of mathematical calculations to be performed virtually instantaneously. Also, research demonstrated that both tools generate reliable and valid profiles of information about the client. Therefore, to maximize the amount of meaningful information available for the client's career exploration process, it is important to develop a matching procedure that takes advantage of the full score profiles available for both the client and occupations. Finally, with these two types of career information, interests and work values, it is important that the comparison of the client's score profile and the score profiles of each OU be based on the *shape* or *pattern* of the scores, rather than the absolute *level* or *amount* of each score. There is no concern about directing a client to explore occupations that are "under" or "over" the level of interest or "under" or "over" the amount of work values reinforcement. Instead, the goal is to direct a client to occupations that tend to have the same high interests or work values, as well as the same low interests or work values (i.e., the same pattern).

When a client provides a score profile from either the **O*NET Computerized Interest Profiler** or the **O*NET Work Importance Profiler**, the correlation coefficient serves as the index of correspondence. The correlation between a client's profile (*X*) and an OU profile (*Y*) is given mathematically as follows:

$$r_{XY} = \frac{\Sigma(X - \overline{X})(Y - \overline{Y})}{N\sigma_X\sigma_Y}$$

where $\overline{X}$ and $\overline{Y}$ and σ_X and σ_Y are the means and standard deviations of *X* and *Y*, respectively, and *N* is the number of scores to be correlated (i.e., the number of scores constituting the client's profile).[6] The correlation indexes the similarity of the shape (but not the level) between the client and occupation profiles and is the correspondence index most vocational counselors prefer. The correlation can range from -1.0 to +1.0. A correlation of +1.0 indicates that the rank orders of client and OU scores are identical, whereas a correlation of -1.0 indicates that the rank order of client scores is opposite the rank order of OU scores. A value of 0.0 indicates no correspondence between the client score profile and the OU score profile.

[5]Both the **O*NET Interest Profiler** and the **O*NET Work Importance Locator** provide the client with recommendations as to how to proceed when scores are equal or very similar.

[6]Note that *σ* represents variability of the *sample* at hand and uses a divisor of *N*.

An Example

To demonstrate how the correlation coefficient is used, Figure 1 contains two OU-specific interest profiles and one client interest profile. The client profile correlates perfectly with the profiles of OU 1 and OU 4 (r = 1.0). Therefore, OUs 1 and 4 would be targeted as promising areas for career exploration. Figure 2 contains the same client profile, but two different OU-specific profiles. While the level of these OU patterns are similar to the client profile, there is less correspondence between the pattern of client profile and the profiles for OU 2 and OU 3 (r = -1.0 and -.27, respectively). Therefore, these occupations would not be targeted for career exploration.

*Occupations Listed on the O*NET Computerized Interest Profiler and O*NET Work Importance Profiler Score Reports*

Having effected the client/OU match, the matching program selects those OUs considered most promising for career exploration. For the **O*NET Computerized Interest Profiler**, the client score profile will contain scores for each of the six interest areas: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional. For the **O*NET Work Importance Profiler**, the client score profile will contain scores on each of the 21 needs (i.e., items) from the instrument.[7] After calculating the correlation coefficient between the client score profile and each OU score profile, the scoring program next applies a series of decision rules to the results. OUs that satisfy the following set of decision rules appear on the specific Profiler's score report. OUs are presented in descending order of the correlation, within Job Zone. The correlation between a client and OU profile must be of sufficient magnitude for an OU to appear on the Profiler score report. OUs for which the client/OU correlation is notably high are denoted (by ">>") as "strong matches." The degree of correlation that must be attained for an OU to appear on the score report or to be denoted a strong match depends upon the number of scores in the client profile. Hence, there are separate cutoffs for the **O*NET Computerized Interest Profiler** and the **O*NET Work Importance Profiler** (see Table 1). The minimum correlation cutoff represents the value for which the statistical significance of the correlation is $p < .10$ as derived from a one-tailed significance test. The "strong match" cutoff denotes the value for which the statistical significance of the correlation is $p < .05$ as derived from a one-tailed significance test. There are no limits on the number of OUs that may be presented within a Job Zone.

[7] The 21 needs are used rather than the 6 values because they (a) demonstrated similar test-retest reliabilities to those of the values and (b) contain unique information not found in the values, permitting more differentiated client and OU profiles and, thus, more refined client/OU matches (cf. McCloy, Waugh, Medsker, Rivkin, & Lewis, 1999b).

