

Comparisons Between NAEP and O*NET on Academic Preparedness for Job Training for Five Target Occupations

Final Report

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Executive Summary

This report describes the results from a study that a) identified relevant linkages between the National Assessment of Educational Progress (NAEP) in reading and mathematics and training performance requirements for selected occupations, and b) compared the levels of knowledge, skills, and abilities (KSAs) required for the relevant NAEP reading and mathematics content to the levels of KSAs required for the relevant job training content. The KSAs included in the current study come from the O*NET. The O*NET, or Occupational Information Network, is the U.S. Department of Labor's occupational information database. The O*NET contains *standardized descriptions* of 974 occupations, including the five occupations that are the focus of the National Assessment Governing Board's (Governing Board) program of research on academic preparedness for job training programs. The purpose of this program of research is collect evidence to determine the feasibility of using NAEP to report on the academic preparedness of U.S. 12th grade students for entry into job training. The five target occupations selected by the Governing Board for this program of research are: Automotive Master Technicians, Computer Support Specialists, Heating, Ventilation and Air Conditioning Technicians (HVAC), Licensed Practical Nurses (LPNs), and Pharmacy Technicians. Because the O*NET descriptors provide a "common language" for describing similarities and differences across occupations, it is a very useful resource for the present research.

For this study, tasks (i.e., performance requirements) for each occupation were extracted from O*NET. Occupational experts from each of the target occupations reviewed the O*NET task lists for their appropriateness to job training. This review was necessary because the O*NET tasks describe *job* performance requirements, but not *training* performance requirements, and the focus of the Governing Board's research is preparedness for *job training*. Based on the feedback from the occupational experts, edits were made to the O*NET task lists to ensure their applicability to job training. These lists of training performance requirements served as common content of job training programs. Next, occupational experts used these lists to identify NAEP reading and mathematics content that is relevant ("linked") to training performance requirements. The occupational experts also identified the training performance requirements that are relevant ("linked") to NAEP reading and mathematics content. Irrelevant content was removed from further consideration. Finally, trained project analysts used academically-relevant KSAs from O*NET to systematically rate the levels of KSAs needed for the relevant NAEP reading and mathematics content and the levels of KSAs needed for the relevant job training content. Disconnects between the levels of KSAs needed for NAEP reading and mathematics and the levels needed for job training were flagged for discussion.

An overview of the findings is as follows:

- The range of reading and mathematics skills required by NAEP (both grade 8 and grade 12) is broader than the range of reading and mathematics skills required by job training. This was demonstrated by the finding that considerably more content on NAEP was rated as irrelevant to job training than was job training content rated as irrelevant to NAEP.
- The NAEP reading objectives most relevant to job training content are the objectives associated with the Locate/Recall cognitive target for NAEP informational reading.

- The NAEP reading objectives that were least relevant to job training content were the objectives associated with the Critique/Evaluate cognitive target.
- The NAEP mathematics objectives most relevant to job training content were the objectives associated with the Numbers Sense and Operations and Measurement (except for Computer Support Specialists) content areas. This was true for both grade 8 and grade 12 NAEP.
- The NAEP mathematics objectives that were least relevant to job training content were the objectives associated with Geometry (except for HVAC) and Algebra (except for LPNs). This was true for both grade 8 and grade 12 NAEP.
- The percentage of the mathematics objectives linked to occupations decreased considerably from grade 8 to grade 12, indicating that as the complexity of the objectives increased from grade 8 to grade 12 their relevance to job training decreased.
- Disconnects were found between the levels of KSAs required for proficiency on NAEP and the levels of KSAs required for entry into job training such that higher levels of the KSAs were required for NAEP than for job training. The largest disconnects occurred between grade 12 NAEP mathematics and job training. Disconnects also occurred between grade 12 reading and job training. The disconnects in required levels of KSAs tended to be smaller when comparing grade 8 content to job training content, particularly for grade 8 reading, which demonstrated several “matches” with KSA levels for training content (most notably with Written Comprehension, which was rated as “Moderate” for both the NAEP grade 8 reading content and for the job training content across all occupations).

The above set of findings call into question the validity of inferences that can be made about using NAEP to report on the preparedness of U.S. 12th grade students for entry into job training. Based on the findings from this study in conjunction with converging evidence from prior studies (ACT, 2010a; 2010b, WestEd & Measured Progress, 2011; 2012; WestEd & Educational Policy Improvement Center, 2013), we offer the following recommendations for the Governing Board’s consideration:

- Given that there is converging evidence across studies that the Number Properties and Operations content area for mathematics and the Locate/Recall cognitive target from NAEP informational reading are most relevant to job training, consider the possibility of using subscores from these content areas to report on students’ academic preparedness for job training.
- Given the greater correspondence between grade 8 content and job training content in reading and mathematics, consider the possibility of administering the grade 8 assessments to 12th grade students to make determinations about their academic preparedness for entry into job training.
- Consider the possibility of updating the working definition of job preparedness to include trainee outcomes, such as trainee performance in job training. Actual performance in job training is at a level that is somewhat beyond “just qualified” for placement into job training. Including training outcomes in the working definition of job preparedness might potentially lead to evidence that is more supportive of grade 12 NAEP as an indicator of job preparedness. Furthermore, including training outcomes as elements of the working definition of job preparedness would expand opportunities for future research investigations.

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Chapter 1: Introduction

Background

The National Assessment Governing Board (Governing Board), which sets policy and provides general oversight and direction for the National Assessment of Educational Progress (NAEP), is conducting a program of research to determine the feasibility of using NAEP to report on the preparedness of U.S. 12th grade students for entry into postsecondary education and job training. The 12th Grade NAEP Preparedness Research Program was set in motion in 2002 when the Governing Board established the National Commission on NAEP 12th Grade Assessment and Reporting. This Blue-Ribbon Panel was charged to review the National Assessment of Educational Progress (NAEP) at grade 12 and recommend improvements. In 2004, the panel made five recommendations, including that NAEP be transformed to measure the preparedness of 12th graders for college and careers. The panel's rationale was that:

1. Grade 12 is the transition point to for most students to postsecondary education, training, the military and the workforce;
2. for national security and economic viability, it is important for the U.S. to have an indicator for 12th grade student achievement;
3. NAEP is trusted for its quality and integrity; and
4. as the only source of nationally representative data on 12th grade student achievement, NAEP is uniquely positioned to serve as a preparedness indicator.

In 2008, the Technical Panel on 12th Grade Preparedness Research was formed to assist the Governing Board in planning research and validity studies to support inferences about NAEP as an indicator of academic preparedness for college and job training. There was no single, generally accepted definition of “preparedness” to guide the research agenda. Therefore, a working definition was needed to design and conduct the NAEP research. As such, the Technical Panel defined preparedness as a subset of readiness¹. *Readiness* includes characteristics that are commonly referred to as “noncognitive factors”—factors such as motivation, persistence, conscientiousness, and interpersonal skills—which are important to achievement, but which NAEP does not purport to measure. Therefore, for the purposes of the NAEP Preparedness Research Program, *preparedness* was defined as the academic knowledge and skill levels in reading and mathematics necessary to be qualified for placement into a job training program or into a credit-bearing entry-level general education course that fulfills requirements toward a two-year transfer degree at a postsecondary institution (National Assessment Governing Board, 2009). According to this definition and to the guidance provided by the Technical Panel, preparedness does *not* mean success in postsecondary education and training. It refers only to eligibility to enter into postsecondary education and training.

The Technical Panel recommended a multi-method approach to the research, using a variety of studies, which, taken together, would provide evidence to support statements about preparedness for postsecondary education and job training based on NAEP performance. The five recommended types of research are:

¹ The Technical Panel relied on the prior discussions from the National Commission on NAEP 12th Grade Assessment and Reporting in 2004, and the 2006 work of the Board's *Ad Hoc* Committee on Planning for NAEP 12th Grade Assessments to develop a working definition of preparedness.

- **content alignment studies** between NAEP and widely used examinations for college admissions, post-secondary course placement, and workplace skills;
- **statistical linking studies** that link performance on NAEP to other relevant tests and postsecondary outcomes;
- **a higher education survey** of the tests and cut scores used for placement in remedial courses at two-year and four-year colleges;
- **judgmental standard setting** by expert panels to determine the NAEP scores that represent the knowledge and skills needed to qualify for job training programs or for entry-level college credit courses without remediation; and
- **benchmarking studies** in which NAEP assessments are given to reference groups of interest. These reference groups may include college freshmen, as in a 2010 pilot study. Future benchmarking studies may involve military recruits or individuals entering job training programs.

The findings from studies adopting these methods are to be used as validity evidence to either support or refute claims about 12th grade NAEP as an indicator of preparedness for postsecondary education and job training. By looking across findings from a range of study types, this program of research enables the Governing Board to evaluate the degree to which the results are mutually confirming or disconfirming. Considerably more studies have been conducted investigating 12th grade NAEP as an indicator of college preparedness than studies investigating 12th grade NAEP as an indicator of job preparedness. In fact, sufficient mutually confirming evidence has been collected on studies of 12th grade NAEP as an indicator of college preparedness to support the development of a validity argument regarding supportable claims about academic preparedness for college in relation to performance on 12th grade NAEP (Fields, 2013; 2014). The research studies on academic preparedness for job training are fewer and less supportive of claims regarding 12th grade NAEP as an indicator of job training preparedness. In the section that follows, we provide a brief overview of the inferences supported by evidence collected on 12th grade NAEP as an indicator of college preparedness, and we briefly summarize findings from three studies investigating 12th grade NAEP as an indicator of job training preparedness.

Brief Overview of Prior Research Studies

Studies Focusing on College Preparedness

To date, more than 30 studies have been conducted using one of the five study design methods. Findings from the studies focusing on college preparedness were recently synthesized into a validity argument addressing evidence in support of statements related to academic preparedness for college (Fields, 2014). Findings were largely consistent across studies and, for reading, support the inference that the percentage of students scoring at or above a score of 302 on the grade 12 NAEP reading scale is a plausible estimate of the percentage of students who possess the knowledge, skills, and abilities in reading that would make them academically prepared for college. For mathematics, findings support the inference that the percentage of students scoring at or above 163 on the grade 12 NAEP mathematics scale is a plausible estimate of the percentage of students who possess the knowledge, skills and abilities in mathematics that would make them academically prepared for college (Fields, 2014, pgs. 10 -11).

Studies Focusing on Job Training Preparedness

Compared to the number of studies conducted to investigate NAEP as an indicator of academic preparedness for college, various feasibility issues have caused there to be far fewer studies investigating NAEP as an indicator of academic preparedness for job training, and the findings from these few studies have been less conclusive.

Content Alignment Study between Grade 12 NAEP and WorkKeys. A content alignment study between 12th grade NAEP and WorkKeys (used to assess job-related skills) found some similarities between NAEP and WorkKeys, but also identified significant differences in both focus and rigor (ACT, 2010a; 2010b). The findings indicated that NAEP is broader both in focus and rigor. Also, the WorkKeys exams in Applied Mathematics and Reading for Information focus exclusively on the application of academic skills in the workplace, whereas NAEP covers a considerably wider range of mathematical topics and reading skills.

Judgmental Standard Setting Study. A judgmental standard setting (JSS) study was conducted in an effort to identify NAEP scale scores at 12th grade representing the knowledge and skills in reading and mathematics needed to qualify for entry into job training programs for five targeted occupations. The findings from the JSS study did not produce supportable conclusions about where to set reference points on the NAEP scale to denote the minimum academic knowledge and skills needed for academic preparedness for entering job training for the targeted occupations. Rather, there was significant variability in the cut scores set by replicate panels within and across occupations (Loomis, 2012; WestEd & Measured Progress, 2011; 2012).

One challenge encountered during the JSS study involved difficulty with developing agreed-upon borderline performance descriptions (BPDs) of the academic knowledge, skills, and abilities (KSAs) needed to be minimally prepared to enter job training programs (Kilpatrick, 2012). Panelists had difficulty understanding the academic language (particularly for mathematics) contained within the NAEP frameworks. Furthermore, the lack of a common set of expectations for requirements for placement into job training programs also contributed to the panelists' difficulty with developing reasonable BPDs (Kilpatrick, 2012). Another major challenge encountered during the JSS study is that panelists identified many grade 12 NAEP items as "irrelevant" to their respective job training programs. Including such construct-irrelevant variance could negatively impact results. Some panelists suggested that grade 8 NAEP would have been a better match to the requirements of their job training programs (Loomis, 2012).

As a result of these challenges, a primary conclusion from the JSS study was that additional research was needed to determine the prerequisite KSAs in reading and mathematics needed to qualify for entry into job training programs. As a result, a third study (a course content analysis) was conducted to identify the prerequisite KSAs evident in course materials for entry-level job training courses (WestEd & Educational Policy Improvement Center, 2013).

Course Content Analysis Study. For this study, the NAEP reading and mathematics frameworks were used to identify a foundational set of KSAs, which are the "objectives" in the NAEP Reading and Mathematics Framework documents. The NAEP objectives occupy the lowest level in the organizational structure of the frameworks. Teams of mathematics and reading content experts and occupational course instructors collaborated to analyze course artifacts (e.g., syllabi, textbooks, assignments) for job training programs for the five target occupations to identify which of the NAEP objectives were evidenced in the course artifacts. The findings from this study indicate that the reading and mathematics content identified in the

course artifacts are largely included in the grade 12 NAEP frameworks, but that the content of the NAEP frameworks are much larger and broader (similar to what was found in the content alignment study between NAEP and WorkKeys). The course artifacts revealed that few NAEP objectives are covered in the job training programs.

In particular, for mathematics, the largest numbers of NAEP mathematics objectives (across all training programs) were found for the Number Properties and Operations domain. None of the course artifacts showed evidence of covering NAEP objectives in the Data Analysis, Statistics, and Probability domains. Moreover, although this study did not explicitly investigate the NAEP grade 8 objectives and items, the NAEP experts noticed that when “exclusions” (i.e., content irrelevant to the job training program) were removed from the grade 12 mathematics objectives, much of the complex mathematics knowledge and skills that differentiate the grade 8 objectives from the grade 12 objectives disappeared. This led the report authors to suggest that the grade 8 mathematics objectives might better describe the KSAs covered in job training course materials than the grade 12 objectives. Also, between 83 and 101 of the 130 grade 12 mathematics objectives were not evident in any of the course materials across the five target occupations.

For reading, only the NAEP reading objectives related to reading informational texts were evidenced in course artifacts. There was no evidence of NAEP reading objectives related to literary texts in the course artifacts. Of the three cognitive targets pertaining to informational text (i.e., Locate/Recall, Integrate/Interpret, and Critique/Evaluate), the most evidence was found for the Locate/Recall target and the least evidence was for the Critique/Evaluate target in the course artifacts. Moreover, the number of reading objectives not evident in any of the course materials across the five target occupations ranged between 6 and 25 of the 37 objectives.

Purpose of the Current Study

The U.S. Department of Labor maintains an extensive occupational information database: the Occupational Information Network, or O*NET. The 974 occupations currently housed in the database include standardized descriptions assembled through a rigorous process to ensure consistency across occupations. O*NET data have been used widely in research. The current study utilizes O*NET as a resource in two ways. First, the performance requirements (tasks) from O*NET serve as the foundation for identifying training performance requirements for target occupations, and relevant linkages between training performance requirements and NAEP reading and mathematics objectives are identified. Second, this study uses a subset of academically relevant O*NET KSA descriptors to compare the levels of KSAs needed to be proficient on NAEP reading and mathematics with the levels of KSAs needed to be prepared for entry into job training.

This study expands upon the prior research studies on job training by explicitly including 8th grade NAEP in the study. Both the JSS study and the course content analysis study reported anecdotal evidence that the content covered by the grade 8 reading and mathematics assessments might be a closer match to the KSAs required for entry into job training than the grade 12 assessments. As a result, both grade 8 and grade 12 were included in the current study. Including the grade 8 reading and mathematics content allows us to provide evidence beyond the anecdotal evidence obtained in the JSS study and course content analysis study as to whether the grade 8 assessments might be better indicators of academic preparedness for job training than the grade 12 assessments.

In addition to including grade 8 in the study design, this study adopts an additional “lesson learned” from the prior studies by identifying and removing irrelevant NAEP reading and mathematics content upfront. Prior to comparing the levels of KSAs needed for NAEP versus the levels needed for job training, reading and mathematics content on NAEP that was deemed irrelevant to job training was removed from consideration when making KSA ratings. Similarly, job training content that did not entail some use of reading and/or mathematics skills was also removed. In this sense, the trained project analysts made ratings on only the NAEP reading and mathematics content that was deemed relevant to the job training content and on only the job training content deemed relevant to the NAEP reading and mathematics content in question. This should help to minimize the impact of construct-irrelevant variance on KSA ratings. Notable differences in the mean ratings for the levels of KSAs needed for NAEP and the levels needed for job training were flagged as disconnects between NAEP and job training.

Finally, the current study adopts an innovative approach to identifying the KSAs by using the standardized descriptors from O*NET. Standardized information on the performance requirements for the target occupations was also obtained from O*NET, and adapted with input from occupational experts for applicability to job training.

This study will help to identify (a) relevant linkages between NAEP reading and mathematics content and job training content (b) gaps in relevant content between NAEP reading and mathematics content and job training content, and (c) disconnects in the levels of KSAs needed for proficiency on NAEP and the levels needed for entry into job training, based on the subset of relevant content.

A discussion of the considerations that influenced the design of this study and the steps involved in conducting the research are provided in the next chapter on Methods.

Chapter 2: Method

In this chapter, we address considerations that influenced the study design, describe the method developed as an outgrowth of those considerations, and detail the steps to conduct the study.

Considerations

The design of this study was influenced by findings from prior studies, practical constraints, and inherent challenges with doing this research. Those considerations and their influence on the study's design are discussed below.

Grade 8 NAEP Reading and Mathematics Assessments

Both the judgmental standard setting study and the course content analysis study reported anecdotal evidence that some content covered by the grade 8 reading and mathematics assessments might be a closer match to the KSAs required for entry into job training than the parallel content in the grade 12 assessments. As a result, both grade 8 and grade 12 are included in the current study. The inclusion of the grade 8 reading and mathematics content will allow us to provide evidence beyond the anecdotal evidence obtained in the judgmental standard setting study and course content analysis study as to whether the grade 8 assessments might be better indicators of academic preparedness for job training than the grade 12 assessments.

Variability of Job Training Requirements within Occupations

The Governing Board acknowledges that, “job training programs constitute a variety of pathways, including apprenticeship programs, on-the-job training programs, and vocational institute or certification programs (National Assessment Governing Board, 2009). The challenge involved with investigating academic preparedness for job training given the variability within programs was discussed in a paper commissioned by the Governing Board. Dr. Neal Schmitt, a prominent expert in field of industrial-organizational psychology, explained in the paper that collecting validity evidence to support the use of NAEP as an indicator of academic preparedness for job training is “much more difficult” than efforts to show that the level of academic skills displayed by students on NAEP is related to their preparedness for college. He explained, “There are certainly differences in grading policies and the courses taken by college students that make comparisons difficult, but the differences in employing organizations and their training requirements likely make the college experience seem homogenous and simple by comparison” (Schmitt, 2004, p. 22). As a result, he concluded that “this nonequivalence issue” makes the task of establishing preparedness for training “extremely challenging.”

Evidence to support Schmitt's conclusion has been borne out in the findings from the JSS study and the course content analysis study. During the JSS study, WestEd found that occupations “varied dramatically” in how they train their workforces and how job training programs are accredited or certified (WestEd & Measured Progress, 2011). This variability in training program requirements was cited as one of the reasons the JSS panelists had considerable difficulty in developing agreed upon Borderline Performance Descriptions (BDPs) for the JSS (Kilpatrick, 2012). Moreover, the panelists participating in the JSS study explained that the student populations served by the job training programs varied, such that within occupational areas there was variability with respect to whether students in the program were coming directly from high school or returning after an absence from formal education; this difference in student populations was discussed in relation to whether the grade 8 frameworks would have been a

better match to training requirements (Loomis, 2012). Additional confirming evidence that establishing preparedness for training is “extremely challenging” came from the course content analysis study. One of the limitations reported in this study was that there was a “high degree of variability across courses” with regard to the course artifacts submitted for the same occupations (WestEd & Educational Policy Improvement Center, 2013).

In light of the challenges discussed above with regard to the variability within job training programs, for the current study, we attempted to incorporate a more standardized approach to describing job training programs. We looked to the Department of Labor’s occupational information network, or O*NET, as a means of providing greater standardization in describing the target occupations.