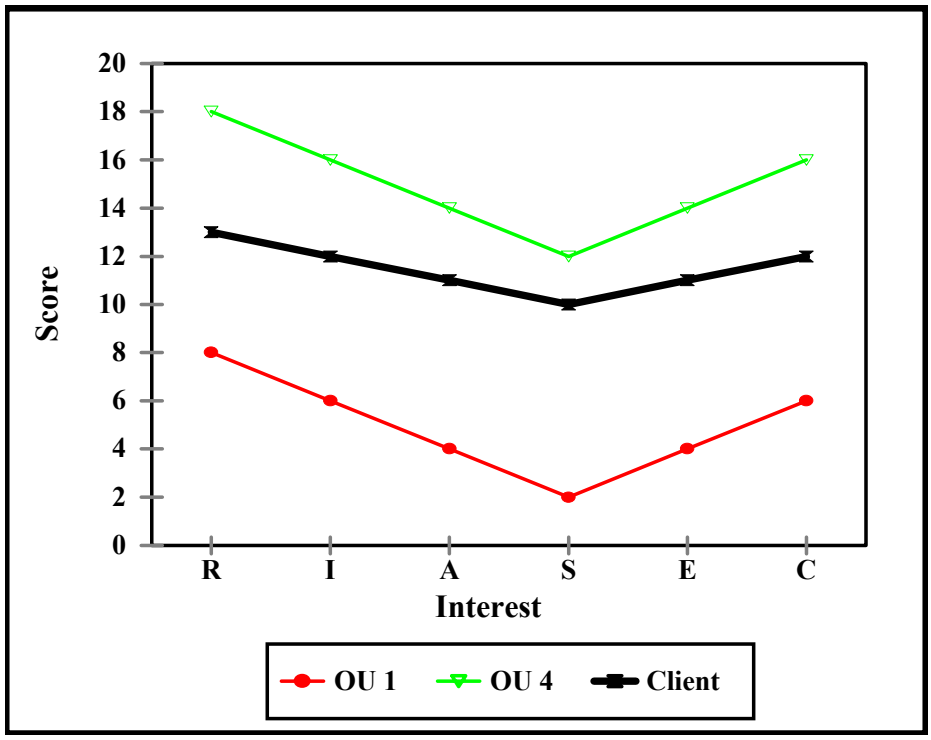

***Figure 1*. Sample Client and OU Profiles for the O*NET Interest Profiler: High Correlations**

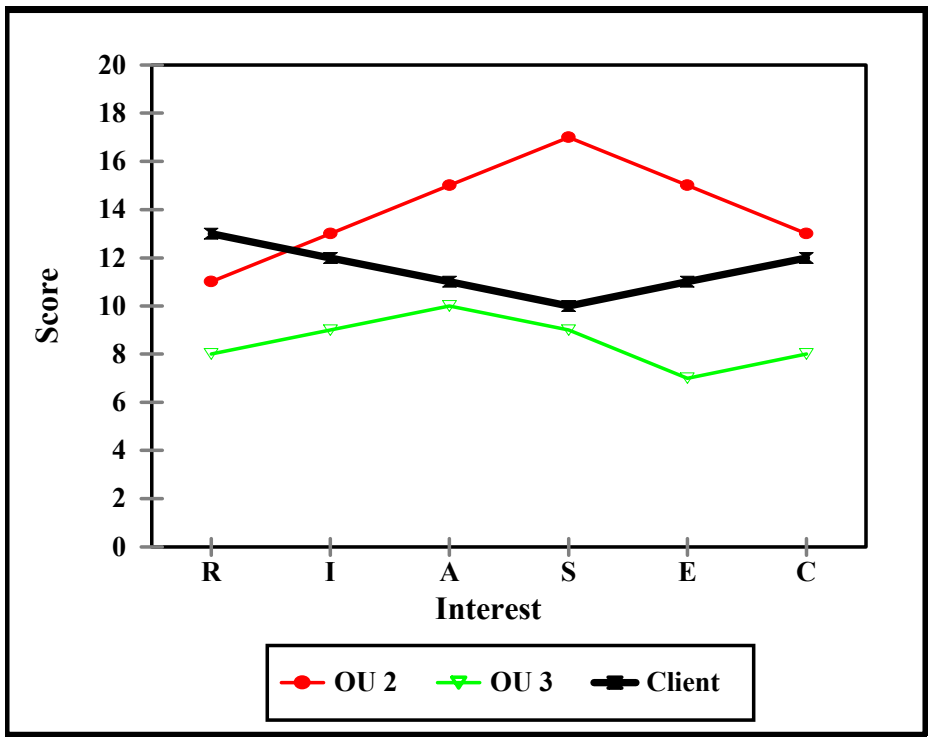

***Figure 2*. Sample Client and OU Profiles for the O*NET Interest Profiler: Low Correlations**

Table 1
Minimum Correlation Values for an OU to Appear on the Profiler Score Report and to be Labeled a "Strong Match"

Career Exploration Tool	Minimum Correlation	Strong Match Correlation
O*NET Computerized Interest Profiler	.608	.729
O*NET Work Importance Profiler	.291	.368

O*NET Ability Profiler

Scores on the **O*NET Ability Profiler** are calculated by a special computer program—the O*NET Ability Profiler Scoring Program (National Center for O*NET Development, 1999a; Silva, 1999; Silva, Lewis, Rivkin, & Koritko, 1999). When determining the correspondence between a client score profile from the **O*NET Ability Profiler** and the corresponding OU score profiles, the O*NET Ability Profiler Scoring Program uses the correlation coefficient and a second index to refine the profile correspondence. Specifically, if a client*s **O*NET Ability Profiler** score profile correlates equally with two or more OUs, the OUs are ordered from lowest to highest on *d*, the Euclidean distance. The Euclidean distance between two measures *X* and *Y* is given mathematically as follows:

$$d = \sqrt{\sum_{i=1}^{k} (X_i - Y_i)^2}$$

where X and Y are scores from the client and OU profiles, respectively, and *k* is the number of scores in a given score profile. The *d* value indexes the proximity of the client profile to the OU profile. Thus, Euclidean distance introduces level to the matching process. For OUs exhibiting equal correlations with the client profile, the OU(s) having the most proximal profile(s) will be listed ahead of those having profiles less similar in level. The matching program uses *d* with the **O*NET Ability Profiler** because the goal is to increase the face validity of the selected OUs by guiding the client to OUs for which they are more likely to be qualified rather than to OUs for which they may be under- or over-qualified.