O*NET

The O*NET is the U.S. Department of Labor’s (DOL) occupational information database (Peterson, Mumford, Borman, Jeanneret & Fleishman, 1999). It offers an extensive repository of current occupational information, it is based on a thorough review of an extensive body of literature, and it has been used widely in research projects (e.g., see Russell et al., 2008; Waters et al., 2009). DOL created O*NET in the 1990s to replace its predecessor, the *Dictionary of Occupational Titles (DOT)*. First, a prototype O*NET database was developed on a sample of occupations (Peterson, Mumford, Borman, Jeanneret, & Fleishman, 1995). Then, a series of efforts were initiated to populate the database with descriptions of all occupations in the Standard Occupational Classification (SOC). Currently, O*NET contains *standardized descriptions* of 974 detailed occupations.² To ensure a controlled data collection and management process, occupational data are regularly updated in scheduled analysis cycles.³

O*NET descriptors provide a “common language” for describing similarities and differences in occupations. In addition, O*NET consists of cross-occupation descriptors (e.g., knowledge, skills, and abilities) and occupation-specific descriptors (e.g., task statements), thus making the O*NET a very useful resource for the purposes of this study. We therefore used it as the foundation for comparisons between the content of NAEP reading and mathematics and the content of job training programs.

O*NET is organized around a content model comprising six domains. Information within each domain is organized by different levels of description. For the purposes of this study, the O*NET descriptors we focused on were: task statements, knowledge, skills, and abilities (KSAs). The task statements served as an occupation-specific descriptor and the KSAs served as a common descriptor to be applied across job training programs and across NAEP. Because the O*NET task statements are requirements for on-the-job performance and not training performance, we recruited occupational experts to review and revise the O*NET task statements to make them applicable to training. These revised lists are referred to as “training performance requirements” in the current report, and they are the tasks that trainees receive training on in their training/apprenticeship programs. These lists of training performance requirements served as the content of the job training programs in the current investigation.

² A complete listing of occupations can be found here:
http://www.onetcenter.org/taxonomy/2010/data_coll.html

³ Additional information about O*NET is available at the O*NET website <http://online.onetcenter.org/>.

Availability of Content Experts

Findings from the JSS study indicate that it was difficult to recruit occupational experts to participate as panelists in the study (WestEd & Measured Progress, 2011). Several explanations for the difficulty in recruiting panelists were provided, including that (a) instructors teaching courses in job training programs could not obtain authorization to take time away from teaching classes to participate and (b) many instructors also work as practicing technicians, thus making it even more difficult to commit the time to participate in the JSS study. Furthermore, they found that some of those who did participate lacked the content knowledge and skills to effectively interact with the NAEP content, particularly the grade 12 mathematics content.

For O*NET, the task statements are developed with the input of job incumbents and occupational experts. The ability and skill ratings, however, are made by trained job analysts. The rationale for this is that job incumbents/occupational experts are more likely to be familiar with the day-to-day duties and conditions of their job, whereas trained job analysts have a better understanding of the ability and skill constructs (Tsacoumis, 2007).

Given the difficulty recruiting occupational experts in the JSS study and the precedent set by O*NET to use occupational experts to develop task statements and use trained analysts to make ability and skill ratings for occupations, we adopted a similar method for the current study. We recruited occupational experts to edit the O*NET task lists to apply to training and to identify NAEP reading and mathematics content relevant to training performance requirements (and vice versa), and we used trained HumRRO project analysts to make KSA ratings on the linked content (i.e., the NAEP reading and mathematics content identified as relevant to training performance requirements and the training performance requirements identified as relevant to NAEP). Because HumRRO trains the analysts who make ability and skill ratings for the O*NET occupations, we were able to adapt that same training material to train HumRRO project analysts to make KSA ratings for this study. This approach allowed us to minimize the need for occupational experts and to capitalize on HumRRO's expertise in training analysts to make ability and skill ratings.

Method Description

The method comprised seven major steps. Figure 1 lists the steps.

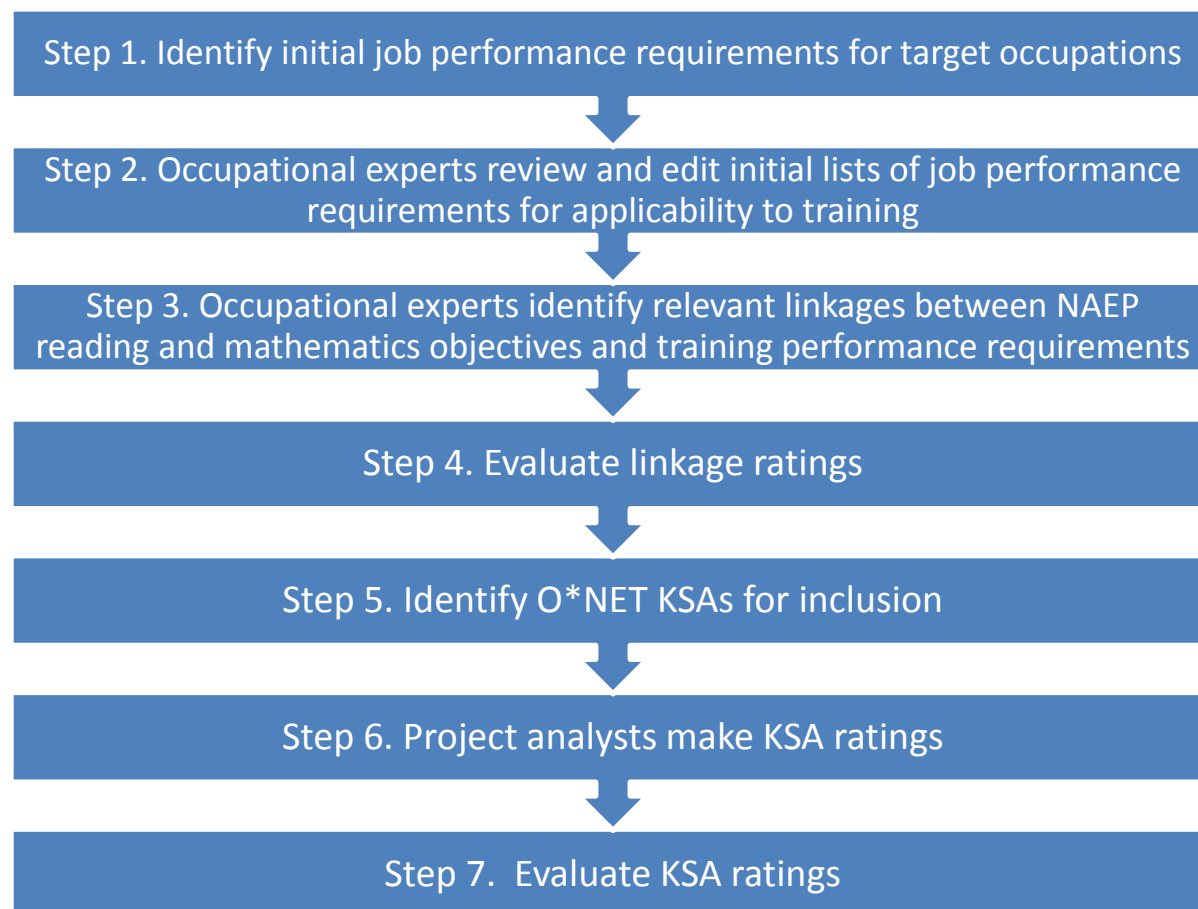


Figure 1. Method steps employed in this study.

Each step of the methodology is described in detail below.

Step 1: Identify Initial Performance Requirements for Target Occupations

The occupations investigated in this study were carefully selected by the Governing Board to meet five criteria:

- represent a broad range of occupations in different sectors of the economy that have and are likely to continue to have a high potential for employment,
- require postsecondary training of at least 3 months but do not require a bachelor's degree,
- have good wage potential,
- have a military counterpart, and
- be recognizable to the public.

Both the JSS study and the course content analysis study targeted the same five occupations in their investigations. We investigated the same occupations so findings from this study can be compared to the findings from those studies. The five occupations selected by the Governing Board that meet these criteria and that are the focus of this study are:

- Automotive Master Technician
- Computer Support Specialist
- Heating, Ventilation, and Air Conditioning Technician (HVAC)
- Licensed Practical and Licensed Vocational Nurse (LPN)
- Pharmacy Technician

The initial set of standardized job-specific information for each target occupation was obtained by downloading the tasks, or performance requirements, from O*NET OnLine⁴ (see Appendix A). A benefit of using the O*NET performance requirements to describe the target occupations is that the task information is standardized (i.e., the tasks are described at a similar level of specificity) across occupations. As mentioned above, job incumbents and occupational experts identify the tasks for their occupations; then, trained O*NET analysts review the information provided by those individuals and ultimately develop the final task statements. In developing the task statements, the O*NET analysts define a task as “a discrete behavior/activity with a meaningful outcome” (Cunningham, 2000). Having trained analysts develop the O*NET task statements (based on the input from job incumbents and occupational experts) helps ensure that the tasks reflect a similar specificity level (i.e., standardized) across occupations. In the end, the task statements are written at a moderate level of specificity in the sense that they provide a clear indication of the behavior/activity performed. Task statements, however, are not broken down into their finest level of specificity. For example, one of the O*NET task statements for pharmacy technicians is, “Mix pharmaceutical preparations, according to written prescriptions.” This task is written at a moderate level of specificity in the sense that it clearly conveys the activity performed, but it does not break the task down into each of the steps involved with its performance (e.g., set-up the mixing equipment, add the material to be mixed, turn on the equipment). This standardization across occupations helped to ensure that, when it came time for the trained project analysts to make ratings on the levels of KSAs needed for the occupations, the ratings were based on a comparable set of information for each occupation.

To help ensure that the list of performance requirements for each occupation was as complete as possible, the lists of tasks from O*NET were cross-referenced against lists of course objectives obtained from the course content analysis study (WestEd & Educational Policy Improvement Center, 2013)⁵ previously sponsored by the Governing Board. A total of 609

⁴ All five target occupations are classified as “Job Zone 3” on O*NET. Zone 3 occupations are described as those requiring “training in vocational schools, related on-the-job experience, or an associate’s degree.” This classification is consistent with the Governing Board’s criterion that target occupations be ones that “require postsecondary training of at least three months, but do not require a bachelor’s degree.” Moreover, all five target occupations are identified on O*NET as “bright outlook” occupations, meaning that they are expected to grow rapidly in the next several years, have large numbers of job openings, or are new and emerging occupations. This classification is consistent with the Governing Board’s criterion of having “high potential for employment.”

⁵ A sample of the course objectives from the course content analysis study can be downloaded from <http://www.nagb.org/content/nagb/assets/documents/what-we-do/preparedness-research/judgmental-standard-setting-studies/appendix-c-sample-learning-objectives-from-course-syllabi.pdf>.

course objectives for the five occupations were reviewed for consideration. Many of the course objectives were inappropriate for inclusion on the list of performance requirements, as they were not consistent with the definition of a task as “a discrete behavior/activity with a meaningful outcome.” For example, many of the course objectives described a knowledge or an ability such as, “Understand basic computer concepts” (for Computer Support Specialist), or “Demonstrate the ability to describe basic refrigeration and air conditioning” (for HVAC). We eliminated such course objectives from consideration.

Step 2: Occupational Experts Review and Edit Initial Lists of Performance Requirements for Applicability to Training

Once the initial lists of performance requirements were identified, the next step was to vet the lists with occupational experts. Occupational experts were recruited to verify the accuracy and completeness of the task lists for job training purposes. Because the O*NET task lists were developed based on actual job performance, it was important to have occupational experts review and revise the lists to ensure that the tasks described activities that were relevant to training/apprenticeship programs rather than activities that would be performed only by current [or actual] employees.

To help ensure the quality of the recruited occupational experts, the occupational experts were identified through internet searches of the following national certifying organizations websites:

- Accreditation Commission for Education in Nursing (ACE);
- Air Conditioning, Heating, and Refrigeration Institute (AHRI);
- American Association of Health-System Pharmacists (ASHP);
- Association for Career and Technical Education (ACTE);
- Automotive Youth Educational Systems (AYES);
- National Automotive Technicians Education Foundation (NATEF);
- National Association of State Directors of Career Technical Education Consortium (NASDCTEC);
- National League for Nursing Accrediting Commission (NLNAC);
- North American Council of Automotive Teachers (NACAT); and
- Partnership for Air-Conditioning, Heating, Refrigeration Accreditation (PAHRA).

Contact information for potential occupational experts was identified through the above websites. In many instances, those searches led to instructors at community colleges. From those community colleges, affiliates with similar programs were identified and additional occupational experts were identified from those institutions' websites. Potential occupational experts were contacted via email to recruit their participation (see Appendix B). Prior to completing the reviews, all candidate experts completed a background form to ensure their qualifications for conducting the review (see Appendix C). The average number of years of experience with the occupation (instructing and/or practicing) was 24.40 years ($sd = 8.80$), and all of the occupational experts were involved in professional activities (e.g., serving on a certification board, member of a professional organization, etc.) and/or had received awards/recognitions (e.g., certificate of achievement, instructor of the year) in their occupations.

Three occupational experts from each occupation independently vetted the initial performance requirements lists. Each occupational expert was provided with (a) the list of tasks from O*NET, (b) the list of “task-like” course objectives from the course content analysis study for cross-referencing with the O*NET tasks, and (c) a set of detailed instructions for reviewing the appropriateness of the tasks for training/apprenticeship programs (see Appendix D). The occupational experts were also asked to verify that the tasks were appropriately identified as “core” or “supplementary.” O*NET identifies core tasks as those that job incumbents rate as being both relevant and important to the occupation. Supplementary tasks are those rated as low in relevance or as unimportant (trivial) to the occupation. Given our focus on training/apprenticeship, we felt it was important to verify those designations for the purposes of this study. Tasks that were verified as supplementary to training were dropped.

The feedback from all the occupational experts was combined into a single revised list of training performance requirements for each occupation. A final review and approval of the revised lists was provided by one of the occupational experts in each occupation who had provided particularly insightful input. Overall, the edits made to the original O*NET task lists were relatively minor, which seems logical given that training/apprenticeship programs are intended to prepare trainees to perform tasks required for the job. Edits generally consisted of providing some additional clarification of existing tasks, removing parts of tasks that described procedures or equipment/tools that were not relevant to training/apprenticeship, and removing tasks verified to be supplemental. In addition, based on the feedback provided by the occupational experts, two additional training performance requirements were added to Automotive Master Technician, Computer Support Specialist, HVAC Technician, and Pharmacy Technician, and three additional training performance requirements were added to LPN. The final revised lists of training performance requirements for each occupation are provided in Appendix E.

Step 3: Occupational Experts Identify Relevant Linkages between NAEP Objectives and Training Performance Requirements

Findings from the JSS study and the course content analysis study revealed that some of the NAEP reading and mathematics content was deemed as irrelevant to the target occupations. Consequently, for this study, the occupational experts were asked to systematically identify the NAEP objectives that are relevant to the lists of training performance requirements for each occupation. These dichotomous “linkage ratings” were made for the NAEP reading and mathematics objectives, grades 8 and 12. Rather than identifying which NAEP *items* are relevant to which training performance requirements, the occupational experts made linkage ratings between NAEP *objectives* and training performance requirements. There are considerably fewer NAEP objectives than NAEP items for the 2013 operational assessment. Consequently, linking objectives to training performance requirements presented less of a cognitive load on the occupational experts, but still allowed us to determine at a relatively fine-grained level the content on the NAEP reading and mathematics assessments that is relevant to the training performance requirements for each occupation. In addition, items rotate on and off the assessments and are associated with varying degrees of difficulty, while the objectives remain stable across assessment years.

For reading, we know from the course content analysis study that the NAEP objectives for literary texts were not found to be relevant to any of the training programs. Across all occupations, the occupational experts in the current study confirmed that literary texts are *irrelevant* to all of the training performance requirements. Accordingly, the occupational experts were not asked to make individual linkage ratings between the NAEP literary text objectives and training performance requirements. Instead, the occupational experts made

linkage ratings only between the 24 objectives relevant to informational texts and the training performance requirements for their occupation. For NAEP reading, the objectives are the same for grades 8 and 12. Consequently, the occupational experts made linkage ratings only between one set of reading objectives and the training performance requirements for their occupation. The NAEP reading objectives were identified from the bulleted lists in Exhibit 8 of the NAEP Reading Framework document (National Assessment Governing Board, 2013a). The subset of reading objectives (i.e., the objectives relevant to informational texts) included in this study is provided in Appendix F.

For mathematics, the grade 8 objectives and the grade 12 objectives were obtained from the NAEP Mathematics Framework (National Assessment Governing Board, 2013b). The 100 objectives for grade 8 mathematics are listed in Appendix G, and the 130 objectives for grade 12 mathematics are listed in Appendix H.

The occupational experts provided their independent linkage ratings in an Excel spreadsheet. Five Excel spreadsheets were developed—one for each occupation. Each spreadsheet contained three separate worksheets: one for linking NAEP reading objectives to training performance requirements, one for linking NAEP grade 8 mathematics objectives to training performance requirements, and one for linking NAEP grade 12 mathematics objectives to training performance requirements. In addition to listing the NAEP objectives, each worksheet included the hierarchical framework within which the objectives were located. For example, for reading, the objective, “Make complex inferences within and across texts to summarize major ideas” was identified as falling under the “Integrate/Interpret” cognitive target, and for grade 8 mathematics, the objective, “Write or rename rationale numbers” was identified as part of the “Number Sense” subtopic under the “Number properties and Operations” content area. We included this hierarchical framework in the rating spreadsheets to help the occupational experts better understand the broader context within which the objectives were located. Additionally, the Excel spreadsheets included hypertext links to define key terms. For example, the objective, “Use place value to model and describe integers and decimals” included a hypertext link that defined integers as, “numbers that can be written without fractions or decimals, and includes counting numbers (1, 2, 3, . . .), zero, and the negative counting numbers (-1, -2, -3, . . .).” We included the hypertext definitions to help clarify the meanings of the objectives for the occupational experts and to guard against possible sources of confusion with the terminology (identified as a problem encountered by the occupational experts in the JSS study, particularly with mathematics; Kilpatrick, 2012).

The occupational experts were emailed the Excel spreadsheet along with a detailed set of instructions for making the linkage ratings (see Appendix I). The occupational experts were instructed to first make linkage ratings between the NAEP reading objectives and training performance requirements, followed by linkage ratings between grade 8 mathematics objectives and training performance requirements, and finally between grade 12 mathematics objectives and training performance requirements. Each worksheet in the rating spreadsheet was formatted as a matrix such that the objectives appeared in rows and the training performance requirements appeared in columns. The occupational experts were instructed to enter a “y” in the cell if the objective was relevant to the training performance requirement, and to leave the cell blank if the objective was not relevant to the training performance requirement. If the objective uses the word “or” (for example, “Write *or* rename rational numbers.”), then the occupational experts were instructed to enter a ‘y’ if either verb (i.e., “write” or “rename”) is relevant to the training performance requirement. However, if the objective uses the word “and” (for example, “Make *and* test a geometric conjecture about regular polygons.”), then the occupational experts were instructed that both parts (i.e., “making” and “testing”) must be

relevant to the training performance requirement in order to enter a “y” in the cell. A screenshot of the rating matrix for Pharmacy Technicians is provided in Figure 2.

	A	B	C	D	E	F	G	H
1	Cognitive Target	Standard	Objective (Is the objective relevant to the task?)	1. Receive written, faxed, or electronic prescriptions or refill requests and verify that information is complete and accurate.	2. Interview patients to collect demographic information, current medications, allergy information, medical conditions, and insurance information.	3. Maintain proper storage and security conditions for drugs, including checking refrigerator temperatures and entering into temperature logs.	4. Answer telephones, responding to questions or requests, and directing inquiries to pharmacists, as necessary.	5. From generated prescription labels, prepack bulk medicines, fill bottles with prescribed medications, affix labels, and review for any issues that require a pharmacist to counsel a patient such as early or late refills, drug interactions, or drug duplication.
2	Locate/Recall	Identify textually explicit information (such as definitions, facts, and supporting details) and make simple inferences within and across texts.	Identify definitions within and across texts and make simple inferences.	y	y			
3	Locate/Recall	Identify textually explicit information (such as definitions, facts, and supporting details) and make simple inferences within and across texts.	Identify facts within and across texts and make simple inferences.	y	y	y		
4	Locate/Recall	Identify textually explicit information (such as definitions, facts, and supporting details) and make simple inferences within and across texts.	Identify supporting details within and across texts and make simple inferences.	y	y			

Figure 2. Screenshot of Excel linkage rating matrix for pharmacy technicians (reading).

Step 4: Evaluate Linkage Ratings

Results of the linkage ratings from the occupational experts were used to identify and remove the NAEP objectives that were deemed irrelevant to training performance requirements and the training performance requirements that were deemed irrelevant to NAEP objectives.

For the purposes of identifying irrelevant NAEP objectives and irrelevant training performance requirements, rather than evaluating agreement among occupational experts at the level of each pairwise linkage (i.e., each cell in the rating matrix), we evaluated agreement at the level of the margin totals for each column and each row. That is, if there was unanimous agreement among occupational experts that a NAEP objective was linked to one or more training performance requirements, then the objective was considered to be relevant to the occupation. Similarly, if there was consensus among occupational experts that a training performance requirement was linked to one or more NAEP objectives, then the training performance requirement was considered to be relevant to NAEP. Likewise, if there was consensus among occupational experts that an objective was *not* linked to any of the training performance requirements, then the objective was identified as irrelevant to the occupation and flagged for removal. Finally, if there was consensus among occupational experts that a training performance requirement was *not* relevant to any of the objectives, then the training performance requirement was identified as irrelevant to NAEP and flagged for removal. Where there was not consensus among the three occupational experts, additional input was obtained from a lead occupational expert to arbitrate the discrepancy. If the occupational expert provided a rationale with evidence to support the relevance of the objective/performance requirement, then it was included as relevant.

Step 5: Identify O*NET KSAs for Inclusion

The O*NET taxonomy includes a total of 120 KSAs (i.e., 33 knowledges, 35 skills and 52 abilities). Three senior HumRRO researchers reviewed the list of 120 KSAs to determine which ones to include in the current study. The senior HumRRO research staff consisted of the project lead for this study who also leads HumRRO's efforts on the O*NET task analysis project, a senior technical contributor who has extensive experience conducting research with O*NET, and another senior technical contributor who has extensive experience conducting research on NAEP.

The primary criterion for inclusion was that the O*NET descriptor, or O*NET "element," had to be academically relevant in some way. The O*NET includes traditional academic descriptors such as Written Expression and Number Facility. The O*NET also includes descriptors such as psychomotor abilities (e.g., Manual Dexterity) and sensory abilities (e.g., Peripheral Vision), which, although potentially relevant to many of the occupations, are clearly not relevant to NAEP. Therefore, many of the O*NET elements were easily eliminated from the list of KSAs for inclusion in this study. Once the project leader eliminated the elements that were clearly unrelated to NAEP, input from the two senior technical contributors was obtained to identify the final set of KSAs for inclusion in this study. Because HumRRO leads the effort to train the O*NET analysts who make the ability and skill ratings for the O*NET occupations, we used the clarifications of the O*NET elements that are used in those trainings to help make the final determination about which KSAs to include in the current study. The goal was to err on the side of including KSAs from O*NET that might potentially be academically relevant. With that guidance in mind, a list of 25 O*NET elements (see Appendix J) was identified for inclusion in the current study with the understanding that some of the elements might eventually be dropped after ratings were made by project analysts.

Step 6: Project Analysts Make KSA Ratings

In this step, trained project analysts made systematic ratings on a) the levels of KSAs need to be proficient on the relevant NAEP reading and mathematics content and b) the levels of KSAs needed to qualify for entry into job training programs where trainees are trained on the relevant training performance requirements (i.e., "tasks").

Twenty-three HumRRO raters were trained as project analysts for the current study. All project analysts were HumRRO research staff with advanced degrees (nearly half with PhDs) working in education related programs or Industrial-Organizational psychology related programs at HumRRO. Five of the 23 project analysts also work on HumRRO's analyst project for O*NET.

Training of the HumRRO project analysts was modeled after the training that HumRRO conducts for O*NET in which analysts are trained to make ability and skill ratings for the O*NET occupations. Adaptations to the O*NET training were made to incorporate the application of the rating process to NAEP. Consistent with the guidance provided by the O*NET Analyst project, eight project analysts were assigned to rate each occupation to help ensure the target level of interrater reliability was achieved (Peterson et al., 1997; Tsacoumis & Willison, 2010). Analysts rated from one to three occupations.

HumRRO project analysts attended an on-site training session (or attended via WebEx for those remotely located). An overview of the training follows.

Overview of Project Analyst Training

The training session consisted of the following parts:

- a Microsoft PowerPoint presentation providing background on the Governing Board's preparedness research agenda;
- an explanation of the distinction between job preparedness and career readiness;
- an explanation of the purpose of the current study;
- a discussion of the steps involved with making KSA ratings on NAEP reading and mathematics content and on training performance requirements, including a discussion of rating tips (adapted for the O*NET Analyst training materials);
- an explanation of the materials used to make KSA ratings (adapted from the materials used for the O*NET Analyst project);
- practice ratings on several KSAs; and
- group discussion of rationales for practice ratings.

The project analysts were tasked with making seven "sets" of KSA ratings, with each "set" consisting of a rating on each of the 25 O*NET elements identified in Step 5. Consequently, in total, each project analyst made 175 ratings (i.e., 7 X 25) per occupation. The seven "sets" of content on which analysts made KSA ratings were as follows:

- **NAEP Grade 8 Reading Content Relevant to Training Performance Requirements –** This consisted of the subset of NAEP reading objectives that the occupational experts identified as relevant to the training performance requirements for the occupation. Project analysts used this set of objectives and the Cognitive Targets to which they belonged to home in on the subset of operational items from the 2013 grade 8 reading assessment that reflected the cognitive targets and objectives relevant to job training. When reviewing the grade 8 operational items, the project analysts were instructed to pay particularly close attention to the items' achievement level designation (i.e., basic, proficient, advanced). Based on this subset of relevant NAEP grade 8 reading content (i.e., cognitive targets, objectives, items, and item information), project analysts rated the level of each O*NET element needed to be "proficient" on NAEP. Project analysts were instructed to use the description of grade 8 reading proficiency from the Reading Framework document as the definition of proficiency to guide their KSA ratings (National Assessment Governing Board, 2013a p. 65).
- **Training Performance Requirements Relevant to NAEP Reading –** This consisted of the subset of training performance requirements that the occupational experts identified as relevant to the NAEP reading objectives. Based on this subset of training performance requirements, project analysts rated the level of each O*NET element needed to qualify for placement into a job training program where trainees are prepared to perform that set of tasks.⁶

⁶ Because NAEP reading objectives are the same for Grade 8 and Grade 12, there are not separate linkages between training performance requirements and Grade 8 objectives and between training performance requirements and Grade 12 objectives, like there is for mathematics.

- **NAEP Grade 12 Reading Content Relevant to Training Performance Requirements –** This consisted of the subset of NAEP reading objectives that the occupational experts identified as relevant to the training performance requirements for the occupation. Project analysts used this set of objectives and the Cognitive Targets to which they belonged to home in on the subset of operational items from the 2013 grade 12 reading assessment that reflected the cognitive targets and objectives relevant to job training. When reviewing the grade 12 operational items, the project analysts were instructed to pay particularly close attention to the items' achievement level designation (i.e., basic, proficient, advanced). Based on this subset of relevant NAEP grade 12 reading content (i.e., cognitive targets, objectives, items, and item information), project analysts rated the level of each O*NET element needed to be "proficient" on NAEP. Project analysts were instructed to use the description of grade 12 reading proficiency from the Reading Framework document as the definition of proficiency to guide their KSA ratings (National Assessment Governing Board, 2013a p. 66).
- **NAEP Grade 8 Mathematics Content Relevant to Training Performance Requirements –** This consisted of the subset of grade 8 mathematic objectives that the occupational experts identified as relevant to the training performance requirements for the occupation. Project analysts used this set of objectives to identify the subset of operational items from the 2013 grade 8 mathematics assessment that mapped onto those objectives. When reviewing the grade 8 operational items, the project analysts were instructed to pay particularly close attention to the items' achievement level designations (basic, proficient, advanced) and the items' mathematical complexity ratings (low, moderate, high). Based on this subset of relevant NAEP grade 8 mathematics content (i.e., content areas, subtopics, objectives, items, and item information), project analysts rated the level of each O*NET element needed to be "proficient" on NAEP. Project analysts were instructed to use the description of grade 8 mathematics proficiency from the Mathematics Framework document as the definition of proficiency to guide their KSA ratings (National Assessment Governing Board, 2013b p. 72).
- **Training Performance Requirements Relevant to NAEP Grade 8 Mathematics –** This consisted of the subset of training performance requirements that the occupational experts identified as relevant to the NAEP grade 8 mathematics objectives. Based on this subset of training performance requirements, project analysts rated the level of each O*NET element needed to qualify for placement into a job training program where trainees are prepared to perform that set of tasks.
- **NAEP Grade 12 Mathematics Content Relevant to Training Performance Requirements –** This consisted of the subset of grade 12 mathematics objectives that the occupational experts identified as relevant to the training performance requirements for the occupation. Project analysts used this set of objectives to identify the subset of operational items from the 2013 grade 12 mathematics assessment that mapped onto those objectives. When reviewing the grade 12 operational items, the project analysts were instructed to pay particularly close attention to the items' achievement level designations (basic, proficient, advanced) and the items' mathematical complexity ratings (low, moderate, high). Based on this subset of relevant NAEP grade 12 mathematics content (i.e., content areas, subtopics, objectives, items, and item information), project analysts rated the level of each O*NET element needed to be "proficient" on NAEP. Project analysts were instructed to use the description of grade 12 mathematics proficiency from the Mathematics Framework document as the definition of proficiency to guide their KSA ratings (National Assessment Governing Board, 2013b p. 74).

- Training Performance Requirements Relevant to NAEP Grade 12 Mathematics –**
 This consisted of the subset of training performance requirements that the occupational experts identified as relevant to the NAEP grade 12 mathematics objectives. Based on this subset of training performance requirements, project analysts rated the level of each O*NET element needed to qualify for placement into a job training program where trainees are prepared to perform that set of tasks.

An example of the rating forms used to collect project analysts' KSA ratings on relevant NAEP reading and mathematics content is presented in Figure 3, and an example of the rating forms used to collect project analysts' KSA ratings on training performance requirements linked to NAEP is presented in Figure 4. The rating scale on which project analysts made their ratings was a 7-point scale with the scale anchors specific to each O*NET element. For example, as seen in Figure 3, project analysts were asked to rate the level of Written Comprehension needed to be proficient on the set of NAEP grade 8 reading content relevant to the occupation. The rating scale in Figure 3 shows that a rating of 2 is equivalent to the ability to understand signs on the highway. In contrast, a rating of 6 is equivalent to the ability understand an instruction book on repairing missile guidance systems. For all O*NET elements, a rating of 0 indicates that the KSA is irrelevant to the content in question. These rating scales are the same ones used by the O*NET analysts, which maintains comparability between this study and the O*NET analysis.

Definitions

Content: NAEP G8 RD

To make ratings on the level of ONET elements needed to be proficient on the NAEP Grade 8 Reading assessment, refer to the excel spreadsheet labeled "Reading Linkages." Locate the worksheet labeled, "Rd obj linked to tasks." These are the NAEP Reading objectives linked to the job. Use this document to identify the set of NAEP G8 Reading items on which your ratings will be based. When making a rating on each ONET element, ask yourself, "What level of this ONET element is needed to be proficient on this set of NAEP items?"

Next Content
Previous Content

O*Net Elements : Written Comprehension

The ability to read and understand information and ideas presented in writing.

Clarification: Ideas presented in writing can include text, data, charts, graphs, and figures.

Linkage Rating

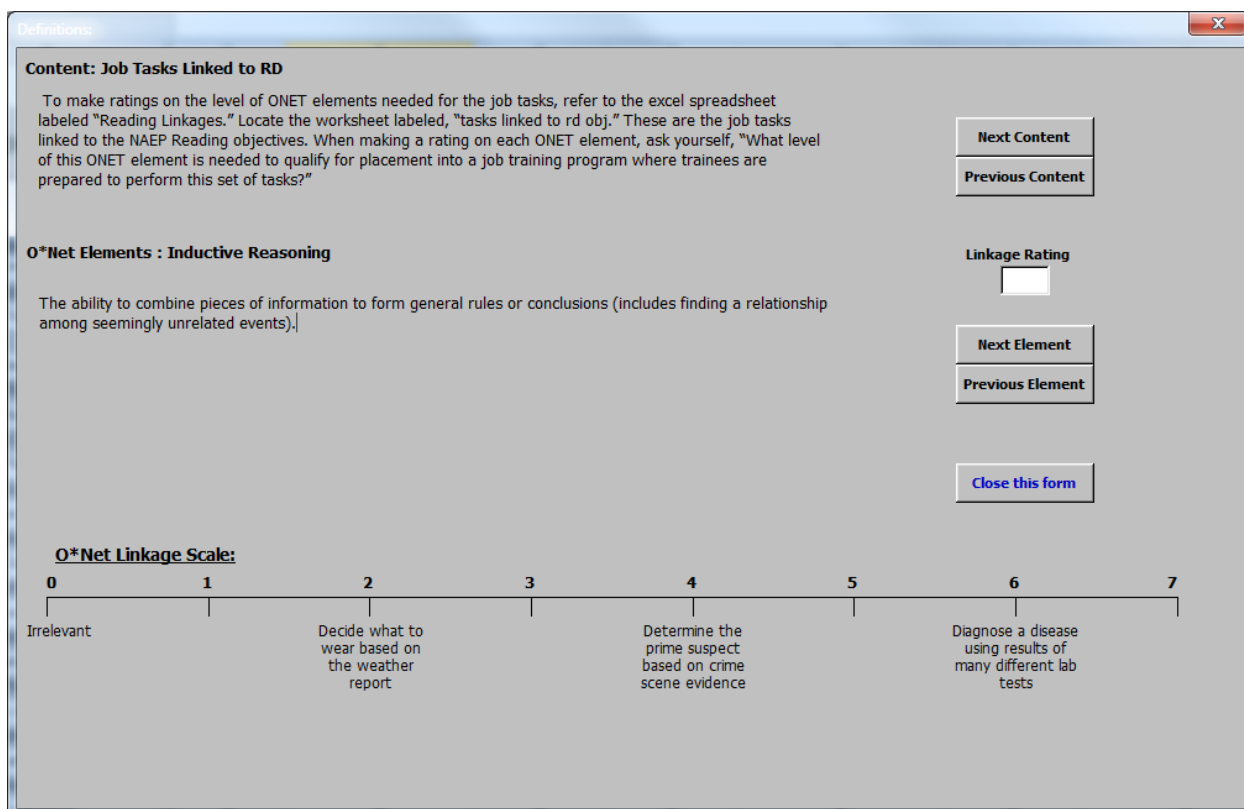
Next Element
Previous Element

Close this form

O*Net Linkage Scale:

0	1	2	3	4	5	6	7
Irrelevant		Understand signs on the highway		Understand an apartment lease		Understand an instruction book on repairing missile guidance systems	

Figure 3. Screenshot of a KSA rating for NAEP grade 8 reading.



Content: Job Tasks Linked to RD

To make ratings on the level of ONET elements needed for the job tasks, refer to the excel spreadsheet labeled "Reading Linkages." Locate the worksheet labeled, "tasks linked to rd obj." These are the job tasks linked to the NAEP Reading objectives. When making a rating on each ONET element, ask yourself, "What level of this ONET element is needed to qualify for placement into a job training program where trainees are prepared to perform this set of tasks?"

O*Net Elements : Inductive Reasoning

The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).]

Linkage Rating

Next Content
Previous Content

Next Element
Previous Element

Close this form

O*Net Linkage Scale:

0	1	2	3	4	5	6	7
Irrelevant		Decide what to wear based on the weather report		Determine the prime suspect based on crime scene evidence		Diagnose a disease using results of many different lab tests	

Figure 4. Screenshot of a KSA rating for training performance requirements linked to NAEP grade 8 reading.

In determining the level of each O*NET element required for the particular content in question, the project analysts followed a set of detailed steps to guide them through the process. The detailed steps are included in Appendix K. An overview of the rating steps is provided in Figure 5.

Step 7: Evaluate KSA Ratings

The project analysts' KSA ratings were combined for each occupation. Mean ratings were used to identify disconnects between the levels of KSAs needed (a) for proficiency on NAEP and (b) for entry into job training. When making their KSA ratings, project analysts considered only the (a) NAEP reading and mathematics content that was rated as relevant to job training and (b) job training content that was rated as relevant to NAEP. We used the O*NET level scale as the benchmark for comparison, comparing the levels of O*NET elements needed for NAEP to the levels of O*NET elements needed for training. A disconnect occurred if there was a mismatch between the levels required by NAEP and the levels required for job training. Chapter 3 details the process and specific decision criteria we used when making determinations about disconnects.

Once project analysts completed the KSA training, they were instructed to independently rate 50 KSAs (out of a total of 175 KSA ratings). We then evaluated the quality of these preliminary ratings by checking to see if any of the individual project analysts stood out as an outlier. Although we provided training and thorough instructions for making ratings, idiosyncratic rater errors (e.g., halo, extreme responses, and central tendency) were possible. We used Cronbach's alpha to identify outliers. Analysts were flagged as outliers if removal of their ratings resulted in an increase in the coefficient alpha. Outliers were provided feedback on their preliminary ratings. Based on that feedback, analysts revised their preliminary ratings before continuing with the rating task. This step

served as a check on the calibration among analysts prior to the analysts completing the full set of ratings. Chapter 3 details the process and specific decision criteria that we used to evaluate the reliability and agreement among analysts on the full set of ratings.

Overview of Steps for Making KSA Ratings	
<p><u>Materials Needed:</u></p> <ul style="list-style-type: none"> • Job Information Document • Excel Rating Spreadsheets (i.e., Rating Forms) • NAEP Framework Documents (Reading and Mathematics) • Linkages between NAEP and Jobs (i.e., “relevant” content) • Operational NAEP Items from 2013 Reading and Mathematics Assessments 	
<p>Steps for Reading</p> <ol style="list-style-type: none"> 1. <i>*Review the Job Information document (includes occupation title, job description, generalized work activities, work context, and job zone information from O*NET).</i> 2. <i>Review the Rating Forms. For each O*NET element, read the O*NET element title, its definition, clarification of its definition (if one is available), and the scale anchors.</i> 3. Review the NAEP Reading Framework document. 4. Review the Linkages Excel spreadsheet to identify the NAEP reading objectives “linked” (i.e., relevant) to the training performance requirements, and the training performance requirements linked to the NAEP reading objectives. 5. Review the grade 8 NAEP reading items that are related to the linked objectives in Step 4. 6. After reviewing and considering the information in Steps 1 – 5, make ratings on the level of each O*NET element needed to be proficient on the set of relevant NAEP grade 8 reading content. 7. After reviewing and considering the information in Steps 1 – 5, make ratings on the level of each O*NET element needed for entry into a job training program where trainees are prepared to perform the set of tasks linked to the NAEP reading content. 8. Repeat the same process for NAEP grade 12 reading. 	
<p>Steps for Mathematics</p> <ol style="list-style-type: none"> 1. <i>Same as Step 1 for Reading.</i> 2. <i>Same as Step 2 for Reading.</i> 3. Review the NAEP Mathematics Framework document. 4. Review the Linkages Excel spreadsheet to identify the NAEP mathematics objectives “linked” (i.e., relevant) to the training performance requirements, and the training performance requirements linked to NAEP mathematics objectives. 5. Review the grade 8 NAEP mathematics items that are mapped to the linked objectives in Step 4. 6. After reviewing and considering the information in Steps 1 – 5, make ratings on the level of each O*NET element needed to be proficient on the set of relevant NAEP grade 8 mathematics content. 7. After reviewing and considering the information in Steps 1 – 5, make ratings on the level of each O*NET element needed for entry into a job training program where trainees are prepared to perform the set of tasks linked to the NAEP grade 8 mathematics content. 8. Repeat the same process for NAEP grade 12 mathematics. <p><i>*Steps in italics mirror the steps O*NET analysts follow when making ability and skill ratings for O*NET occupations. Non-italicized steps represent adaptations to the O*NET Analysis process to account for the application of the process to NAEP.</i></p>	

Figure 5. Overview of steps for making KSA ratings.