An Example

To illustrate the use of both the correlation and Euclidean distance, consider the hypothetical client and OU score profiles for the **O*NET Ability Profiler** appearing in Figures 3 and 4. The nine ability scores given in the figures are as follows:

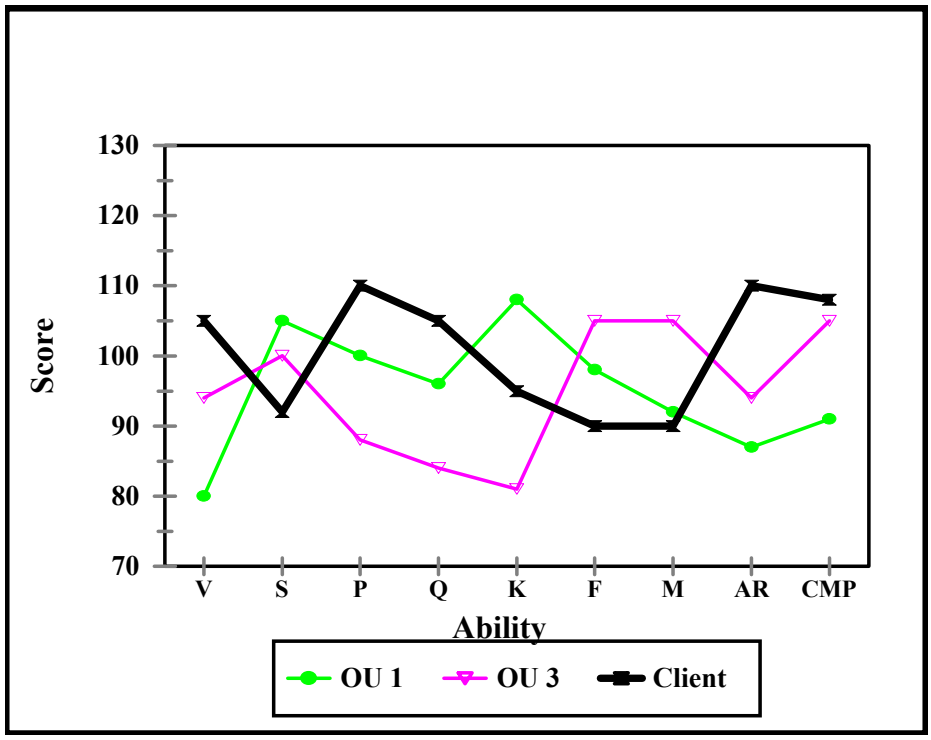

***Figure 3*. Sample Client and OU Profiles for the O*NET Ability Profiler: Low Correlations**

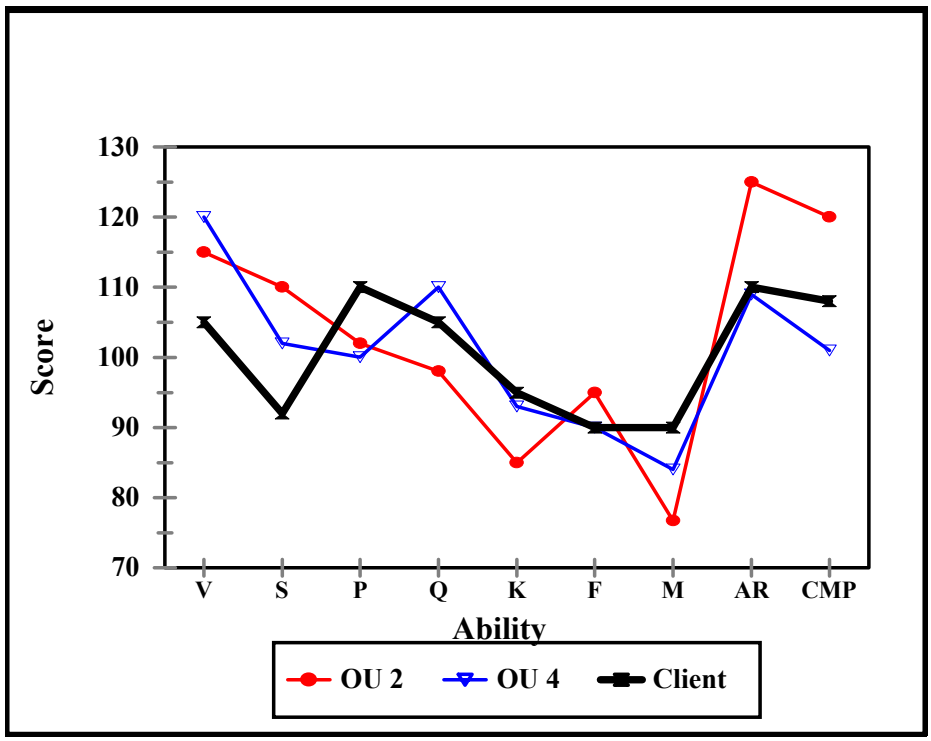

***Figure 4*. Sample Client and OU Profiles for the O*NET Ability Profiler: High Correlations**

- Verbal (V)
- Spatial (S)
- Form Perception (P)
- Clerical (Q)
- Motor Coordination (K)
- Finger Dexterity (F)
- Manual Dexterity (M)
- Arithmetic Reasoning (AR)
- Computation (CMP; corresponds to usual CM abbreviation)

The correspondence indices between the client profile and four OU profiles are given in Table 2. The values of the correlation coefficient in Table 2 indicate that the client's profile has a dissimilar shape to the score profiles for OU 1 and OU 3 (see Figure 3) and a similar shape to OU 2 and OU 4 (see Figure 4). In addition, the client profile correlates equally with the score profiles for OU 2 and OU 4. The Euclidean distance values for OU 2 and OU 4 indicate that the client's profile corresponds more closely with the score profile for OU 4 than for OU 2; that is, the client profile is less distant from the OU 4 profile (d = 23.24) than from the OU 2 profile (d = 34.75). Thus, given the choice of the two OUs, the client might wish to explore OU 4 first.

Table 2
Correspondence Indices for Hypothetical Client and OU Profiles from the O*NET Ability Profiler

Occupational Unit	Correlation Coefficient	Euclidean Distance
OU 1	-.46	45.06
OU 2	.68	34.75
OU 3	-.36	44.96
OU 4	.68	23.24

In sum, using both the correlation and the Euclidean distance provides a refined determination of the correspondence between a client profile and various OU profiles. Using the distance index only in the event of ties preserves the preeminence of profile shape (as vocational counselors suggest).

Occupations Listed on the Client's O*NET Ability Profiler Score Report
Having effected the client/OU match, the Ability Profiler Scoring Program selects a list of OUs considered most promising for career exploration. The client score profile must contain

the following six ability scores: AR, CM, V, S, Q, and P.[8] After calculating the correlation coefficient (and Euclidean distance, should equal correlations occur) between the client score profile and each OU score profile, the scoring program next applies a series of decision rules to the results. OUs that satisfy the following decision rules appear on the Ability Profiler Score Report.

OUs for which the client/OU correlation is of sufficient magnitude are denoted (by ">>") as "strong matches." The degree of correlation that must be attained depends upon the number of scores in the client profile. Hence, there are separate cutoffs for profiles comprising six, seven, eight, and nine scores (see Table 3). The O*NET Ability Profiler Scoring Program uses double precision math to calculate the correlation between client and OU profiles. At a minimum, correlations are truncated to 10 decimal places. Table 3 reports each cutoff to its full 15-digit value. Each correlation cutoff represents the value for which the statistical significance of the correlation is $p < .10$ as derived from a one-tailed significance test.

The scoring program lists a minimum of 10 OUs on the score report for each of the five Job Zones, regardless of the magnitude of the client/OU profile correlation. OUs are presented in descending order based on the correlation, within Job Zones. A client's score report may contain as many as 25 OUs in each Job Zone, but OUs 11-25 appear only if they represent strong matches.

Table 3
Minimum Correlation Values for an OU To Be Labeled a "Strong Match"

	Number of Scores in Client/OU Ability Profile			
	6	**7**	**8**	**9**
Minimum Correlation	.608 (399646359134)	.550 (862990741590)	.506 (726930391213)	.475 (1588585453743)

Note. Each cutoff value is a 15-digit value. In the interest of exactitude, all digits are reported in the table. To facilitate reading of the values, each cutoff is reported to three digits, with the remaining 12 digits presented below in parentheses. Each cutoff is the critical value of the correlation at $p < .10$ using a one-tailed test of significance.

[8] Scores on the three performance abilities—Motor Coordination (K), Finger Dexterity (F), and Manual Dexterity (M)—are used if they are available.

Clients Using Multiple Tools

For clients using multiple **O*NET Career Exploration Tools**, a matching procedure is needed to compare a client's total score profile generated from those tools (e.g., **O*NET Ability Profiler** and **O*NET Work Importance Profiler**) with the related occupation total score profile of each O*NET OU. As in the case of a single profile, where possible, the procedure needs to help the client identify which occupations constitute a "strong" match with his or her assessment information. Also, as in the case of the single profile, different matching procedures were necessary.

Multiple Manual Tools

Currently, one combination of matching multiple manual (i.e., hand-scored) tools' results has been developed for the **O*NET Interest Profiler** and the **O*NET Work Importance Locator**. (Possible ways to include the **O*NET Ability Profiler** are discussed later in this report.) A simple matching procedure is necessary when these two tools are used in tandem. As when completing either measure separately, the client hand-scores each tool and identifies the respective primary scores (i.e., the highest interest score and the highest work value score). Occupations are cross-classified into interest/work value pairs, with each interest area further differentiated into six work value categories. For example, occupations for which the Realistic interest area was primary are now subclassified on the basis of their primary work value score. This subclassification yields 36 interest/work value categories (e.g., Realistic/Achievement, Artistic/Recognition) within each Job Zone. Clients are directed to identify the interest/work value subarea corresponding to the pairing of their primary scores. O*NET OUs categorized by these subareas are presented to clients in the *O*NET Occupations Combined List: Interests and Work Values* (National Center for O*NET Development, 1999b; see Figure 5).