Chapter 3: Results

We began our analysis by first analyzing the linkage ratings provided by occupational experts to identify the relevant (i.e., “linked”) content between NAEP objectives and job training performance requirements (Step 4 in Figure 1). Next, we analyzed the KSA ratings on the linked content to identify disconnects between the levels of KSAs needed for proficiency on the relevant NAEP reading and mathematics content (which included NAEP items pertaining to the linked NAEP objectives) and the levels of KSAs needed for entry into job training (where trainees are trained on the relevant training performance requirements) (Step 7 in Figure 1).

Findings from Occupational Experts’ Linkage Ratings

Three occupational experts for each occupation provided independent linkage ratings between NAEP reading and mathematics objectives and training performance requirements (tasks). The linkage ratings were used to identify NAEP objectives that are relevant to training performance requirements, and vice versa. NAEP objectives that were not linked to any of the training performance requirements were flagged for removal. Similarly, training performance requirements that were not linked to any of the NAEP objectives were flagged for removal. The percentage of rated content on which there was 100% agreement among the occupational experts’ independent ratings is displayed in Table 1. For example, for the Automotive Master Technician occupation, all three occupational experts agreed on 83.3% (20) of the NAEP reading objectives as being either relevant or irrelevant to any of the training performance requirements. In other words, they disagreed on 16.7% (4) of the objectives (e.g., two experts rated the objective as relevant, but the third expert rated it as irrelevant). The Automotive Master Technician experts were in unanimous agreement (100%) on the relevance of tasks to NAEP reading objectives. Table 1 shows the same statistics for grade 8 and grade 12 Mathematics.

Table 1. Percentage of Linkage Ratings on Which Occupational Experts Displayed 100% Agreement

	Reading ^a				Grade 8 Math				Grade 12 Math			
	NAEP		Tasks		NAEP		Tasks		NAEP		Tasks	
	n	%	n	%	n	%	n	%	n	%	n	%
AMT	24	83.3	23	100.0	100	80.0	23	100.0	130	92.3	23	91.3
CSS	24	83.3	12	100.0	100	72.0	12	16.7	130	83.8	12	16.7
HVAC	24	87.5	24	83.3	100	71.0	24	50.0	130	70.0	24	58.3
LPN	24	20.8	18	77.8	100	62.0	18	44.4	130	63.1	18	66.6
PT	24	45.8	15	33.3	100	74.0	15	46.6	130	82.3	15	6.7

Note. ^a There is only one set of reading linkages because the NAEP objectives for reading are the same in grades 8 and 12.

AMT = Automotive Master Technician; CSS = Computer Support Specialist; HVAC = Heating Ventilation/Air Conditioning Technician; LPN = Licensed Practical Nurse; PT = Pharmacy Technician.

Agreement tended to be highest among the occupational experts for Automotive Master Technicians. Agreement tended to be lowest among the occupational experts for LPN and for Pharmacy Technicians. Anecdotal input from LPN occupational experts suggests that differences in LPN certification requirements across states might be one reason why agreement tended to be lower for LPNs. For the occupation of Pharmacy Technician, one of the occupational experts stood

out as an outlier. This occupational expert worked in an oncology center within a hospital, which might have contributed to the difference in her ratings. Arbitration of the content on which there was not 100% agreement was obtained in consultation between the project leader and a representative occupational expert from each group who demonstrated strong expertise and insight on the task.

NAEP Reading Objectives Linked to Training Performance Requirements

The final determinations on the relevance of the 24 NAEP reading objectives (informational texts only) to training performance requirements for each occupation are displayed in Appendix L. The summary of the percentages of reading objectives associated with each of the reading cognitive targets (Locate/Recall, Integrate/Interpret, and Critique/Evaluate) are presented in Table 2. As shown in the second row of Table 2, the percentage of reading objectives rated as relevant to training performance requirements ranged from 25.0% for Pharmacy Technicians to 83.3% for Computer Support Specialists. Overall, most linkages between reading objectives and training performance requirements occurred for the objectives associated with the Locate/Recall cognitive target (85.7%). The fewest linkages occurred for the objectives associated with the Critique/Evaluate cognitive target (32.5%). The Computer Support Specialist occupation tended to have more relevant linkages with the objectives associated with the Critique/Evaluate cognitive target (62.5%) than the other occupations. One potential explanation for the greater relevance of Critique/Evaluate objectives to Computer Support Specialists is that several of the training performance requirements for Computer Support Specialists dealt with troubleshooting activities, which may have triggered more associations with the Critique/Evaluate objectives.

Table 2. Relevant NAEP Reading Objectives across Occupations

	Occupation					Total across Jobs
	AMT	CSS	HVAC	LPN	PT	
Total Number of Objectives Linked	17	20	18	14	6	75
% of Total Objectives Linked	70.8	83.3	75.0	58.3	25.0	62.5
% of Locate/Recall Objectives Linked	100.0	100.0	100.0	71.4	57.1	85.7
% of Integrate/Interpret Objectives Linked	88.8	88.8	88.8	66.7	22.2	71.1
% of Critique/Evaluate Objectives Linked	25.0	62.5	37.5	37.5	0.0	32.5

Note. There are 24 NAEP reading objectives for informational texts. Reading objectives are the same for grade 8 NAEP reading and grade 12 NAEP reading.

NAEP Mathematics Objectives Linked to Training Performance Requirements

The final determinations on the relevance of the 100 grade 8 mathematics objectives to training performance requirements for each occupation are displayed in Appendix M, and the final determinations on the relevance of the 130 grade 12 mathematics objectives for each occupation are displayed in Appendix N. Summaries of the percentages of objectives linked by content area for each occupation are presented in Table 3 for grade 8 and grade 12.

As shown in the second row in Table 3, the percentage of grade 8 mathematics objectives rated as relevant to training performance requirements ranged from 20% for Computer Support Specialists to 56% for HVAC Technician. The HVAC Technician occupation had the most overall linkages due to the fact that most (86%) of the grade 8 Geometry objectives were rated as relevant to HVAC Technician. The Automotive Master Technician occupation also had some (33%) of the grade 8 Geometry objectives rated as relevant to its training performance

requirements. None of the other occupations rated any of the Geometry objectives as relevant to their training performance requirements. The relevant linkages between HVAC Technician and Automotive Master Technician to Geometry objectives might be due to there being training performance requirements for those two occupations, particularly for HVAC, that involve manipulating objects by connecting parts, rotating tools, assembling and installing equipment, and so forth.

Across all occupations, the most linkages occurred between grade 8 mathematics objectives and training performance requirements for the objectives associated with the Number Properties and Operations content area (63%) and with the Measurement content area (63%). However, for Measurement, the Computer Support Specialists rated 0% of the objectives as relevant to their training, whereas all other occupations rated a majority of the Measurement objectives as relevant to their training. Overall, the fewest linkages occurred for the objectives associated with Data Analysis, Statistics and Probability (21%) and with Algebra (17%). However, the LPNs did rate as much as 44% of the grade 8 Algebra objectives as relevant to the training performance requirements in their occupation.

Table 3 also displays the summary of linkages with the grade 12 mathematics objectives. As shown in the second row under grade 12, the percentage of grade 12 mathematics objectives rated as relevant to training performance requirements ranged from a low of 9% for Pharmacy Technicians to a high of 32% for HVAC Technicians. The overall pattern of linkages across occupations is similar to the overall pattern for grade 8, such that Number Properties and Operations and Measurement are the two content areas with the most overall linkages, and Algebra is the content area with the fewest overall linkages. The primary difference between grades 8 and 12 is that the percentage of linked objectives is reduced by about half for grade 12. This is true for all of the content areas except Data Analysis, Statistics and Probability for which the percentage of linked objectives only decreased by about a fourth from grade 8 to grade 12.

The findings for grade 12 mathematics are largely consistent with findings from the JSS study (Loomis, 2012; WestEd & Measured Progress, 2011; 2012). As part of the JSS study, occupational experts for HVAC and for Computer Support Specialists were asked to rate the relevance of the grade 12 mathematics objectives prior to their participation in the study. They found that, for both Computer Support Specialists and HVAC (the only two occupations for which this information is reported), the Number Properties and Operations content area had the greatest percentage of its objectives rated as relevant, while objectives from the Algebra content area were rated among the lowest in relevance. They also found that HVAC rated considerably more objectives from Geometry as relevant than did Computer Support Specialists, and that Computer Support Specialists rated very few of the objectives from the Measurement content area as relevant. These results are consistent with the results from the current study.

Table 3. Summary of Relevant Grade 8 and Grade 12 Mathematics Objectives across Occupations

	Grade 8 Math (n = 100)						Grade 12 Math (n = 130)					
	AMT	CSS	HVAC	LPN	PT	Total across jobs	AMT	CSS	HVAC	LPN	PT	Total across jobs
Total Number of Objectives Linked	40	20	56	43	27	186	17	14	42	38	12	113
% of Total Objectives Linked	40.0	20.0	56.0	43.0	27.0	37.2	13.1	10.8	32.2	29.2	9.2	18.9
% of Number Properties & Operations Objectives Linked	66.7	48.1	59.3	74.1	66.7	63.0	30.0	25.0	35.0	50.0	35.0	35.0
% of Measurement Objectives Linked	91.7	0.0	91.7	75.0	58.3	63.3	50.0	0.0	77.7	22.2	16.7	33.3
% of Geometry Objectives Linked	33.3	0.0	85.7	0.0	0.0	23.8	0.0	0.0	50.0	0.0	0.0	10.0
% of Data Analysis, Statistics & Probability Objectives Linked	9.1	31.8	27.3	27.3	9.1	20.9	6.3	28.1	18.8	21.9	6.3	16.3
% of Algebra Objectives Linked	11.1	0.0	27.8	44.4	0.0	16.7	0.0	3.3	10.0	30.0	0.0	8.7

Summary of Findings on the Relevance of NAEP Objectives to Training Performance Requirements across NAEP Reading and Mathematics and across Occupations

A summary of the percentages of NAEP objectives rated relevant to training performance requirements across NAEP reading and mathematics and across occupations is displayed in Table 4. Note that in the current linkage study, the occupational experts did not make individual linkage ratings on the full set of NAEP reading objectives, which cover both literary texts and informational texts. This was because the occupational experts indicated that the whole topic of literary texts (e.g., poetry, fiction, literary nonfiction) is irrelevant to job training performance requirements. Consequently, the percentages reflected in the second column in Table 4 do not reflect percentages based on the total number of NAEP reading objectives. To provide a clearer indication of how well the breadth of NAEP reading assessments are covered by occupations, a column was added to Table 4 showing the percentage of the full set of NAEP reading objectives linked to occupations. When considering the full set of NAEP reading objectives, it is clear that the breadth of NAEP reading is not very well covered by the occupations' training performance requirements.

Overall, based on the results in Table 4, it appears that, Automotive Master Technicians and Computer Support Specialists had more linkages with NAEP reading than with NAEP mathematics (particularly for grade 12), and HVAC, LPN and Pharmacy Technicians had more linkages with NAEP grade 8 mathematics than with grade 12 mathematics or with NAEP reading. Moreover, for every occupation, a larger percentage of grade 8 mathematics objectives were rated relevant than grade 12 mathematics objectives. Across the occupations and across reading and mathematics, the NAEP objectives appear to have the most relevance to HVAC Technicians and the least relevance to Pharmacy Technicians.

Table 4. Summary across Occupations and across Reading and Mathematics of NAEP Objectives Rated Relevant to Training

	Reading ^a			Grade 8 Math (n = 100)		Grade 12 Math (n = 130)	
	Number of Objectives Linked	% of Informational Text Objectives Linked (n = 24)	% of all Objectives Linked (n = 37)	Number of Objectives Linked	% of Objectives Linked	Number Objectives Linked	% of Objectives Linked
AMT	17	70.8	45.9	40	40.0	17	13.1
CSS	20	83.3	54.1	20	20.0	14	10.8
HVAC	18	75.0	47.4	56	56.0	42	32.2
LPN	14	58.3	37.8	43	43.0	38	29.2
PT	6	25.0	16.2	27	27.0	12	9.2

Note. ^a There is only one set of reading linkages because the NAEP objectives for reading are the same in grades 8 and 12.

Training Performance Requirements Linked to NAEP Objectives

As mentioned previously, the list of training performance requirements for each occupation is provided in Appendix E. Each list includes a set of columns: one for NAEP reading, one for NAEP grade 8 mathematics, and one for NAEP grade 12 mathematics. If a training performance requirement was linked as relevant to one or more of the NAEP objectives within that content topic, then an 'X' appears in the cell for that column. A summary of the training performance requirements (tasks) rated relevant to NAEP reading, NAEP grade 8 mathematics, and NAEP grade 12 mathematics is displayed below in Table 5.

The percentage of training performance requirements rated as relevant to NAEP reading objectives ranged from a low of 60% for Pharmacy Technicians to a high of 100% for Computer Support Specialist. The percentage of training performance requirements rated as relevant to grade 8 mathematics ranged from a low of 58% for Computer Support Specialist to a high of 96% for HVAC; this same pattern emerged for grade 12 mathematics, although the percentage range was slightly lower (50% for Computer Support Specialist to 92% for HVAC). Most typically the types of training performance requirements that were *not* linked to NAEP were those that did not involve the use of academic skills (e.g., "Help patients with bathing, dressing, maintaining personal hygiene, moving in bed, or standing and walking" for LPNs), or that involved speaking/verbal activities (e.g., "Answer telephones, responding to simple questions or requests . . ." for Pharmacy Technicians) that are not measured by NAEP.

Table 5. Summary of the Percentages of Training Performance Requirements Rated Relevant to NAEP Objectives

	Reading ^a		Grade 8 Math		Grade 12 Math	
	Num. Tasks Linked	% of Tasks Linked	Num. Tasks Linked	% of Tasks Linked	Num. Tasks Linked	% of Tasks Linked
AMT	20	87.0	20	87.0	20	87.0
CSS	12	100.0	7	58.3	6	50.0
HVAC	16	66.7	23	95.8	22	91.7
LPN	13	72.2	15	83.3	15	83.3
PT	9	60.0	12	80.0	10	66.6

Note. ^a There is only one set of reading linkages because the NAEP objectives for reading are the same in grades 8 and 12.

How Much of NAEP Content is Relevant to Training and How Much of Training Content is Relevant to NAEP?

Finally, we compared the percentages of NAEP objectives that were rated relevant to the training performance requirements (tasks) with the percentages of training performance requirements that were rated relevant to NAEP objectives. Those results are presented in Table 6. Overall, there is a trend showing that NAEP objectives tend to cover the breadth of the reading and mathematics skills needed for the training performance requirements, but that the training performance requirements do *not* cover the breadth of the reading and mathematics skills needed for the NAEP objectives. That is, there are a lot more NAEP objectives that are rated irrelevant to training than there are training performance requirements rated irrelevant to

NAEP objectives. This trend is demonstrated by the lower percentages in the columns in Table 6 labeled “% of Objectives Linked” and the higher percentages in the columns labeled “% of Tasks Linked” Across all jobs, 40% of all NAEP reading objectives were linked as relevant to training, 37% of NAEP grade 8 mathematics objectives were linked as relevant to training, and only 19% of NAEP grade 12 mathematics objectives were linked as relevant to training. This is compared to 77% of training tasks linked as relevant to NAEP reading objectives, 81% of training tasks linked as relevant to grade 8 mathematics objectives, and 75% of training tasks rated as relevant to grade 12 mathematics objectives.

Table 6. Comparison of NAEP Contents’ Relevance to Training with Training Contents’ Relevance to NAEP

	Reading (Literary and Informational Text) (n = 37)	Reading (Informational Text Only) (n = 24)		Grade 8 Math (n = 100)		Grade 12 Math (n = 130)	
	% of Objectives Linked	% of Objectives Linked	% of Tasks Linked	% of Objectives Linked	% of Tasks Linked	% of Objectives Linked	% of Tasks Linked
AMT	45.9	70.8	87.0	40.0	87.0	13.1	87.0
CSS	54.1	83.3	100.0	20.0	58.3	10.8	50.0
HVAC	47.4	75.0	66.7	56.0	95.8	32.2	91.7
LPN	37.8	58.3	72.2	43.0	83.3	29.2	83.3
PT	16.2	25.0	60.0	27.0	80.0	9.2	66.6
Across Jobs	40.3	62.5	77.2	37.2	80.9	18.9	75.2

Findings from Project Analysts’ KSA Ratings

The purpose of analyzing the KSA ratings was to identify disconnects between the level of a KSA required to be proficient on NAEP and the level of that KSA required to be academically prepared for entry into job training. To identify disconnects, we used the O*NET level scale as the benchmark for comparison. Only the NAEP reading and mathematics content that was rated as relevant to job training and only the job training content that was rated relevant to NAEP reading and mathematics content were considered by project analysts when making their KSA ratings.

Pros and Cons of Project Analyst Experience

There were several benefits of using HumRRO research staff as project analysts, including their grasp on concepts of test validity, their familiarity with NAEP, their understanding of the KSA constructs, and the ease of access for providing them with training and feedback. Although the trained project analysts undoubtedly had a better grasp on the KSA constructs than the occupational experts who provided the linkage ratings, a downside of using HumRRO research staff to provide KSA ratings is that they likely do not have as clear of an understanding of the activities and behaviors involved with each of the training performance requirements. For example, one of the training performance requirements for HVAC Technician that was identified as relevant to one or more of the grade 8 mathematics objectives was, “Assemble, position, and install heating and cooling equipment.” To help improve understanding of the performance

requirements such as this, the project analysts were provided with a packet of information for each occupation that mirrored the same job information that the O*NET analysts use to make ability and skill ratings for the O*NET occupations. This packet of information included the job description from O*NET, the generalized work activities for the occupation (e.g., *processing information, updating and using relevant knowledge, interacting with computers*), descriptions of the context in which the work is performed (e.g., *the importance of being exact or accurate, the freedom to make decisions, the need to use email*), and the job zone for the occupation.⁷

Project analysts were also encouraged to seek out additional resources to help them better understand the training performance requirements (e.g., consulting with individuals who work in those occupations, reviewing training course material found on-line, including watching training videos downloaded from the internet). Whenever analysts consulted additional resources for clarification on the training performance requirements, they were instructed to post the information to an internal project folder for all analysts to use when making their ratings. This helped to ensure that all analysts' ratings were based on a common set of information.

As a check on the project analysts' understanding of the occupations, we asked analysts to rate their familiarity with their assigned occupation(s) *prior* to making ratings, and then again *after* they had completed the rating activity (see Table 7). Analysts rated their level of familiarity with each of their assigned occupations on a 7-point Likert scale where 1 = no familiarity with the occupation, 3 = some familiarity with the occupation, and 7 = extremely familiar with the occupation. Prior to making the ratings, the overall mean familiarity rating across occupations was 3.58, which represented a moderate to moderately large level of familiarity with the occupations. The occupation with the highest mean familiarity rating was Computer Support Specialists ($M = 4.50$), and the occupation with the lowest mean familiarity ratings was HVAC Technician ($M = 2.63$)⁸. After analysts had spent time learning more about the occupations and their training performance requirements and after KSA ratings were completed, they were asked to use the same scale to rate their familiarity with their assigned occupation(s). Across all occupations, the mean level of familiarity after making ratings increased. The magnitude of the effect size increase was moderate for Computer Support Specialists, which had the highest mean familiarity rating to begin with, and large or very large for all other occupations, particularly for HVAC Technician, which had the lowest mean familiarity rating at the beginning. The overall mean familiarity rating after completing the rating task was 4.80. The large increase in analysts' familiarity with the occupations and the training performance requirements for the occupations serves to demonstrate the effectiveness of the packet of occupation information and the additional resources obtained during the course of the rating activity in helping to increase the project analysts' understanding of their assigned occupations and the training performance requirements for those occupations. While the project analysts did not obtain expert status in their understanding of the occupations, which is a limitation of using project analysts and not occupational experts, they did become very familiar with their assigned occupations during the course of this project.

⁷ O*NET defines *work activities* as, "general types of job behavior occurring on multiple jobs;" *work context* as, "physical and social factors, and structural job characteristics that influence the nature of the work;" and *job zone* as, "how much education people need to do the work, how much related experience people need to do the work, and how much on-the-job training people need to do the work."

⁸ Care was taken to ensure that no one was assigned to rate an occupation with which their familiarity was a 1 on the familiarity scale.