Multiple Computerized Tools

A correlation coefficient algorithm has been presented for determining the correspondence between a client's score profile from a single computerized Profiler and the score profiles of the OUs. This correlation coefficient was identified as the most appropriate indicator of the similarity of the score profiles from a client and from OUs (for the **O*NET Ability Profiler**, the Euclidean distance is used to break ties among equally correlating OUs). The correlation is again the correspondence index of choice when matching a client's total score profile (i.e., a score profile that comprises scores from two or more Profilers) to the total score profiles of the OUs, regardless of Profilers involved. (The Euclidean distance is not used when multiple Profilers are scored.) The computation of the correlation, however, requires a few extra steps.

An Example

Consider first the algorithm chosen for determining the correspondence between a client's score profile from a single computerized Profiler and OU profiles. Here, the algorithm is simply to determine the correlation between the client's profile and all other OU profiles.

REALISTIC

REALISTIC — ACHIEVEMENT

JOB ZONE 1 — REALISTIC — ACHIEVEMENT

OU #	*OU Title*
92902A	Electronic Semiconductor Processors **
92902B	Electronic Semiconductor Wafer Etchers and Engravers **
79002A	Forest and Conservation Workers
93947E	Hand Painting, Coating, or Decorating Workers *
34058G	Horse Riders/Exercisers
92543	Printing Press Machine Operators and Tenders *
83005A	Production Inspectors, Testers, Graders, Sorters, Samplers, Weighers **
85717B	Test Card and Circuit Board Repairers **

JOB ZONE 2 — REALISTIC — ACHIEVEMENT

OU #	*OU Title*
85302B	Automotive Specialty Technicians
87102D	Carpenter Assemblers and Repairers
85999F	Divers
34056E	Equestrian Performers
89502A	Fabric and Apparel Patternmakers
79021	Farm Equipment Operators
63008B	Forest Fire Fighters
63005	Forest Fire Inspectors and Prevention Specialists
89926A	Gem and Diamond Workers
87308	Hard Tile Setters
32905	Medical and Clinical Laboratory Technicians
89923	Medical Appliance Makers
34058E	Motor Racers
85308	Motorcycle Mechanics and Repairers
63008A	Municipal Fire Fighters
89511	Shoe and Leather Workers and Repairers- Precision
87102C	Tank Builders and Coopers
24505D	Textile Science Technicians
85305C	Truck and Trailer Body Repairers
93117	Watch, Clock, and Chronometer Assemblers, Adjusters, and Calibrators- Precision

JOB ZONE 3 — REALISTIC — ACHIEVEMENT

OU #	*OU Title*
85323B	Aircraft Body and Bonded Structure Repairers
85305B	Automotive Body Repairers
85302A	Automotive Master Mechanics
85999C	Blacksmiths
87302	Brick Masons
89311	Cabinetmakers and Bench Carpenters
24505A	Chemical Technicians
22514C	Civil Drafters
89397B	Custom Precision Woodworkers
85311A	Diesel Engine Mechanics
87202A	Electricians
22514B	Electronic Drafters
92902C	Electronic Semiconductor Test and Development Technicians
85717A	Electronics Mechanics and Technicians
89911C	Engravers/Carvers
85321	Farm Equipment Mechanics
97702E	Flight Navigators
63014B	Highway Patrol Pilots
34058F	Jockeys and Sulky Drivers
85328A	Motorboat Mechanics
93197A	Musical Instrument Makers, Metalworking
89128	Precision Etchers and Engravers, Hand or Machine
39008	Radio Operators
85317	Rail Car Repairers
87102B	Rough Carpenters
89123B	Silversmiths
97702C	Small Aircraft Pilots
85328B	Small Engine Mechanics
22599A	Sound Engineering Technicians
89398	Standard Precision Woodworkers
89905C	Stone Cutters and Carvers
85921B	Stringed Instrument Repairers and Tuners
39999D	Studio, Stage, and Special Effects Technicians
89911E	Tracers and Letterers

Figure 5. **Sample Page from *O*NET Occupations Combined List: Interests and Work Values* (National Center for O*NET Development, 1999b)**

* Occupation included based on its highest interest area and second highest work value.
** Occupation included based on its highest interest area and third highest work value.
*** Occupation included based on its second highest interest area and highest work value.

The OUs are rank-ordered by correlation within Job Zones, such that the OUs with profiles that are most correlated with the client's profile are listed first—these are the OUs with the greatest correspondence to the client's profile. Regardless of the number of scores in the profile (i.e., 6 to 9 scores for the **O*NET Ability Profiler**, 6 scores for the **O*NET Interest Profiler**, and 21 scores for the **O*NET Work Importance Profiler**), calculation of the correlation is straightforward and requires no adjustments. Calculating the correlation becomes more complicated, however, when a client completes any two or all three of the Profilers. Under this circumstance, the client profile is a composite profile of 12, 13, 14, 15, 27, 28, 29, 30, 33, 34, 35, or 36 scores, depending upon the Profilers the client completed.[9]

To calculate the correspondence between the client and OU profiles appropriately, two factors must be addressed. First, the scores on the various Profilers are scaled differently. Due to differences in scaling, the correlations between client and OU profiles would all likely be quite high. For example, consider a hypothetical composite client profile (X) comprising scores from the **O*NET Computerized Interest Profiler** (six scores, ranging from 0-30) and a complete **O*NET Ability Profiler** (nine scores, scaled with mean of 100 and standard deviation of 20, thus ranging from about 40-160) such as that given in Table 4. The correlation of this client profile with an OU profile (Y) is very high (r = .98) and is mostly a function of the difference in scales of the two sets of measures. One might question how scale differences can affect the correlation, which removes the scaling of the variables. The removal of scale occurs *across* profiles (e.g., as when correlating **O*NET Ability Profiler** scores with **O*NET Computerized Interest Profiler** scores) but not *within* profiles (as occurs with a composite profile—one comprising multiple measures). Therefore, the scores for each Profiler under consideration must be standardized *within each measure* before calculating the correspondence between a client profile and an OU profile.

Second, because each Profiler yields a different number of scores to the composite score profile, the correlation between a client profile and an OU profile will primarily depend upon the measure that contributes more scores to the profile. Returning again to Table 4, even after standardizing the raw Profiler scores *within each instrument* (as depicted in the columns z_x and z_y), the correlation between the profiles will be more a function of the correspondence between the client/OU **O*NET Ability Profiler** scores (of which there are nine) than of the correspondence between the client/OU **O*NET Computerized Interest Profiler** scores (of which there are but six).[10] Although there might be occasions when a client would like certain scores to have more weight with regard to identifying the OUs with greatest correspondence (e.g., a client might consider it more important for his or her abilities to fit an OU than for his or her interests to do so), the most general approach would be to allow each Profiler to contribute equally to determining the correspondence between a client profile and an OU profile.

[9]Underlined values arise *only* when a client does not obtain scores for all three performance abilities (Abilities K, F, and M) from the **O*NET Ability Profiler**. If none of the three performance ability scores is available, the Profiler yields six scores; if one is available, seven scores; and if two are available, eight scores.

[10]Note that z is calculated using σ, the variability of the *sample* at hand, which uses a divisor of N.

Table 4
Hypothetical Client and OU Profiles for the O*NET Ability Profiler and O*NET Computerized Interest Profiler

X	Y	X_{dev}	Y_{dev}	z_x	z_y	$z_x z_y$	wt $z_x z_y$
11.00	12.00	-3.67	-5.33	-1.02	-1.12	1.15	1.15
12.00	13.00	-2.67	-4.33	-.74	-.91	.68	.68
18.00	18.00	3.33	.67	.93	.14	.13	.13
21.00	20.00	6.33	2.67	1.76	.56	.99	.99
13.00	26.00	-1.67	8.67	-.46	1.82	-.85	-.85
13.00	15.00	-1.67	-2.33	-.46	-.49	.23	.23
98.00	91.00	-15.89	-15.67	-1.22	-1.24	1.51	1.01
136.00	115.00	22.11	8.33	1.69	.66	1.12	.75
102.00	106.00	-11.89	-.67	-.91	-.05	.05	.03
114.00	108.00	0.11	1.33	.01	.11	.00	.00
113.00	106.00	-0.89	-.67	-.07	-.05	.00	.00
99.00	81.00	-14.89	-25.67	-1.14	-2.04	2.32	1.55
108.00	121.00	-5.89	14.33	-.45	1.14	-.51	-.34
124.00	122.00	10.11	15.33	.77	1.22	.94	.63
131.00	110.00	17.11	3.33	1.31	.26	.35	.23

The Chosen Algorithm: A Not-So-Simple Average

Let us first consider one equation for calculating the correlation between two variables, X and Y:

$$r_{xy} = \frac{\sum z_x z_y}{n}$$

where r_{xy} is the correlation coefficient; z_x and z_y are the standard scores for X and Y, respectively; and n is the number of scores on X or Y. Stated simply, the formula shows that the correlation is a type of mean—the mean value of the cross-products of the standard scores. The next-to-last column in Table 4 provides the cross-products of the corresponding *z* scores in the preceding two columns. The average of the cross-products for the first six scores is

$$r_{xy} = \frac{(1.15 + 0.68 + 0.13 + 0.99 - 0.85 + 0.23)}{6}$$

which yields a value of .388 for the correlation between this client's **O*NET Computerized Interest Profiler** scores (X) and the interest score profile for this particular OU (Y). A similar calculation for the nine subsequent cross-product values yields a correlation of .643 between the client's **O*NET Ability Profiler** scores (X) and the ability score profile for the OU (Y).