Table 7. Check on Rater Familiarity of Occupations

	Familiarity Prior to Rating		Familiarity After Rating		Effect Size
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>d</i>
AMT	3.25	1.28	4.63	0.92	1.23
CSS	4.50	1.51	5.25	1.16	0.56
HVAC	2.63	0.52	4.50	0.53	3.56
LPN	4.13	0.35	4.75	0.46	1.52
PT	3.38	0.92	4.88	0.64	1.90
Overall	3.58	1.17	4.80	0.79	1.75

Data Quality Checks

We evaluated the quality of the data by examining the descriptive statistics for the ratings. The descriptive statistics on each O*NET element for each occupation and for each set of rated content are displayed in Appendix O. There was some range restriction in the KSA level ratings. That is, none of the KSAs received mean ratings of a ‘6’ or higher on the 7-point level scale. This is probably because the behavioral anchors for 6 and above on the O*NET level scale are generally very high-level behaviors. For example, the level ‘6’ anchor for Written Expression is “Write an advanced economic textbook.” It is quite possible that none of the rated content reached or exceeded the extremes of the scale anchors. We also checked for logical inconsistencies in raters’ patterns of ratings, such as rating the level of Written Comprehension needed for the NAEP grade 8 mathematics content as higher than the level of Written Comprehension needed for the NAEP grade 12 reading content. Any such logical inconsistencies were flagged for the project analysts to check their ratings for accuracy and revise as necessary.

We also investigated O*NET elements that were rated as irrelevant (i.e., rated a ‘0’) or had very low mean ratings, and/or that had particularly high standard deviations, indicating lack of agreement among raters. Recall that, from the complete list of O*NET KSAs, we selected the ones that *might* have some academic relevance. Of those 25 potentially relevant KSAs, there were four O*NET elements consistently flagged across the rated NAEP content for all occupations as having either low mean ratings (i.e., near a mean of 1.00 on a scale of 1 to 7) and/or as having high standard deviations (i.e., $sd \geq 1.00$). Those four O*NET elements were Quality Control Analysis, Operations Analysis, Systems Analysis, and Systems Evaluation. The data for these O*NET elements suggests that their application to NAEP was too much of a stretch. Consequently, these four O*NET elements were dropped from all further analyses for all occupations. Also, for NAEP reading, grades 8 and 12, four of the remaining 21 O*NET elements were rated as irrelevant (i.e., received a rating of ‘0’) by five or more of the project analysts across all occupations. The O*NET elements that were rated as irrelevant to NAEP reading by the majority of analysts were Number Facility, Mathematical Reasoning, Mathematics Knowledge, and Visualization. Consequently, given that these elements were rated as irrelevant to NAEP reading by the majority of analysts, these elements were also dropped from further analyses for NAEP reading (grades 8 and 12) bringing the total number of KSAs for reading to 17.

Interrater Reliability

To examine the interrater reliability of the ratings, we calculated the intraclass correlations (ICC [3,1] and [3,8]; Shrout & Fleiss, 1979) among the analysts' ratings to look at consistency across constructs within NAEP content and within occupation content⁹. The O*NET target level of multi-rater reliability is an ICC (3,8) of .80 or greater. The value of .80 has been judged to be a good rule-of-thumb that has been used previously in the O*NET context (e.g., McCloy, Waugh, & Medsker, 1998). As shown in Table 8, nearly all multi-rater ICCs show acceptable levels of reliability across all occupations and across all rated content. The exception was Computer Support Specialists for training tasks linked to NAEP content. However, the ICCs for those content topics were still above .70 and therefore close to the target level of reliability. Overall, the ICCs based on the ratings for training performance requirements tended to be slightly lower than the ICCs based on the ratings for NAEP content. This is likely due to the reasons discussed above regarding project analysts' limited familiarity with the activities involved with performance of the training tasks. Nonetheless, the reliability among the project analysts was still quite high.

Table 8. Interrater Reliability for KSA Ratings by Occupation and by Content Topic

Content Topic	AMT		CSS		HVAC		LPN		PT	
	ICC (3,1)	ICC (3, 8)	ICC (3,1)	ICC (3, 8)	ICC (3,1)	ICC (3, 8)	ICC (3,1)	ICC (3, 8)	ICC (3,1)	ICC (3, 8)
G8 Reading	.43	.86	.50	.89	.41	.85	.65	.94	.38	.83
Tasks linked to Reading	.34	.80	.24	.72*	.41	.85	.58	.92	.52	.90
G12 Reading	.38	.83	.51	.89	.41	.86	.60	.92	.43	.86
G8 Math	.56	.91	.62	.93	.58	.92	.63	.93	.59	.92
Tasks linked to G8 Math	.33	.80	.32	.79*	.42	.86	.47	.88	.53	.90
G12 Math	.55	.91	.66	.94	.60	.92	.62	.93	.66	.94
Tasks linked to G12 Math	.33	.80	.32	.79*	.47	.88	.47	.88	.50	.88

Note. * The target ICC (3,8) is .80 or higher. Flagged cells did not meet this standard. For reading content (the first three rows of the table), ratings were made on 17 KSAs and for mathematics content (bottom four rows of table) ratings were made on 21 KSAs. The four KSAs included for mathematics, but not for reading were: Mathematical Reasoning, Number Facility, Visualization, and Mathematics Knowledge.

Interrater Agreement

The standard error of the mean (SE_M) was used to identify ratings deemed to have insufficient agreement across raters. The SE_M s are included in the tables of descriptive statistics in Appendix O. An SE_M greater than 0.51 means that the upper and lower bounds of the confidence interval are more than one scale point away from the observed mean. This is the criterion used in the O*NET analyst project to flag O*NET descriptors on which analysts demonstrated less than acceptable agreement. For the O*NET analyst project, across six cycles of data the average percentage of ratings flagged for insufficient interrater agreement was 3.75% (Russell, et al., 2008). The same SE_M criterion for interrater agreement was adopted for the current study.

⁹ The formula ICC [(3,1) for single-raters and (3, k) for multiple raters] is for a two-way mixed-effects model. For readers most familiar with the language of McGraw & Wong (1996), these ICCs are consistency estimates.

Project analysts made ratings on 21 O*NET elements for mathematics content and 17 O*NET elements for reading content. Consequently, across the seven sets of rated content, analysts provided a total of 135 ratings per occupation. For Automotive Master Technicians, one of the 135 ratings (Flexibility of Closure for grade 12 mathematics) was flagged for insufficient agreement, which equates to 0.70% of the ratings. For Computer Support Specialists none of the ratings were flagged for insufficient interrater agreement. For HVAC Technicians, 5 of the 135 ratings (Information Ordering and Active Learning for grade 8 reading, and Originality, Speed of Closure, and Judgment & Decision Making for grade 12 mathematics) were flagged for insufficient agreement, which equates to 3.78% of the ratings. Similarly, for LPN, five of the ratings (Speed of Closure for grade 8 mathematics, and Problem Sensitivity, Category Flexibility, Speed of Closure, and Flexibility of Closure for grade 12 mathematics) were flagged for insufficient interrater agreement. Finally, for Pharmacy Technicians, four of the ratings (Flexibility of Closure for grade 8 reading, Mathematical Reasoning for tasks linked to reading, and Critical Thinking and Speed of Closure for grade 12 mathematics) were flagged for insufficient interrater agreement, which equates to 2.96% of the ratings.

In summary, the percentage of ratings flagged for insufficient interrater agreement in the current study was, overall, less than the percentage of ratings flagged for insufficient interrater agreement across six cycles of the O*NET analyst project. Of the 15 flags in the current study, all but one occurred for ratings on NAEP content with the majority of those occurring for grade 12 mathematics. The most commonly flagged KSA, with four flags, was Speed of Closure, which is defined as “the ability to quickly make sense of, combine, and organize information into meaningful patterns.”

Finally, it should be noted that because a different cohort of project analysts rated each occupation, caution should be taken in making comparisons about the relative mean level of a particular KSA needed for one occupation versus another occupation. While all analysts attended the same training, the interrater reliability analyses and interrater agreement analyses were conducted within rater cohorts to ensure consistency and agreement among raters within a particular cohort rating a particular occupation. As such, comparisons of KSA ratings within occupations are warranted. However, this does not ensure calibration across the five cohorts of project analysts. Given project constraints on time and resources, there was no replication of separate cohorts of project analysts rating the same occupation. As such, it is possible that some cohorts may have been more conservative or more lenient in their ratings than other cohorts.

Comparison of Levels of KSAs for NAEP and for Job Training

As noted previously, the 0 point on the level rating scale was for irrelevant and the remaining values (i.e., 1 to 7) indicated the level of the O*NET KSA needed for the set of rated content (e.g., the level of the KSA needed to be proficient on the set of relevant NAEP grade 8 reading content, or the level of the KSA needed to be qualified for job training on the set of relevant training performance requirements).

To assist in evaluating disconnects between the levels of KSAs needed for the relevant NAEP reading and mathematics content compared to the levels of KSAs needed for the relevant job training content, we categorized the project analysts’ mean KSA ratings into high, moderate/high, moderate, moderate/low, and low categories. These cut points were rationally determined based on the rating scale (see Table 9)¹⁰.

¹⁰ Tables of effect size differences are included in Appendix P for each occupation and for each KSA. For ease of explanation, within the text of the report results are discussed in terms of rating category levels (i.e., low, moderate/low, moderate, moderate/high, and high).

Table 9. Cut Points for Determining Categories of KSA Levels

Category Level	Cut Points
High	$\bar{X} \geq 4.50$
Moderate/High	$4.00 \leq \bar{X} < 4.50$
Moderate	$3.00 \leq \bar{X} < 4.00$
Moderate/Low	$2.00 \leq \bar{X} < 3.00$
Low	$\bar{X} < 2.00$

For each occupation, comparisons between the category levels for each KSA across the set of rated content are provided in Appendix Q. For each KSA, if the category level assigned to the KSA for proficiency on the set of relevant NAEP content (where relevant NAEP content is defined by the linked objectives and items pertaining to those objectives) was the same as the category level assigned to the KSA for entry into job training (where training is defined by the set of relevant training performance requirements), then it was identified as a “match.” If the category level of the KSA needed for NAEP (reading or mathematics) was higher than the category level needed for job training (e.g., Moderate vs. Low) or vice versa, then there was said to be a “disconnect” between the level of the KSA needed for NAEP and the level of the KSA needed for job training.

A summary of the disconnect analysis across all KSAs and all occupations is provided in Table 10. A discernable pattern emerges for the NAEP mathematics content in Table 10 such that there is a consistent pattern of a lower percentage of disconnects between NAEP grade 8 mathematics and training content than between NAEP grade 12 mathematics and training content. In other words, the “match” between the levels of KSAs needed for NAEP and the levels of KSAs needed for job training is better for grade 8 mathematics than for grade 12 mathematics. This is true for all occupations.

There is no such discernable pattern for NAEP reading. For LPNs there is a lower percentage of disconnects between KSA levels for grade 8 reading and job training than between grade 12 reading and job training, but for Automotive Master Technicians, HVAC Technicians, and Pharmacy Technicians there is a lower percentage of disconnects between KSA levels for grade 12 reading and job training. And for Computer Support Specialists, the percentage of disconnects between reading and job training is the same for grade 8 and grade 12 (47%).

Another discernable pattern evident in Table 10 is the direction of the pattern of disconnects. When there are disconnects between the levels of KSAs for NAEP and the levels of KSAs for job training, there are always more disconnects favoring NAEP (i.e., where the KSA category level for NAEP is higher than the category level for job training) when considering grade 12 content than when considering grade 8 content. This is true for both NAEP reading and NAEP mathematics. This finding seems consistent with the logic that the grade 12 assessments are more difficult than the grade 8 assessments and therefore require higher levels of the KSAs.

Table 10. Summary of All KSA Category Level Disconnects for Relevant NAEP Content and Relevant Training Content

Occupations:	NAEP Grade 8 Reading Content and Training Content			NAEP Grade 12 Reading Content and Training Content			NAEP Grade 8 Math Content and Training Content			NAEP Grade 12 Math Content and Training Content		
	KSAs with category level disconnect		KSAs where disconnect higher for NAEP		KSAs with category level disconnect		KSAs where disconnect higher for NAEP		KSAs with category level disconnect		KSAs where disconnect higher for NAEP	
	% of total KSAs	% of total KSAs	% of disconnect KSAs	% of total KSAs	% of total KSAs	% of disconnect KSAs	% of total KSAs	% of total KSAs	% of disconnect KSAs	% of total KSAs	% of total KSAs	% of disconnect KSAs
AMT	64.7	11.8	18.2	58.8	29.4	50.0	42.9	23.8	55.6	47.6	28.6	60.0
CSS	47.1	0.0	0.0	47.1	29.4	62.5	47.6	19.0	40.0	52.4	28.6	54.5
HVAC	58.8	11.8	20.0	47.1	23.5	50.0	71.4	23.8	33.3	76.2	42.6	56.3
LPN	47.1	5.9	12.5	76.5	47.1	61.5	38.1	23.8	62.5	61.9	52.4	84.6
PT	70.6	11.8	16.7	41.7	23.5	57.1	33.3	9.5	28.6	66.7	52.4	78.6

Note. Total number of KSAs for reading is 17; total number of KSAs for mathematics is 21.

Relevant NAEP content for reading consists of the reading objectives (and the cognitive targets to which they pertain) that were linked as relevant to training performance requirements and the NAEP items that pertain to those objectives. Relevant NAEP content for mathematics consists of the mathematics objectives (and the content areas and subtopics to which they pertain) that were linked as relevant to training performance requirements and the NAEP items that map onto those objectives. Relevant training content consists of the training performance requirements that were linked as relevant to the NAEP objectives.

Of the 17 KSAs rated on reading content, the most pertinent O*NET KSAs for reading are Written Comprehension, Written Expression, and knowledge of English Language. Table 11 reflects the pattern of results on just those three reading-specific KSAs across the five occupations. As seen in Table 11, there are fewer disconnects between the levels of these KSAs needed for NAEP reading and the levels needed for job training when focusing on grade 8 reading. This is particularly the case for Written Comprehension. Table 11 shows that the percentages of KSAs in each category level are more similar when comparing NAEP reading and job training on grade 8 content than when comparing NAEP and job training on grade 12 content.

Table 11. Comparison of Reading Specific KSA Category Levels for Relevant NAEP Reading Content and Relevant Training Content

Jobs	% of NAEP Reading Objectives Linked to Job	O*NET Descriptors	Level Needed for G8 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content	Match	Level Needed for G12 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content	Match
AMT	45.9	Written Comprehension	Mod	Mod	Yes	M/High	Mod	No
		Written Expression	Mod	M/Low	No	Mod	M/Low	No
		English Language	Mod	M/Low	No	M/High	M/Low	No
CSS	54.1	Written Comprehension	Mod	Mod	Yes	M/High	Mod	No
		Written Expression	M/Low	Mod	No	Mod	Mod	Yes
		English Language	Mod	Mod	Yes	M/High	Mod	No
HVAC	47.4	Written Comprehension	Mod	Mod	Yes	M/High	Mod	No
		Written Expression	M/Low	M/Low	Yes	Mod	M/Low	No
		English Language	Mod	M/Low	No	Mod	M/Low	No
LPN	37.8	Written Comprehension	Mod	Mod	Yes	M/High	Mod	No
		Written Expression	M/Low	M/Low	Yes	Mod	M/Low	No
		English Language	Mod	M/Low	No	M/High	M/Low	No
PT	16.2	Written Comprehension	Mod	Mod	Yes	M/High	Mod	No
		Written Expression	M/Low	Mod	No	Mod	Mod	Yes
		English Language	Mod	Mod	Yes	Mod	Mod	Yes
Percent Low			0.0	0.0		0.0	0.0	
Percent M/Low			26.7	40.0		0.0	40.0	
Percent Moderate			73.0	60.0		46.7	60.0	
Percent M/High			0.0	0.0		53.3	0.0	
Percent High			0.0	0.0		0.0	0.0	
Total Number of Disconnects (n = 15)					6			12
Of disconnects, number for which KSA category level is higher for NAEP					4			12

Note. G8 = grade 8; G12 = grade 12; RD = reading.

Relevant NAEP content for reading consists of the NAEP reading objectives (and the cognitive targets to which they pertain) that were linked as relevant to training performance requirements, and the NAEP items that pertain to those objectives. Relevant training content consists of the training performance requirements that were linked as relevant to the NAEP reading objectives.

Table 12 provides this same focused comparison for the O*NET KSAs that are particularly relevant to mathematics: Mathematical Reasoning, Number Facility, and Mathematics Knowledge. For grade 12, there are no matches between NAEP mathematics content and job training content on any of the mathematics-specific KSAs across any of the occupations. In all cases, the levels of the KSAs needed for NAEP grade 12 mathematics are higher than the levels of the KSAs needed for job training. Additionally, the disconnects most often span two or three category levels (e.g., High vs. Moderate/Low). The disconnects remain pervasive when comparing job training to NAEP grade 8 mathematics.

Only for the occupation of Pharmacy Technician is there a match between the levels of the KSAs needed for grade 8 mathematics and the levels of the KSAs need for job training. The match in KSA levels for Pharmacy Technicians might be due in part to the fact that only about a fourth of the grade 8 mathematics objectives were considered by the project analysts when making their KSA ratings on NAEP, which might account for why Pharmacy Technicians tended to have lower KSA ratings on the NAEP grade 8 mathematics content than did the other occupations. The lower KSA level ratings on the grade 8 mathematics content ultimately led to matches on KSA levels between NAEP and job training for Pharmacy Technicians.

Table 12. Comparison of Mathematics Specific KSA Category Levels for Relevant NAEP Mathematics Content and Relevant Training Content

Jobs	% of G8 NAEP Math Obj. Linked to Job	% of G12 NAEP Math Obj. Linked to Job	O*NET Descriptors	Level Needed for G8 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G8 NAEP MA Content	Match	Level Needed for G12 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G12 NAEP MA Content	Match
AMT	40.0	13.1	Mathematical Reasoning	M/High	M/Low	No	M/High	M/Low	No
			Number Facility	High	M/Low	No	High	M/Low	No
			Mathematics	M/High	M/Low	No	High	M/Low	No
CSS	20.0	10.8	Mathematical Reasoning	Mod	Low	No	M/High	Low	No
			Number Facility	M/High	M/Low	No	M/High	M/Low	No
			Mathematics	M/High	M/Low	No	High	M/Low	No
HVAC	56.0	32.2	Mathematical Reasoning	M/High	M/Low	No	High	Mod	No
			Number Facility	M/High	Mod	No	High	Mod	No
			Mathematics	High	Mod	No	High	Mod	No
LPN	43.0	29.2	Mathematical Reasoning	M/High	M/Low	No	High	M/Low	No
			Number Facility	High	Mod	No	High	Mod	No
			Mathematics	High	Mod	No	High	Mod	No
PT	27.0	9.2	Mathematical Reasoning	Mod	Mod	Yes	M/High	Mod	No
			Number Facility	Mod	Mod	Yes	High	Mod	No
			Mathematics	Mod	Mod	Yes	High	Mod	No
Percent Low				0.0	6.7		0.0	6.7	
Percent M/Low				0.0	46.7		0.0	40.0	
Percent Moderate				26.7	46.7		0.0	53.3	
Percent M/High				46.7	0.0		26.7	0.0	
Percent High				26.7	0.0		73.3	0.0	
Total Number of Disconnects (n = 15)						12			15
Of disconnects, number for which KSA category level is higher for NAEP						12			15

Note. G8 = grade 8; G12 = grade 12; MA = mathematics.

Relevant NAEP content for mathematics consists of the NAEP mathematics objectives (and the content areas and subtopics to which they pertain) that were linked as relevant to training performance requirements, and the NAEP items that map onto those objectives. Relevant training content consists of the training performance requirements that were linked as relevant to the NAEP mathematics objectives (grade 8 and grade 12).

The O*NET reading-specific KSAs are undoubtedly relevant to NAEP reading, and the O*NET mathematics-specific KSAs are undoubtedly relevant to NAEP mathematics. However, in addition to those O*NET KSAs, several other O*NET KSAs are of particularly high interest. Those are Deductive Reasoning, Inductive Reasoning, Critical Thinking, Complex Problem Solving, and Judgment and Decision Making. These were chosen based on the mention of such KSAs in the NAEP framework documents. For example, the Mathematics Framework document indicates that students are expected to “. . . use reasoning, planning, judgment, and creative thought” (National Assessment Governing Board, 2013b, p. 48), and the proficiency definition references “ability to solve real-world problems.” As such, another set of summary tables focusing on these high interest KSAs is presented in Table 13 (for reading) and Table 14 (for mathematics). As shown in Table 13, the correspondence in the percentage of these KSAs in each category level is higher when comparing NAEP content and job training content for grade 8 than when comparing NAEP content and job training content for grade 12. This same pattern occurred even more so for mathematics (Table 14). Interestingly, this set of KSAs was more frequently categorized as “Low” and “Moderately/Low” than what occurred for the reading- and mathematics-specific KSAs. This was especially evident for Judgment and Decision Making.