If one were to calculate the correlation between X and Y using all 15 values, this correlation would be closer to the correlation for the nine **O*NET Ability Profiler** scores (i.e., .643) than the correlation for the six **O*NET Computerized Interest Profiler** scores (i.e., .388) because the profile correspondence is more a function of the ability scores (of which there are nine) than of the interest scores (of which there are but six). Specifically,

$$r_{xy} = \frac{(1.15 + 0.68 + \cdots + .94 + .35)}{15} = .54.$$

If we wish the different number of scores from the two Profilers to contribute equally to the correlation between the client's and the OU's total score profiles, we could weight each of the cross-products from one of the measures so that their summed weight would equal the number of scores in the other measure's score profile. For example, if one weights each of the nine **O*NET Ability Profiler** cross-product values by the fraction 6/9, the sum of the nine cross-products receives a total weight of six rather than nine:

$$(1.15 + \cdots + 0.23) + \frac{6}{9}(1.51 + \cdots + .35).$$

This reduced sum of the nine cross-products has thus been calibrated to provide equal weight to that given by the six scores provided by the **O*NET Computerized Interest Profiler**. These values are supplied in the last column of Table 4. Note that the values for the six interest scores do not change upon weighting, as their weighting is equal to one, yielding a total of six scores.

The sum of the six interest cross-products and the nine ability cross-products, re-weighted to yield a total weight of 6/9*9 = 6, is then divided by 6+6 = 12 to determine the average of the cross-products and, thus, obtain a corrected correlation between the client and OU total score profiles. Hence, for the two Profilers given above,

$$r_{xy} = \frac{(1.15 + \cdots + 0.23 + 1.01 + \cdots 0.23)}{12} = .52.$$

A Simpler Approach. Although the weighting of the cross-products was demonstrated in the equations above, there is no need to weight the cross-products. The value of .52 that was obtained by re-weighting some of the cross-products is mathematically equivalent to the mean of the two correlations for the two profiles:

$$r_{xy} = \frac{.388 + .643}{2} = .515 \approx .52.$$

A Final Complication. The mean correlation, however, is not the final index of correspondence. Whenever one averages correlations, one typically applies Fisher's *r* to *z* transformation to each of the correlations before averaging:

$$z' = \frac{1}{2}\left[\ln\frac{(1+r)}{(1-r)}\right].$$

Continuing with the example drawn from Table 4 above, the correlations of .388 and .643 yield *zN* values of 0.409 and 0.763, respectively.

The mean of the individual *zN* values—here, the value is 0.586—is then transformed back to the correlation metric by taking the antilog of the mean:

$$r_{xy} = \frac{(e^{2z} - 1)}{(e^{2z} + 1)} \ .$$

Therefore, the value of correspondence yielded by the multiple-profile algorithm for Table 4 is .527.

To summarize, the mean index of correspondence between a client's total score profile and an OU's total score profile is calculated by (a) determining the correlation between the client and OU profiles for each Profiler, (b) transforming each of those correlations to Fisher *zN* values, (c) calculating the mean of the Fisher *zN* values, and (d) transforming the mean *zN* value back to the correlation metric.

Scores from Manual and Computerized Tools

Many users of the **O*NET Career Exploration Tools** may complete both a manual tool and a computerized tool. In this case, the score information from the manual tools will be provided to the matching program, and the computer will match clients to occupations. The score information provided will differ for the two O*NET manual tools, which in turn affects the matching procedure. Suggested procedures to address these situations are described below.

O*NET Interest Profiler (paper-and-pencil version)

Clients completing the **O*NET Interest Profiler** (paper-and-pencil) receive a score for each of the six interest areas. The scores could be provided to the computer via an entry screen. The computer could then create a multiple score profile by combining the score profiles from the computerized and manual tools.

The matching algorithm for multiple computerized tools would then be used to identify those occupations considered most promising for the client's career exploration.

O*NET Work Importance Locator

Clients completing the **O*NET Work Importance Locator** receive a primary work value score. This score also could be provided to the computer via an entry screen. In this instance, however, there is no "profile" from the manual assessment tool. Instead, the computer would select those occupations having a corresponding primary work value. For example, if the client's primary work value score was Recognition, those occupations for which Recognition was the highest work value score would be selected. The program would then determine the correspondence between the client's score profile from the computerized assessment tool(s) and the score profiles for the subset of occupations identified as having the same primary work value score as the client.

A further refinement to the entry of work value scores from the Locator may be necessary. Specifically, clients might have to enter their secondary work value score in addition to their primary score. The distribution of primary work value scores across occupations is quite imbalanced—many occupations have the same primary work value score, and some work values (e.g., Recognition) are primary for just a few occupations. Clients for whom Recognition is their top work value would have very few occupations to explore if only the primary work value score were provided. If the primary and secondary scores were provided, the program could form a subset of occupations having a primary work value that matched the client's primary or secondary score. The effect would be to increase the pool of occupations within which the computerized profile matching procedure would be performed.

Summary

To facilitate client career exploration, DOL has developed a diverse set of O*NET assessment tools that clients can use to assess their abilities, interests, and work values (features of the work and workplace they deem most important). Except for the **O*NET Ability Profiler**, the assessment tools are offered in both computerized and paper-and-pencil formats. Clients can score the paper-and-pencil versions. Given a set of scores on one or more of the Profilers, clients then obtain a set of occupations deemed most promising for career exploration. The occupations are a subset of the 1,122 O*NET Occupational Units (OUs).