Table 13. Comparison of Other High Interest KSA Category Levels for Relevant NAEP Content and Training Content (Reading)

Jobs	O*NET Descriptors	Level Needed for G8 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content	Match	Level Needed for G12 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content	Match
AMT	Deductive Reasoning	M/Low	Mod	No	Mod	Mod	Yes
	Inductive Reasoning	Mod	Mod	Yes	Mod	Mod	Yes
	Critical Thinking	Mod	Mod	Yes	M/High	Mod	No
	Complex Problem Solving	Low	Mod	No	M/Low	Mod	No
	Judgment and Decision Making	M/Low	M/Low	Yes	M/Low	M/Low	Yes
CSS	Deductive Reasoning	M/Low	M/Low	Yes	Mod	M/Low	No
	Inductive Reasoning	M/Low	Mod	No	Mod	Mod	Yes
	Critical Thinking	Mod	Mod	Yes	M/High	Mod	No
	Complex Problem Solving	Low	M/Low	No	M/Low	M/Low	Yes
	Judgment and Decision Making	M/Low	M/Low	Yes	Mod	M/Low	No
HVAC	Deductive Reasoning	Mod	Mod	Yes	Mod	Mod	Yes
	Inductive Reasoning	Mod	Mod	Yes	Mod	Mod	Yes
	Critical Thinking	Mod	M/Low	No	M/High	M/Low	No
	Complex Problem Solving	M/Low	Mod	No	Mod	Mod	Yes
	Judgment and Decision Making	M/Low	M/Low	Yes	M/Low	M/Low	Yes
LPN	Deductive Reasoning	M/Low	M/Low	Yes	Mod	M/Low	No
	Inductive Reasoning	M/Low	Mod	No	M/High	Mod	No
	Critical Thinking	Mod	Mod	Yes	High	Mod	No
	Complex Problem Solving	Low	M/Low	No	Mod	M/Low	No
	Judgment and Decision Making	M/Low	M/Low	Yes	M/Low	M/Low	Yes
PT	Deductive Reasoning	M/Low	Mod	No	Mod	Mod	Yes
	Inductive Reasoning	Mod	M/Low	No	Mod	M/Low	No
	Critical Thinking	M/Low	M/Low	Yes	Mod	M/Low	No
	Complex Problem Solving	Low	M/Low	No	M/Low	M/Low	Yes
	Judgment and Decision Making	M/Low	Low	No	M/Low	Low	No
Percent Low		16.0	4.0		0.0	4.0	
Percent M/Low		52.0	48.0		28.0	48.0	
Percent Moderate		32.0	48.0		52.0	48.0	
Percent M/High		0.0	0.0		16.0	0.0	
Percent High		0.0	0.0		4.0	0.0	
Total Number of Disconnects (n = 25)				12	13		
Of disconnects, number for which KSA category level is higher for NAEP				2	11		

Table 14. Comparison of Other High Interest KSA Category Levels for Relevant NAEP Content and Training Content (Mathematics)

Jobs	O*NET Descriptors	Level Needed for G8 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP G8 MA Content	Match	Level Needed for G12 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP G12 MA Content	Match
AMT	Deductive Reasoning	Mod	Mod	Yes	Mod	Mod	Yes
	Inductive Reasoning	Mod	Mod	Yes	M/Low	Mod	No
	Critical Thinking	Mod	Mod	Yes	Mod	Mod	Yes
	Complex Problem Solving	Mod	Mod	Yes	Mod	Mod	Yes
	Judgment and Decision Making	M/Low	M/Low	Yes	M/Low	M/Low	Yes
CSS	Deductive Reasoning	Mod	Mod	Yes	Mod	Mod	Yes
	Inductive Reasoning	Mod	Mod	Yes	Mod	Mod	Yes
	Critical Thinking	Mod	Mod	Yes	Mod	Mod	Yes
	Complex Problem Solving	Mod	Mod	Yes	Mod	Mod	Yes
	Judgment and Decision Making	M/Low	M/Low	Yes	M/Low	M/Low	Yes
HVAC	Deductive Reasoning	Mod	Mod	Yes	High	Mod	No
	Inductive Reasoning	Mod	Mod	Yes	M/High	Mod	No
	Critical Thinking	Mod	Mod	Yes	M/High	Mod	No
	Complex Problem Solving	M/Low	Mod	No	M/High	Mod	No
	Judgment and Decision Making	M/Low	M/Low	Yes	Mod	Mod	Yes
LPN	Deductive Reasoning	M/High	Mod	No	High	Mod	No
	Inductive Reasoning	Mod	Mod	Yes	M/High	Mod	No
	Critical Thinking	Mod	Mod	Yes	M/High	Mod	No
	Complex Problem Solving	Mod	M/Low	No	M/High	M/Low	No
	Judgment and Decision Making	M/Low	M/Low	Yes	M/Low	M/Low	Yes
PT	Deductive Reasoning	Mod	Mod	Yes	M/High	Mod	No
	Inductive Reasoning	M/Low	M/Low	Yes	Mod	M/Low	No
	Critical Thinking	M/Low	M/Low	Yes	Mod	M/Low	No
	Complex Problem Solving	M/Low	M/Low	Yes	Mod	M/Low	No
	Judgment and Decision Making	Low	Low	Yes	M/Low	Low	No
Percent Low		4.0	4.0		0.0	4.0	
Percent M/Low		32.0	32.0		20.0	28.0	
Percent Moderate		60.0	64.0		44.0	68.0	
Percent M/High		4.0	0.0		28.0	0.0	
Percent High		0.0	0.0		8.0	0.0	
Total Number of Disconnects (n = 25)				3	14		
Of disconnects, number for which KSA category level is higher for NAEP				2	13		

Chapter 4: Discussion

The purpose this investigation was two-fold. First, this study systematically assessed the relevance of NAEP reading and mathematics objectives in grades 8 and 12 to a set of standardized training performance requirements (tasks) for target occupations. Second, this study systematically compared the levels of KSAs needed for proficiency on NAEP reading and mathematics with the levels of KSAs needed for entry into job training, with KSA ratings based on the subset of content identified as relevant by occupational experts. Although not an alignment study in the traditional sense (in which NAEP is compared to another assessment; see Webb, 2009), of the five study types recommended by the Technical Panel, this study most closely fits with the category of studies labeled, “content comparisons and alignment.” By comparing the “content” of NAEP reading and mathematics with the “content” of job training, this study helps to provide evidence regarding the content validity of NAEP as an indicator of academic preparedness for job training.

Is the Reading and Mathematics Content Measured by NAEP Relevant to Job Training?

This study investigated the relevance of NAEP reading and mathematics to job training by describing job training in terms of the performance requirements (tasks) for training, and systematically identifying the NAEP objectives from the reading and mathematics assessments (grade 8 and grade 12) that are relevant to those training performance requirements and vice versa. Overall, results from linkage ratings provided by the occupational experts indicate that NAEP tends to cover the breadth of the reading and mathematics skills needed for the training performance requirements, but the training performance requirements do *not* tend to demand the breadth of the reading and mathematics skills needed for NAEP. That is, there is a lot more content on NAEP that is rated irrelevant to job training content than there is job training content rated irrelevant to NAEP. Across all five occupations, considerably higher percentages of training performance requirements were linked as relevant to NAEP reading and mathematics objectives, than the percentages of NAEP reading and mathematics objectives linked as relevant to training performance requirements, although including grade 8 NAEP did result in a somewhat greater percentage of NAEP mathematics objectives being identified as relevant to job training¹¹.

When training performance requirements were *not* linked as relevant to NAEP, most typically the training performance requirements were non-academic in nature (e.g., “Help patients with bathing, dressing, maintaining personal hygiene, moving in bed, or standing and walking” for LPNs), or the training performance requirements involved speaking/verbal activities not measured by NAEP (e.g., “Answer telephones, responding to simple questions or requests . . .” for Pharmacy Technicians).

Relevance of NAEP Reading Content

The NAEP reading objectives that were most frequently linked as relevant to training performance requirements were the objectives associated with the Locate/Recall cognitive target. The fewest linkages occurred for the objectives associated with the Critique/Evaluate cognitive target. The Computer Support Specialists tended to be the only exception to this trend with several of the Critique/Evaluate objectives linked as relevant to this occupation. This may

¹¹ Because relevant linkages between NAEP and job training content were made at the level of the NAEP objectives, a comparable statement about whether including grade 8 reading resulted in more linked content is not possible given that reading objectives are the same for grade 8 and for grade 12.

be due in part to the fact that several of the training performance requirements for Computer Support Specialists involved troubleshooting activities, which perhaps triggered a greater association with Critique/Evaluate than it did for other occupations. Similarly, the course content analysis study (WestEd & Educational Policy Improvement Center, 2013) also found that, of the three cognitive targets for NAEP reading, evidence of the Critique/Evaluate cognitive target was found most *infrequently* in the course artifacts and the Locate/Recall cognitive target was identified the most frequently. It should be noted that of the three cognitive targets (i.e., Locate/Recall, Integrate/Interpret, and Critique/Evaluate), the Locate/Recall target is the one that requires the lowest level of cognitive complexity.

Relevance of NAEP Mathematics Content

For NAEP mathematics, the objectives most frequently linked as relevant to training performance requirements were those associated with the Number Properties and Operations content area and the Measurement content area. It should be noted that the Number Properties and Operations content area is generally considered to be less challenging than the other content areas. Moreover, only 10% of the items in the 2013 NAEP grade 12 mathematics item pool include this category of items (National Assessment Governing Board, 2013b). The Computer Support Specialist occupation was the exception for the Measurement content area; none of the Measurement objectives were linked as relevant to any of the training performance requirements for Computer Support Specialists. The objectives most *infrequently* linked to training performance requirements tended to be the objectives associated with the Geometry and Algebra content areas. HVAC was an exception for Geometry with many of the Geometry objectives linked as relevant to this occupation. The HVAC occupation included several training performance requirements that involved manipulating objects by connecting parts, rotating tools, assembling and installing equipment, and so forth, which may have triggered greater associations with the Geometry objectives than did the other occupations. The LPN occupation was the exception for Algebra with several of the Algebra objectives linked as relevant to this occupation. One of the training performance requirements for LPNs involves administering medications based on patients' weight and other factors; this appears to have triggered linkages with some of the Algebra objectives.

Relevance of Grade 8 and Grade 12 NAEP Mathematics Objectives

The overall pattern of linkages, in terms of the content areas most frequently and infrequently linked to the occupations, was consistent from grade 8 to grade 12. However, the percentage of the mathematics objectives linked to training performance requirements for occupations decreased considerably from grade 8 to grade 12¹². In other words, as the content of the objectives became more complex in grade 12, the percentage of objectives linked as relevant to training performance requirements decreased.

The next section helps shed light on whether the levels of KSAs required for proficiency on the NAEP reading and mathematics content relevant to job training are comparable to the levels of KSAs required for entry into job training (where training is conceptualized as the training performance requirements rated as relevant to NAEP).

¹² Comparable statements for NAEP reading are not possible based on findings from the linkage exercise given that linkages were made between NAEP objectives and training performance requirements and the NAEP reading objectives are the same for Grade 8 and for Grade 12.

Are the Levels of KSAs Required for NAEP Similar to the Levels of KSAs Required for Training?

Next, we investigated the correspondence between the levels of KSAs needed for proficiency on relevant NAEP reading and mathematics content (i.e., the NAEP objectives rated relevant to training performance requirements and the NAEP items pertaining to those objectives) and the levels of those KSAs needed to be prepared for entry into job training (where job training is defined by the training performance requirements rated as relevant to NAEP objectives). This was accomplished by having trained project analysts make systematic ratings on a set of standardized KSAs from O*NET. Analysts' KSA ratings were based only on the set of NAEP reading and mathematics content deemed relevant to job training and only on the job training content deemed relevant to NAEP reading and mathematics. Eliminating the irrelevant content helped minimize the influence of construct-irrelevant variance on the analysts' KSA ratings, while also helping to reduce the cognitive demand placed on the project analysts by eliminating the need for them to review and consider the impact of the irrelevant content on their ratings.

Findings from KSA Ratings for NAEP Reading

Disconnects were found between the levels of KSAs needed for proficiency on NAEP reading (where NAEP reading is defined by the objectives linked as relevant to training and the NAEP items pertaining to those objectives) and the levels of KSAs needed for entry into job training (where job training is defined by the training performance requirements linked as relevant to NAEP reading objectives). A “match” was defined as a consistent categorization in the level of the KSA—for example, if the level of Written Comprehension required for proficiency on NAEP grade 12 reading was rated as “High,” then in order for there to be a “match” with training, the training content would also need to be rated as requiring a “High” level of Written Comprehension. The category levels were rationally determined based on analysts' mean ratings on the O*NET level scale (a 7-point rating scale). If the level of Written Comprehension required for the training content received a mean rating that fell into a different category level (e.g., “Moderate”), then this was designated as a “disconnect.”

The subset of O*NET KSAs that are most relevant to reading are: Written Comprehension, Written Expression, and knowledge of English Language. The disconnects between NAEP grade 12 reading and job training were always in the same direction such that the levels of the KSAs required for NAEP grade 12 reading were always higher than the levels of the KSAs required for job training. The disconnects between NAEP grade 12 reading and job training were typically within one category level (e.g., “Moderate/High” vs. “Moderate”). This indicates that even though the job training content on which the KSA ratings were based had been linked by occupational experts as relevant to the NAEP reading objectives, the levels of the KSAs needed for proficiency *on that set of linked NAEP reading content* tended to be higher than the levels of the KSAs needed for entry into job training. For grade 8 reading, there were fewer disconnects between the levels of KSAs needed for proficiency on NAEP and the levels of KSAs needed for entry into job training, particularly for Written Comprehension. Across all occupations, there was a match between the level of Written Comprehension required for grade 8 NAEP reading and the level of Written Comprehension required for job training. All occupations showed that a moderate level of Written Comprehension was needed for both proficiency on the grade 8 NAEP reading content and for entry into job training.

Findings from KSA Ratings for NAEP Mathematics

Large disconnects occurred between the levels of the KSAs needed for proficiency on NAEP grade 12 mathematics (where NAEP grade 12 mathematics is defined by the objectives linked

as relevant to training and the NAEP items that map onto those objectives) and the levels of KSAs needed for entry into job training (where training is defined by the training performance requirements rated relevant to the NAEP grade 12 mathematics objectives). The subset of O*NET KSAs that are most relevant to mathematics are Mathematical Reasoning, Number Facility, and Mathematics Knowledge. In no instance was there a “match” between NAEP grade 12 mathematics content and job training content on any of these KSAs across any of the occupations. The disconnects between NAEP grade 12 mathematics content and job training content were always in the same direction—the levels of the KSAs required for NAEP grade 12 mathematics were always higher than the levels of the KSAs required for job training. In nearly every instance, the KSAs were rated two to three category levels higher for NAEP grade 12 mathematics than for job training (e.g., “High” vs. “Moderate Low”). This indicates that even though the training content on which the KSA ratings were based had been linked by occupational experts as relevant to the NAEP grade 12 mathematics objectives, the levels of the KSAs needed for proficiency *on that set of linked NAEP mathematics content* was higher than the levels of the KSAs needed for entry into job training. A similar result was found in the comparison between NAEP grade 8 mathematics content and job training content such that the levels of these KSAs required for proficiency on NAEP grade 8 mathematics were higher than the levels of the KSAs needed for entry into job training. The only exception was for the occupation of Pharmacy Technician. For Pharmacy Technicians there was a “match” between the levels of these KSAs needed for NAEP grade 8 mathematics and the levels of these KSAs needed for job training. This match might be due in part to the fact that only 27% of the NAEP grade 8 mathematics objectives were linked as relevant to training performance requirements for Pharmacy Technicians. Therefore, the project analysts essentially only took into consideration 27% of the NAEP grade 8 mathematics content when making their determinations on the levels of the KSAs needed for NAEP grade 8 mathematics. This might partly explain why the levels of KSAs required for the NAEP grade 8 mathematics content were rated lower for Pharmacy Technicians than for other occupations. The lower KSA ratings for Pharmacy Technicians on the grade 8 mathematics content led to a “match” with the KSA levels required for job training.

Findings for NAEP Reading and Mathematics Based on “Other” O*NET KSAs

Aside from the O*NET KSAs identified as particularly relevant to NAEP mathematics and the O*NET KSAs identified as particularly relevant to NAEP reading, an additional subset of the O*NET KSAs were targeted as KSAs of particular interest. Those KSAs were: Deductive Reasoning, Inductive Reasoning, Critical Thinking, Complex Problem Solving, and Judgment and Decision Making. Once again, the relative levels of these KSAs required for NAEP reading and mathematics content and required for job training content were compared. In evaluating these comparisons for NAEP grade 8 mathematics, we found that similar levels of Deductive Reasoning, Inductive Reasoning, Critical Thinking, Complex Problem Solving, and Judgment and Decision making are needed for proficiency on NAEP grade 8 mathematics content and for preparedness for entry into job training. The “level” needed was most often rated as a “moderate” level (i.e., mean rating between 3.0 and 4.0 on the 7-point level scale). The exception was for Judgment and Decision Making, which most often received a “Moderate/Low” rating for both the level needed for proficiency on NAEP grade 8 mathematics and the level needed for entry into job training. This lower level rating for Judgment and Decision Making may have something to do with the O*NET scale anchors for this construct. Recall that the anchors on the O*NET rating scale are considered to be part of the construct. Therefore, we used the O*NET scale anchors in the current study. However, the O*NET scale anchors were developed based on applications to rating occupations, not rating academic assessments. Consequently, some of the scale anchors are a stretch in terms of their application to NAEP. For example, the

scale anchors for Judgment and Decision Making are: 2 = “Decide how scheduling a break will affect work flow,” 4 = “Evaluate a loan application for degree of risk,” and 6 = “Decide whether a manufacturing company should invest in new robotics technology.” Given that these scale anchors are not well-suited to NAEP, this may have resulted in lower level ratings of Judgment and Decision Making needed for NAEP than would have occurred if those scale anchors had not be used. Should the O*NET KSAs be applied to academic content in the future, it might be worth considering dropping the O*NET scale anchors and simply using a 7-point Likert scale for rating O*NET KSAs.

When comparisons were made between NAEP grade 12 mathematics and training content on the KSA levels for Deductive Reasoning, Inductive Reasoning, Critical Thinking, Complex Problem Solving, and Judgment and Decision Making, the high correspondence that emerged between grade 8 mathematics content and training content decreased substantially. The levels of these KSAs required for proficiency on NAEP grade 12 mathematics content tended to be higher than the levels required for job training.

The pattern of findings on these five KSAs was less consistent for NAEP reading. For grade 8 reading content, there were a fair number of disconnects between the levels of the KSAs required for NAEP grade 8 reading and the levels of the KSAs required for job training. Interestingly, most of the disconnects were in the direction of job training such that the levels required for job training were *higher* than the levels required for proficiency on NAEP grade 8 reading. However, when comparing NAEP grade 12 reading to job training, the direction of the disconnects flipped such that the levels of the KSAs required for NAEP grade 12 reading were higher than the levels of the KSAs required for job training. Consequently, neither the NAEP grade 8 nor the NAEP grade 12 reading content demonstrated a good match with the levels of these KSAs required for job training.

Summary of Findings on Levels of KSAs

Overall, the findings from the investigation of the correspondence between the levels of KSAs needed for NAEP reading and mathematics and levels of KSAs needed for job training indicate that there are substantial disconnects in the levels of KSAs required for proficiency on NAEP reading and mathematics and the levels required for entry into job training with higher levels of KSAs needed for NAEP than for job training. Disconnects were particularly large when comparing grade 12 NAEP (reading and mathematics) to job training requirements, particularly on the set of KSAs that were most relevant to reading and mathematics. Disconnects were also evident between grade 8 NAEP and job training on the KSAs most relevant to reading and mathematics, but the disconnects tended to be smaller than for grade 12. There was a match between the level of Written Comprehension needed for grade 8 NAEP reading and the level needed for job training; for all occupations, project analysts indicated that a Moderate level of Written Comprehension was needed.

Limitations and Challenges

Some limitations should be mentioned. First, as noted in the JSS study (WestEd & Measured Progress, 2011; 2012) and the course content analysis study (WestEd & Educational Policy Improvement Center, 2013), recruiting occupational experts for participation is a challenge. As such, only three occupational experts per occupation were recruited for this study. This was one more occupational expert than was used in the course content analysis study, although input from more occupational experts would have been even better. Agreement among the occupational experts' linkage ratings between NAEP objectives and training performance requirements was reasonably high; however, agreement was determined by 100% agreement

among the three experts that an objective was linked to *at least one* training performance requirement and by 100% agreement that the training performance requirement was linked to *at least one* NAEP objective. In other words, agreement was not determined at the pairwise level such that all experts had to agree that a given NAEP objective was linked to training performance requirements (tasks) numbers 1, 5, 10, 12, and 15, for example, and that a given training performance requirement was linked to NAEP objectives numbers 5 – 10, 15, 21, 30 – 33, and so forth. Determining agreement at the pairwise level would have been a far more stringent criterion and one that would have required a larger and more representative sample of occupational experts in order to have confidence in the results.

Another challenge inherent with job training preparedness research is the variability of training/apprenticeship programs within the same occupation. This has been noted as a challenge by the Governing Board (National Assessment Governing Board, 2009) and by a leading expert in the field of Industrial-Organizational psychology (Schmitt, 2004). Indication of this challenge was revealed in the current study when one of the LPN occupational experts provided feedback that some aspects of the training performance requirements were appropriate for certain states' certification requirements, but not other states'. And also by one of the Pharmacy Technicians who worked in a hospital setting as opposed to in a traditional pharmacy or as an instructor in a training program, and who stood out as an outlier, presumably due to the difference in the way she was trained to perform her work in a hospital setting. Also, some converging evidence was found between this study and the prior studies on academic preparedness for job training; however, some inconsistencies with regard to the magnitude of the relevance of NAEP reading and mathematics content within a given occupation have emerged. Evidence of such inconsistencies comes from the JSS study where they found lack of agreement between replicate panels on where to set cut points on the NAEP scale, and, for example, in this study for which we found that only 9% of the grade 12 mathematics objectives were identified as relevant by the occupational experts for Pharmacy Technicians, but in the course content analysis study they found evidence that 42% of the mathematics objectives were evident in the course artifacts for Pharmacy Technicians (WestEd & Educational Policy Improvement Center, 2013). These inconsistencies are likely due to the variability of training/apprenticeship programs within the same occupation. One way to help offset this inherent challenge would be to recruit and include large numbers of occupational experts representing the full spectrum of training programs across the nation in future studies. This would require considerable time and effort to identify all of the training programs across the nation for each occupation and then to recruit a representative sample of experts from each, although doing so would help to identify the commonalities and the variability across training programs within the same occupation. If those commonalities could be verified and the differences isolated, then that would help to improve the consistency of finding across studies.

Another limitation of this study is its reliance on trained project analysts to make ratings on the levels of KSAs needed for NAEP and levels needed for job training. The ideal analysts for this project would have been individuals who are experts in the training performance requirements for the occupations, experts on NAEP reading and mathematics content, and individuals who have expertise and experience with using the O*NET KSA constructs. Unfortunately, no such experts exist, to our knowledge. Therefore, we relied on HumRRO research staff with advanced degrees in relevant fields who have experience conducting research on test validity, and/or who have expertise with O*NET, and/or who have experience conducting research on NAEP. To help offset their lack of expertise on the training performance requirements for the occupations, we trained the analysts in the same manner that O*NET trains its analysts to make ability and skill ratings for occupations. We also created a system for analysts to share additional occupational insight with other project analysts to help ensure that all analysts based their KSA

ratings on a common set of job training information. Findings from a check on analysts' familiarity with the occupations confirmed that analysts had very good familiarity with the occupation after going through the training and using the job training information to improve their understanding of the training performance requirements for their assigned occupation. Nonetheless, even after going through this process the project analysts likely did not have the same level of expertise as someone who has been working and/or instructing in the occupation for multiple years.

Conclusions and Recommendations

The findings from this study provide some converging evidence with findings from the prior studies investigating the relation between grade 12 NAEP and academic preparedness for job training. First, this study found that NAEP covers a considerably wider range of reading and mathematics skills than what are required for job training. This was evidenced by the finding that there were considerably more NAEP objectives rated as irrelevant to training performance requirements than there were training performance requirements rated as irrelevant to NAEP objectives. This finding is consistent with findings from the content alignment study between NAEP and WorkKeys (ACT, 2010a; 2010b) and from the findings from the course content analysis study (WestEd & Educational Policy Improvement Center, 2013). The current study expanded on the findings from those studies by investigating whether the correspondence between NAEP and job training improves if NAEP grade 8 content is taken into consideration. Results from the linkage exercise indicate that a greater percentage of grade 8 mathematics objectives than grade 12 mathematics objectives are relevant to training performance requirements. Consequently, including grade 8 does appear to improve the correspondence between NAEP and job training. However, even when using the grade 8 objectives there are still large portions of NAEP that are rated as irrelevant to job training.

This study also provides converging evidence for findings from the course content analysis study that, across occupations, the Number Properties and Operations content area for mathematics is the most relevant to job training, and that the Locate/Recall cognitive target for reading is the most relevant to job training. The JSS study also included some preliminary findings that the Number Properties and Operations content area is most relevant to job training followed by the Measurement content area (except for Computer Support Specialists), and that the Geometry content area is among the least relevant content areas (except for HVAC) (Loomis, 2012); these preliminary findings from the JSS study are all consistent with the findings in the current study.

Results from the current investigation also lend some empirical evidence to the anecdotal evidence obtained from the JSS study and the course content analysis study that the KSAs required for the grade 8 content are more closely aligned with academic requirements for job training than the KSAs required for the grade 12 content. Findings from the project analysts' ratings on the levels of KSAs needed for NAEP reading and mathematics content as compared to the levels of KSAs needed for job training content indicate that the magnitude of the disconnect between NAEP and job training is less when considering the grade 8 content. This lends some support to the thoughts expressed in prior studies that the grade 8 content is more closely aligned with job training requirements than the grade 12 content. However, overall, the results indicate that there is still a disconnect between the levels of the KSAs required for grade 8 NAEP reading and mathematics content and the levels of the KSAs required for job training content with higher levels needed for grade 8 NAEP (particularly for mathematics) than for job training.

The findings from this study, in conjunction with findings from the three prior studies, call into question the validity of the inferences that can be made about using scores on the grade 12 NAEP scales as indicators of academic preparedness for job training. Given that there is converging evidence across studies that the Number Properties and Operations content area from mathematics is the most relevant to job training across occupations and that the Locate/Recall cognitive target from informational reading is the most relevant to job training across occupations, we recommend that the Governing Board consider the possibility of using subscores for those content areas for determining academic preparedness for entry into job training. We also recommend that the Governing Board consider the possibility of administering the grade 8 assessments to 12th grade students to make determinations about their academic preparedness for entry into job training, given that the grade 8 content was found to have greater correspondence with job training requirements, both in terms of the percentage of relevant objectives (for mathematics) and in terms of the levels of KSAs needed, than the grade 12 content.

Finally, we recommend that the Governing Board consider the possibility of updating the working definition of job preparedness to include trainee outcomes, such as trainee performance in job training (e.g., scores on tests taken in training, performance evaluation from the trainer, etc.). Performance in job training is at a level that is somewhat beyond “just qualified” for placement into job training. Including training outcomes in the working definition of job preparedness might potentially lead to evidence that is more supportive of grade 12 NAEP as an indicator of academic preparedness for job training. Furthermore, including training outcomes as elements of the working definition of job preparedness would expand opportunities for future research investigations.

References

- ACT, Inc. (2010a). The alignment of the NAEP Grade 12 mathematics assessment and the WorkKeys applied mathematics assessment. Iowa City, IA: Author.
- Cunningham, J.W. (2000). A primer on preparing O*NET task statements. North Carolina State University.
- Educational Policy Improvement Center (2013). National Assessment of Educational Progress Grade 12 Preparedness Research Project Job Training Programs Curriculum Study. Eugene, OR: Author.
- Fields, R. (2013). Validity Argument for NAEP Reporting on 12th Grade Academic Preparedness for College. Washington
- Fields, R. (2014). Towards The National Assessment of Educational Progress (NAEP) as an Indicator of Academic Preparedness for College and Job Training. Washington, DC: National Assessment Governing Board.
- National Assessment Governing Board. (2009). Making new links, 12th grade and beyond: Technical Panel on 12th Grade Preparedness Research final report. Washington, DC: Author.
- National Assessment Governing Board. (2013a). Reading framework for the 2013 National Assessment of Education Progress. Washington, DC: Author. Retrieved from <http://www.nagb.org/publications/frameworks.html>.
- National Assessment Governing Board. (2013b). Mathematics framework for the 2013 National Assessment of Education Progress. Washington, DC: Author. Retrieved from <http://www.nagb.org/publications/frameworks.html>.
- Kilpatrick, J. (2012, April). The Standard for Minimal Academic Preparedness in Mathematics to Enter a Job-Training Program. Presentation at the annual meeting of the National Council on Measurement in Education, Vancouver, Canada.
- Loomis, S. (2012, April). A study of “irrelevant” items: Impact on bookmark placement and implications for college and career readiness. Presentation at the annual meeting of the National Council on Measurement in Education, Vancouver, Canada.
- McCloy, R., Waugh, G., & Medsker, G. (1998). Determining the occupational reinforcer patterns for O*NET occupational units. Alexandria, VA: Human Resources Research Organization.
- McGraw, K. O. & Wong, S. P. (1996). Forming inferences about some intraclass correlations coefficients. *Psychological Methods*, 1, 30-46.
- Peterson, N. G., Mumford, M.D., Borman, W.C., Jeanneret, P.R., & Fleishman, E.A. (1995). *Development of prototype Occupational Information Network (O*NET) content model. Volume I: Report*. Utah Department of Workforce Services.

- Peterson, N. G., Mumford, M. D., Borman, W. C., Jeanneret, P. R., Fleishman, E. A., & Levin, K. Y. (eds.). (1997). O*NET final technical report. Salt Lake City, UT: Utah Department of Workforce Services through a contract with American Institutes for Research.
- Peterson, N. G., Mumford, M.D., Borman, W.C., Jeanneret, P.R., & Fleishman, E.A. (Eds.). (1999). *An occupational information system for the 21st century: The development of O*NET*. (pp. 21-30). Washington, DC: American Psychological Association.
- Russell, T.L., Sinclair, A.L., Erdheim, J., Ingerick, M.J., Owens, K.S., Peterson, N.G., & Pearlman, K. (2008). Evaluating the O*NET occupational analysis system for Army competency development (Technical Report 1237). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Schmitt, N. (2004). Readiness for training standards: Development and validation. *Commissioned paper prepared for the National Assessment Governing Board*. Washington, DC.
- Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin*, 86, 420-428.
- Tsacoumis, S. (2007). The feasibility of using O*NET to study skill changes. A paper prepared for the Workshop on Research Evidence Related to Future Skill Demands, Center for Education, The National Academies.
- Tsacoumis, S. & Willison, S. (2010). O*NET Analyst Occupational Skill Ratings: Procedures (FR-08-70). Alexandria, VA: Human Resources Research Organization.
- Waters, S.D., Russell, T.L., Shaw, M.N., Allen, M.T., Sellman, W.S., & Geimer, J.L. (2009). Development of a Methodology for Linking ASVAB Content to Military Job Information and Training Curricula (FR-09-64). Alexandria, VA: Human Resources Research Organization.
- WestEd & Measured Progress. (2011). National Assessment of Educational Progress Grade 12 Preparedness Research Project Judgmental Standard Setting (JSS) Studies: Process Report. San Francisco, CA.
- WestEd & Measured Progress. (2012). National Assessment of Educational Progress Grade 12 Preparedness Research Project Judgmental Standard Setting (JSS) Studies: Technical Report. San Francisco, CA.

Appendix A: Initial Lists of Performance Requirements (Tasks) from O*NET

Initial O*NET Task List: Automotive Master Technicians

Number	Category	Task
1	Core	Test drive vehicles, and test components and systems, using equipment such as infrared engine analyzers, compression gauges, and computerized diagnostic devices.
2	Core	Examine vehicles to determine extent of damage or malfunctions.
3	Core	Repair, reline, replace, and adjust brakes.
4	Core	Follow checklists to ensure all important parts are examined, including belts, hoses, steering systems, spark plugs, brake and fuel systems, wheel bearings, and other potentially troublesome areas.
5	Core	Confer with customers to obtain descriptions of vehicle problems, and to discuss work to be performed and future repair requirements.
6	Core	Perform routine and scheduled maintenance services such as oil changes, lubrications, and tune-ups.
7	Core	Repair and service air conditioning, heating, engine-cooling, and electrical systems.
8	Core	Test and adjust repaired systems to meet manufacturers' performance specifications.
9	Core	Review work orders and discuss work with supervisors.
10	Core	Tear down, repair, and rebuild faulty assemblies such as power systems, steering systems, and linkages.
11	Core	Plan work procedures, using charts, technical manuals, and experience.
12	Core	Disassemble units and inspect parts for wear, using micrometers, calipers, and gauges.
13	Core	Repair or replace parts such as pistons, rods, gears, valves, and bearings.
14	Core	Rewire ignition systems, lights, and instrument panels.
15	Core	Repair manual and automatic transmissions.
16	Core	Install and repair accessories such as radios, heaters, mirrors, and windshield wipers.
17	Core	Maintain cleanliness of work area.
18	Core	Repair or replace shock absorbers.
19	Core	Replace and adjust headlights.
20	Core	Overhaul or replace carburetors, blowers, generators, distributors, starters, and pumps.
21	Core	Repair radiator leaks.
22	Supplemental	Align vehicles' front ends.
23	Supplemental	Rebuild parts such as crankshafts and cylinder blocks.
24	Supplemental	Repair damaged automobile bodies.

Initial O*NET Task List: Computer Support Specialists

Number	Category	Task
1	Core	Oversee the daily performance of computer systems.
2	Core	Answer user inquiries regarding computer software or hardware operation to resolve problems.
3	Core	Enter commands and observe system functioning to verify correct operations and detect errors.
4	Core	Set up equipment for employee use, performing or ensuring proper installation of cables, operating systems, or appropriate software.
5	Core	Install and perform minor repairs to hardware, software, or peripheral equipment, following design or installation specifications.
6	Core	Maintain records of daily data communication transactions, problems and remedial actions taken, or installation activities.
7	Core	Read technical manuals, confer with users, or conduct computer diagnostics to investigate and resolve problems or to provide technical assistance and support.
8	Core	Refer major hardware or software problems or defective products to vendors or technicians for service.
9	Core	Develop training materials and procedures, or train users in the proper use of hardware or software.
10	Core	Confer with staff, users, and management to establish requirements for new systems or modifications.
11	Core	Prepare evaluations of software or hardware, and recommend improvements or upgrades.
12	Core	Read trade magazines and technical manuals, or attend conferences and seminars to maintain knowledge of hardware and software.
13	Supplemental	Hire, supervise, and direct workers engaged in special project work, problem solving, monitoring, and installing data communication equipment and software.
14	Supplemental	Inspect equipment and read order sheets to prepare for delivery to users.
15	Supplemental	Modify and customize commercial programs for internal needs.
16	Supplemental	Conduct office automation feasibility studies, including workflow analysis, space design, or cost comparison analysis.

Initial O*NET Task List: HVAC

Number	Category	Task
1	Core	Test electrical circuits or components for continuity, using electrical test equipment.
2	Core	Test pipe or tubing joints or connections for leaks, using pressure gauge or soap-and-water solution.
3	Core	Join pipes or tubing to equipment and to fuel, water, or refrigerant source, to form complete circuit.
4	Core	Reassemble and test equipment following repairs.
5	Core	Repair or replace defective equipment, components, or wiring.
6	Core	Lay out and connect electrical wiring between controls and equipment, according to wiring diagrams, using electrician's hand tools.
7	Core	Obtain and maintain required certifications.*¹³
8	Core	Install, connect, and adjust thermostats, humidistats and timers, using hand tools.
9	Core	Comply with all applicable standards, policies, and procedures, including safety procedures and the maintenance of a clean work area.*
10	Core	Inspect and test systems to verify system compliance with plans and specifications or to detect and locate malfunctions.
11	Core	Adjust system controls to setting recommended by manufacturer to balance system, using hand tools.
12	Core	Install auxiliary components to heating-cooling equipment, such as expansion and discharge valves, air ducts, pipes, blowers, dampers, flues and stokers, following blueprints.
13	Core	Recommend, develop, or perform preventive or general maintenance procedures, such as cleaning, power-washing, or vacuuming equipment, oiling parts, or changing filters.
14	Core	Cut or drill holes in floors, walls, or roof to install equipment, using power saws or drills.
15	Core	Assemble, position and mount heating or cooling equipment, following blueprints.
16	Core	Record and report all faults, deficiencies, and other unusual occurrences, as well as the time and materials expended on work orders.
17	Core	Discuss heating-cooling system malfunctions with users to isolate problems or to verify that malfunctions have been corrected.
18	Core	Study blueprints, design specifications, and manufacturers' recommendations to ascertain the configuration of heating or cooling equipment components and to ensure the proper installation of components.

¹³ *Based on current O*NET task writing guidelines, these are considered “requirements of the occupation” and not tasks to be performed. Consequently, these statements were dropped.

Number	Category	Task
19	Core	Measure, cut, thread, or bend pipe or tubing, using pipe fitter's tools.
20	Core	Fabricate, assemble, or install duct work or chassis parts, using portable metal-working tools or welding equipment.
21	Core	Generate work orders that address deficiencies in need of correction.
22	Core	Assist with other work in coordination with repair and maintenance teams.
23	Core	Wrap pipes in insulation, securing it in place with cement or wire bands.
24	Not available* ¹⁴	Install and test automatic, programmable, or wireless thermostats in residential or commercial buildings to minimize energy usage for heating or cooling.
25	Not available	Install dehumidifiers or related equipment for spaces that require cool, dry air to operate efficiently, such as computer rooms.
26	Not available	Install magnetic-centrifugal chillers, compressors, or related equipment to cool air temperatures through the use of recirculating water.
27	Not available	Install or repair air purification systems, such as specialized filters or ultraviolet (UV) light purification systems.
28	Not available	Install or repair self-contained ground source heat pumps or hybrid ground or air source heat pumps to minimize carbon-based energy consumption and reduce carbon emissions.
29	Not available	Install radiator controls for room-level zone control heating of residential or commercial buildings.
30	Not available	Repair or service heating, ventilating, and air conditioning (HVAC) systems to improve efficiency, such as by changing filters, cleaning ducts, or refilling non-toxic refrigerants.

¹⁴ *Information on “Core” versus “Supplementary” was not available for these statements from O*NET on-line.

Initial O*NET Task List: LPN

Number	Category	Task
1	Core	Administer prescribed medications or start intravenous fluids, noting times and amounts on patients' charts.
2	Core	Observe patients, charting and reporting changes in patients' conditions, such as adverse reactions to medication or treatment, and taking any necessary action.
3	Core	Provide basic patient care or treatments, such as taking temperatures or blood pressures, dressing wounds, treating bedsores, or performing catheterizations.
4	Core	Sterilize equipment and supplies, using germicides, sterilizer, or autoclave.
5	Core	Answer patients' calls and determine how to assist them.
6	Core	Measure and record patients' vital signs, such as height, weight, temperature, blood pressure, pulse, and respiration.
7	Core	Work as part of a healthcare team to assess patient needs, plan and modify care, and implement interventions.
8	Core	Collect samples, such as blood, urine, or sputum from patients, and perform routine laboratory tests on samples.
9	Core	Prepare patients for examinations, tests, or treatments and explain procedures.
10	Core	Assemble and use equipment, such as catheters, tracheotomy tubes, or oxygen suppliers.
11	Core	Evaluate nursing intervention outcomes, conferring with other healthcare team members as necessary.
12	Core	Record food and fluid intake and output.
13	Core	Help patients with bathing, dressing, maintaining personal hygiene, moving in bed, or standing and walking.
14	Core	Apply compresses, ice bags, or hot water bottles.
15	Core	Inventory and requisition supplies and instruments.
16	Core	Clean rooms and make beds.
17	Supplemental	Supervise nurses' aides or assistants.
18	Supplemental	Make appointments, keep records, or perform other clerical duties in doctors' offices or clinics.
19	Supplemental	Provide medical treatment or personal care to patients in private home settings, such as cooking, keeping rooms orderly, seeing that patients are comfortable and in good spirits, or instructing family members in simple nursing tasks.
20	Supplemental	Set up equipment and prepare medical treatment rooms.
21	Supplemental	Prepare or examine food trays for conformance to prescribed diet.
22	Supplemental	Wash and dress bodies of deceased persons.
23	Supplemental	Assist in delivery, care, or feeding of infants.