The OUs targeted for further exploration are those with a score profile calculated to be most correspondent with the client score profile. This report described the statistical indices used to determine profile correspondence: the correlation coefficient (all Profilers) and the

Euclidean distance (**O*NET Ability Profiler** only). The correlation provides a numerical index of the similarity of the shapes (but not the levels) of the client and occupation profiles and is the approach most vocational counselors prefer for describing profile correspondence. The Euclidean distance introduces level into the matching process. The rationale for using this second index with the **O*NET Ability Profiler** (only when the correlations between the client profile and two or more OU profiles are equal) is to increase the face validity of the selected OUs by minimizing the likelihood of strongly recommending occupations for which the person is highly under- or over-qualified. Thus, multivariate client and OU data are analyzed using accepted correspondence indices, and the use of the indices reflects accepted practice in vocational counseling.

There may be great benefit from obtaining client feedback on the processes just described for matching client and OU profiles. Comments regarding the usefulness of the assessment and career information they received would be beneficial. Also useful would be a check on client reactions to the OUs presented to them for career exploration.

Yet another topic for client feedback regards the use of multiple O*NET assessment tools. Specifically, it would be useful to know whether clients would prefer the system to allow them to weight their scores from various tools differentially. For example, clients new to the world of work might be most interested in the degree to which their interests are congruent with a given set of occupations. Others might be most interested in finding jobs that are consistent with their pattern of abilities. Experienced workers tend to be particularly interested in the dimensions assessed by the **O*NET Work Importance Profiler** and **O*NET Work Importance Locator**, as these dimensions are often reasons for their dissatisfaction with previous employment settings (e.g., too much supervision, too little opportunity to use their abilities). The present algorithm for matching client score profiles involving multiple assessment tools assigns equal weights to the scores from the multiple tools. Differential weighting could be incorporated into the matching algorithms described in this report and offer an opportunity for enhanced system flexibility for meeting clients' career exploration needs.

Career exploration using the O*NET assessment tools is (and will continue to be) a dynamic process. By computerizing occupational information, O*NET provides a means for keeping pace with occupational changes. Similarly, the career exploration process—specifically, the process by which clients are matched to promising occupations for exploration—can be systematically monitored and updated to ensure maximal benefit to DOL's clients. The client/occupation linkage procedures just described provide another component to a flexible, dynamic career exploration system that can retain its vitality in today's rapidly changing world of work.

References

Dawis, R.V., & Lofquist, L.H. (1984). *A psychological theory of work adjustment*. Minneapolis, MN: University of Minnesota Press.

Dawis, R.V., Lofquist, L.J., & Weiss, D.J. (1968). A theory of work adjustment (a revision). *Minnesota Studies in Vocational Rehabilitation*, *23*.

Holland, J.L. (1985). *Making vocational choices: A theory of vocational personalities and work environments (2nd ed.)*. Englewood Cliffs, NJ: Prentice-Hall.

Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments (3rd Ed.)*. Odessa, FL: Psychological Assessment Resources.

Lofquist, L.H., & Dawis, R.V. (1969). *Adjustment to work*. New York: Appleton-Century-Crofts.

McCloy, R.A., Campbell, J.P., Oswald, F.L., Rivkin, D., & Lewis, P. (1999). *Generation and use of occupation ability profiles for exploring O*NET occupational units* (Vols. I & II). Raleigh, NC: National Center for O*NET Development.

McCloy, R.A., Waugh, G., Medsker, G., Wall, J., Rivkin, D., & Lewis, P. (1999a). *Determining the Occupational Reinforcer Patterns for O*NET occupational units* (Vols. I & II). Raleigh, NC: National Center for O*NET Development.

McCloy, R.A., Waugh, G., Medsker, G., Wall, J., Rivkin, D., & Lewis, P. (1999b). *Development of the O*NET Computerized Work Importance Profiler*. Raleigh, NC: National Center for O*NET Development.

National Center for O*NET Development. (1999a). *O*NET Ability Profiler Scoring Program*. Raleigh, NC: Author.

National Center for O*NET Development. (1999b). *O*NET occupations combined list: Interests and work values*. Raleigh, NC: Author.

Oswald, F.L., Campbell, J.P., McCloy, R.A., Rivkin, D., & Lewis, P. (1999). *Stratifying occupational units by Specific Vocational Preparation.* Raleigh, NC: National Center for O*NET Development.

Rounds, J., Smith, T., Hubert, L., Lewis, P., & Rivkin, D. (1999). *Development of Occupational Interest Profiles for O*NET occupations*. Raleigh, NC: National Center for O*NET Development.

Silva, J. (1999). *O*NET Ability Profiler Scoring Program technical manual*. Raleigh, NC: National Center for O*NET Development.

Silva, J., Lewis, P., Rivkin, D., Koritko, L. (1999) *O*NET Ability Profiler Scoring Program user's guide*. Raleigh, NC: National Center for O*NET Development.

U.S. Department of Labor. (1991). *Dictionary of occupational titles* (Rev. 4th ed.). Washington, DC: U.S. Government Printing Office.

U.S. Department of Labor. (1998). *O*NET 98 data dictionary*. Washington, DC: U.S. Government Printing Office.

Weiss, D.J., Dawis, R.V., England, G.W., & Lofquist, L.H. (1964). Construct validation studies of the Minnesota Importance Questionnaire. *Minnesota Studies in Vocational Rehabilitation*, *18*.