Initial O*NET Task List: Pharmacy Technicians

Number	Category	Task
1	Core	Receive written prescription or refill requests and verify that information is complete and accurate.
2	Core	Establish or maintain patient profiles, including lists of medications taken by individual patients.
3	Core	Maintain proper storage and security conditions for drugs.
4	Core	Answer telephones, responding to questions or requests.
5	Core	Prepack bulk medicines, fill bottles with prescribed medications, and type and affix labels.
6	Core	Mix pharmaceutical preparations, according to written prescriptions.
7	Core	Clean and help maintain equipment or work areas and sterilize glassware, according to prescribed methods.
8	Core	Price and file prescriptions that have been filled.
9	Core	Assist customers by answering simple questions, locating items, or referring them to the pharmacist for medication information.
10	Core	Receive and store incoming supplies, verify quantities against invoices, check for outdated medications in current inventory, and inform supervisors of stock needs and shortages.
11	Core	Order, label, and count stock of medications, chemicals, or supplies and enter inventory data into computer.
12	Core	Operate cash registers to accept payment from customers.
13	Supplemental	Transfer medication from vials to the appropriate number of sterile, disposable syringes, using aseptic techniques.
14	Supplemental	Supply and monitor robotic machines that dispense medicine into containers and label the containers.
15	Supplemental	Prepare and process medical insurance claim forms and records.
16	Supplemental	Deliver medications or pharmaceutical supplies to patients, nursing stations, or surgery.
17	Supplemental	Compute charges for medication or equipment dispensed to hospital patients and enter data in computer.
18	Supplemental	Restock intravenous (IV) supplies and add measured drugs or nutrients to IV solutions under sterile conditions to prepare IV packs for various uses, such as chemotherapy medication.
19	Supplemental	Price stock and mark items for sale.
20	Supplemental	Maintain and merchandise home healthcare products or services.

Appendix B:

Recruitment Email Sent to Occupational Experts to Request Review of Initial List of Performance Requirements

(Automotive Master Technician Email included as Example)

Dear _____:

The occupation of Automotive Master Technician is identified by the Department of Labor as a “Bright Outlook” career; it has a high potential for employment in the future, and it offers the capacity to earn a wage sufficient to support a family.

As such, the National Assessment Governing Board, which administers the National Assessment of Educational Progress (NAEP), is interested in investigating whether students’ scores on 12th grade NAEP are a good indicator of “job preparedness” for Automotive Master Technicians.

The Governing Board has contracted with the Human Resources Research Organization (HumRRO) to conduct this research. To do this study, we first need to identify the major performance requirements (i.e., definable, nontrivial tasks that an individual must be able to perform) to be an Automotive Master Technician. We have an initial list of tasks that comes from the Department of Labor’s Occupational Information Network, or O*NET (<http://www.onetonline.org/>).

We need to “vet” this task list with individuals who have expertise in this occupation (including knowledge of the training required for entering this occupation) to verify that the list accurately reflects training performance requirements.

You have been identified as a potential content expert for providing such a review (through the AYES website).

You will be provided an honorarium for your contribution to this effort.

If you are interested in sharing your expertise, please respond to this email.

If a response is received indicating your interest, you will receive a follow-up email with the task list for you to review, specific questions to keep in mind as you review the list, and a form to complete for receiving payment (“honorarium”) for providing the review.

You can send your review of the task list and your completed form to this email address. Our goal is to have all content experts return their reviews by no later than October 28, 2013.

Thanks for your consideration!

Appendix C: Background Form Completed by Occupational Experts

Please complete the following (this information is simply to provide justification for your content expertise. No personally identifying information will be included in the research report):

Number of years in your occupation: _____

Current Job Title (or most recent job title if recently retired): _____

List any awards/recognitions you have received in your occupation (e.g., employee of the month, etc.): _____

List any relevant professional activities (e.g., serving on a certification board, member of professional organization, etc.): _____

Appendix D: Instructions to Occupational Experts for Reviewing O*NET Task Lists

(Example from Computer Support Specialists)

Instructions for Reviewing the Task List

In reviewing the Task List, please keep the following in mind:

- **A task is typically conceptualized as a behavior/activity with a meaningful outcome¹⁵.** For example, “Perform minor repairs to hardware” is an example of a task. A task is *not* an ability, skill, or knowledge. Please keep this distinction in mind when reviewing the Task List. We are *not* interested in adding abilities, skills, or knowledges to the Task List (that information exists elsewhere). Also, we are *not* interested in adding certifications (e.g., obtain computer support specialist certification) to the Task List.
- The Task List should be appropriate for the kinds of activities trainees learn about in training/apprenticeship programs.
- For purposes of this research, we are interested in ensuring that the Task List represents “definable, nontrivial tasks.” In other words, if the task is trivial/insignificant and/or not very relevant to training/apprenticeship, then it should *not* be included on the Task List.
- The Task List should represent behaviors/activities that all or most individuals in training for occupation perform. The Task List should *not* include tasks that would only be performed by a small number of trainees in the occupation (e.g., those in a particular specialty within the occupation).
- We are *not* interested in breaking down tasks into their finest-grain (most specific) level. For example, for the task “Install and perform minor repairs to hardware” we are *not* interested in identifying each of the individual steps involved in that task.
- We are *not* interested in identifying the conditions of the work environment in which the tasks must be performed (e.g., perform work in small, cramped spaces). While work context is important, the focus of this effort is on the tasks themselves, not the conditions under which those tasks are performed.

Keeping the above points in mind, please carefully review each of the tasks on the Task List and provide an answer to the following questions. (*You may either type your responses directly into this document or type them in a separate document.*)

1. Do these tasks accurately reflect the activities that trainees learn about in training/apprenticeship programs?

¹⁵ Cunningham, J.W. (2000). A primer on preparing O*NET task statements. North Carolina State University.

2. Are there any tasks that should be removed from the list (e.g., tasks that are inappropriate for training/apprenticeship, tasks that are only relevant to a small portion of employees in training for this occupation, etc.)? If so, please identify which tasks, if any, should be removed from the list and briefly explain why. (*You may identify tasks by the number assigned to them in the Excel document.*)
3. Are there any tasks that should be edited to make them more applicable to training/apprenticeship? If so, please use the space provided in the Excel document for entering your suggested edits (*or you may enter edits here*).
4. Are there any tasks that are marked "supplemental" (meaning that actual job incumbents rated these as either not very important and/or not very relevant to their job) that you believe should be labeled as "core" (i.e., tasks that are important and relevant to training/apprenticeship)? If so, which ones?
5. Are there any important tasks that are missing from the list that should be added for training/apprenticeship programs? If so, what are they? (*You may enter additions here and/or in the Excel document.*)

In thinking about your response to question 5, please consider the below list of “task-like” course objectives that were pulled from a sample of course artifacts (e.g., course syllabi, textbook table of contents, etc.) from training courses in this field. The below list is provided as way to “jog your mind” about potential gaps in the Task List that you’ve been asked to review. Please note that the below list may include redundancies and course objectives that represent a range of levels of specificity (with some of the objectives stated at a very specific level and others at a broader level).

“Task-like” course objectives pulled from sample of course artifacts:

- Systems
- Networking
- Programming
- Data Representation
- Information Processing
- Information Security
- Hardware Operation
- Software
- Internet
- troubleshoot hardware faults
- troubleshoot Software Faults

- Create Visual Basic .net programs using proper syntax and procedures
- Document Visual .net programs.
- Analyze and correct programming errors and problems.
- validate interactive user input
- Create programs to access databases.
- write external documentation in the form of pseudocode
- write internal documentation in their programs
- identify programming errors and problems
- correct errors in logic and in coding
- use the IDE to debug programs
- create validation for user input controls
- use validation to prevent errors in interactive user input
- utilize if and select case control structures
- utilize while, for, for each, and do while repetition structures
- design and use sub procedures and functions
- open and process information from sequential files
- write to data files
- create and read from arrays and other structured data
- write to arrays and objects.
- connect to external databases on the same computer
- Create complex programs using easyC for Vex Robotics.
- read and write to external databases on a network
- connect to internet databases to manipulate data
- compare applicable technology products and services
- differentiate between system and application software
- Design a database application using forms and reports based on sound database design and query methods.
- Create a representation of the user's view of data by using data modeling.
- Create single-table and multi-table queries.
- Design databases
- Design a database application
- Create Visual Basic .net program
- create, edit and format a document
- create, edit and format a spreadsheet to include inputting formulas.
- create, edit and format a slide show using transitions.

Appendix E: Revised Lists of Training Performance Requirements

Final Revised List of Training Performance Requirements (with Links to NAEP Identified): Automotive Master Technicians

Number	Task	Links to Reading	Links to G8 Math	Links to G12 Math
1	<i>Test drive vehicles and diagnose needed repairs using scan tools, engine mechanical test equipment, and exhaust analyzers.</i>	X	X	X
2	Examine vehicles to determine extent of body damage.			
3	Inspect brake system concerns and adjust, repair or replace brakes or brake components.	X	X	X
4	Follow checklists to ensure all important parts are examined, including belts, hoses, steering systems, spark plugs, brake and fuel systems, wheel bearings, and other potentially troublesome areas.	X	X	X
5	Confer with customers to obtain descriptions of vehicle problems, and to discuss work to be performed and future repair requirements.			
6	Perform routine and scheduled maintenance services such as oil changes, lube and filter changes.	X	X	X
7	Repair and service air conditioning, heating, and engine-cooling systems, including electrical cooling fans and their controls.	X	X	X
8	Test and adjust repaired systems to meet manufacturers' performance specifications.	X	X	X
9	Complete work orders to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.	X	X	X
10	Use service reference materials such as factory service manuals, general manuals, technical service bulletins, charts, and on-line information services to guide vehicle repairs, replacements, and services.	X	X	X
11	Disassemble units and inspect parts for wear using industry standard precision measuring tools and equipment, such as micrometers, calipers, dial indicators, and brake gages.	X	X	X
12	Inspect internal components of an engine, and repair or replace defective components.	X	X	X
13	Diagnose electrical and electronic systems using digital multi-meters (voltage available, voltage drop, current flow, resistance, continuity).	X	X	X

Number	Task	Links to Reading	Links to G8 Math	Links to G12 Math
14	Remove, rebuild, or replace manual and automatic transmissions.	X	X	X
15	Install and repair electrical or electronic accessories such as, radios and windshield wipers.	X	X	X
16	Maintain cleanliness of work area.			
17	Inspect suspension and steering systems and repair or replace defective components.	X	X	X
18	Replace and adjust headlights.	X	X	X
19	Diagnose malfunctions and replace fuel injectors, fuel pumps, fuel filters, blowers, alternators, coil packs, starters, and water or oil pumps.	X	X	X
20	Inspect cooling system components, including radiator and water pump, and repair or replace defective components.	X	X	X
21	Conduct wheel alignments by measuring and adjusting suspension angles to ensure that wheels are parallel to each other and perpendicular to the ground.	X	X	X
22	<i>Diagnose, repair, or replace differentials, final drives, drive shafts, and drive axels.</i>	X	X	X
23	<i>Remove and replace engine assemblies.</i>	X	X	X
Total Linkages		20	20	20
% of Tasks Linked		87.0	87.0	87.0

Italics denote training performance requirements that were added based on feedback obtained from the review by the occupational experts.

Final Revised List of Training Performance Requirements (with Links to NAEP Identified): Computer Support Specialist

Number	Tasks	Links to Reading	Links to G8 Math	Links to G12 Math
1	Provide user support by answering user inquiries regarding problems with computer software, hardware operation, or network connectivity.	X	X	X
2	Verify system configurations and correct errors.	X	X	X
3	Configure equipment for employee use, performing or ensuring proper installation of cables, operating systems, appropriate software, or network connectivity.	X	X	X
4	Diagnose, troubleshoot, and resolve hardware, software, or network connectivity problems, following design or installation specifications.	X	X	X
5	Document daily data communication transactions, problems and remedial actions taken, or installation activities.	X		
6	Read technical manuals, consult manufacturers' websites, confer with users, or conduct computer diagnostics to investigate and resolve problems or to provide technical assistance and support to end users.	X	X	X
7	Refer major hardware or software problems or defective products encountered by end users to vendors or technicians for service.	X		
8	Develop training materials and procedures, or train users in the proper use of hardware or software.	X		
9	Question staff, users, or management to identify recommendations for new systems or modifications.	X		
10	Evaluate software or hardware, and recommend improvements or upgrades.	X	X	X
11	<i>Enforce best practices in information security, such as informing users of password policies and protection of data containing personally identifiable information.</i>	X		
12	<i>Conduct preventative maintenance, software updates, anti-virus updates, and operating system updates to help prevent against security attacks.</i>	X	X	
Total Linkages		12	7	6
% of Tasks Linked		100.0	58.3	50.0

Italics denote training performance requirements that were added based on feedback obtained from the review by the occupational experts.

**Final Revised List of Training Performance Requirements (with Links to NAEP Identified):
HVAC**

Number	Task	Links to Reading	Links to G8 Math	Links to G12 Math
1	Test electrical circuits or components for continuity, using electrical test equipment.	X	X	X
2	Test pipe or tubing joints or connections for leaks, using pressure gauges, electronic leak detectors, or soap-and-water solutions.		X	X
3	Join pipes or tubing to equipment and to fuel, water, or refrigerant source, to form complete circuit.		X	X
4	Solder and braze pipes or tubing.		X	X
5	Reassemble and test equipment following repairs.	X	X	X
6	Diagnose, repair, or replace defective components.	X	X	X
7	Route and connect electrical wiring between controls and equipment using electricians' hand tools.	X	X	X
8	Use wiring diagrams and manufacturer troubleshooting charts to diagnose and repair defective wiring.	X	X	X
9	Install, connect, and adjust thermostats, humidistats and timers, using electricians' hand tools.	X	X	X
10	Inspect and test systems to detect and locate malfunctions.	X	X	X
11	Adjust system controls to setting recommended by manufacturer to balance system, using electricians' hand tools.	X	X	X
12	Install auxiliary components to heating-cooling equipment, such as expansion and discharge valves, air ducts, pipes, blowers, dampers, flues and stokers, following blueprints.	X	X	X
13	Perform general maintenance procedures such as replacing belts with correct sizes, making proper tension adjustments, replacing filters, testing and cleaning flame sensors, cleaning coils, cleaning ducts, or refilling non-toxic refrigerants.	X	X	X
14	Cut or drill holes in floors, walls, or roof to install equipment, using power saws or drills.		X	X
15	Assemble, position, and install heating or cooling equipment.	X	X	X

Number	Task	Links to Reading	Links to G8 Math	Links to G12 Math
16	Record and report all faults, deficiencies, and other unusual occurrences, as well as the time and materials expended on work orders.	X	X	X
17	Discuss heating-cooling system malfunctions with users to isolate problems or to verify that malfunctions have been corrected.			
18	Use blueprints, design specifications, and manufacturers' recommendations to ascertain the configuration of heating or cooling equipment components and to ensure the proper installation of components.	X	X	X
19	Measure, cut, thread, or bend pipe or tubing, using pipe fitter's tools.		X	X
20	Fabricate, assemble, or install duct work or chassis parts, using metal-working tools or welding equipment.		X	X
21	Wrap pipes in insulation and secure in place.		X	X
22	Install and test automatic, programmable, or wireless thermostats in residential or commercial buildings to minimize energy usage for heating or cooling.	X	X	X
23	<i>Analyze and correct system performance according to manufacturer's specifications.</i>	X	X	X
24	<i>Identify equipment model numbers, serial numbers, and other nomenclature provided by manufacturer to determine the correct replacement equipment or part.</i>	X	X	
Total Linkages		16	23	22
% of Tasks Linked		66.7	95.8	91.7

Italics denote training performance requirements that were added based on feedback obtained from the review by the occupational experts.

**Final Revised List of Training Performance Requirements (with Links to NAEP Identified):
LPN**

Number	Tasks	Links to Reading	Links to G8 Math	Links to G12 Math
1	Administer medications as prescribed.	X	X	X
2	Observe patients for changes in their conditions, such as adverse reactions to medications or treatment.	X	X	X
3	Answer patients' calls and consult their charts or reference manuals, as needed, to determine how to assist them.	X	X	X
4	Measure patients' vital signs, such as height, weight, temperature, blood pressure, pulse, and respiration.		X	X
5	Work as part of a healthcare team to assess patient needs, plan and modify care, and implement interventions and providers' orders.	X	X	X
6	Collect samples, such as blood, urine, or sputum from patients, and perform routine laboratory tests on samples.	X	X	X
7	Prepare patients for examinations, tests, or treatments and explain procedures.	X	X	X
8	Assemble and use equipment, such as catheters or oxygen suppliers.	X	X	X
9	Evaluate nursing intervention outcomes, conferring with other healthcare team members as necessary.	X	X	X
10	Record patients' food and fluid intake and output.	X	X	X
11	Help patients with bathing, dressing, maintaining personal hygiene, moving in bed, or standing and walking.			
12	Apply compresses, ice bags, or hot water bottles as directed.			
13	Inventory and requisition supplies and instruments.	X	X	X
14	Supervise nurses' aides or assistants.			
15	Prepare or examine food trays for conformance to prescribed diet.	X	X	X
16	<i>Document, either electronically or with paper charting, all patient care and assessments, including any changes in patients' conditions.</i>	X	X	X
17	<i>Conduct head-to-toe assessments of patients.</i>		X	X
18	<i>Consult patient charts to obtain instructions for patient care and implement accordingly.</i>	X	X	X
Total Linkages		13	15	15
% of Tasks Linked		72.2	83.3	83.3

Italics denote training performance requirements that were added based on feedback obtained from the review by the occupational experts.

Final Revised List of Training Performance Requirements (with Links to NAEP Identified): Pharmacy Technician

Number	Tasks	Links to Reading	Links to G8 Math	Links to G12 Math
1	Receive written, faxed, or electronic prescriptions or refill requests and verify that information is complete and accurate.	X	X	X
2	Interview patients to collect and record demographic information, current medications, allergy information, medical conditions, and insurance information.	X	X	
3	Maintain proper storage conditions for drugs, including checking refrigerator temperatures and entering into temperature logs.	X	X	X
4	Answer telephones, responding to simple questions or requests, and directing other inquiries to pharmacists, as necessary.			
5	From generated prescription labels, prepack bulk medicines, fill bottles with prescribed medications, affix labels, and review for any issues that may require a pharmacist to counsel a patient such as early or late refills, drug interactions, or drug duplication.	X	X	X
6	Mix and compound pharmaceutical preparations, according to written prescriptions.	X	X	X
7	Aseptically compound sterile preparations following prescribed guidelines for sterile preparation and sterile preparation areas.	X	X	X
8	File prescriptions that have been filled.	X	X	
9	Assist customers by answering simple questions, which do not require the clinical judgment of a pharmacist, locating items, or referring them to the pharmacist for medication information.			
10	Receive and store incoming supplies, verify quantities against invoices, and check for outdated medications in current inventory.		X	X
11	Count stock of medications, chemicals, or supplies, enter inventory data into a computer, and inform supervisor of stock needs and shortages.		X	X
12	Operate cash registers to accept payment from customers.		X	X
13	Prepare and process medical insurance claim forms and records, and contact third party payers for any problems that occur during prescription adjudication.	X	X	X

Number	Tasks	Links to Reading	Links to G8 Math	Links to G12 Math
14	<i>Ensure security and check inventory of controlled substances per State or Federal law, as well as tracking of dose count on scheduled prescriptions for long term care patients.</i>	X	X	X
15	<i>Offer clients pharmacist counseling on all new prescriptions.</i>			
Total Linkages		9	12	10
% of Tasks Linked		60.0	80.0	66.6

Italics denote training performance requirements that were added based on feedback obtained from the review by the occupational experts.

Appendix F: NAEP Reading Objectives (Informational Text Objectives Only)

Cognitive Target	Standard	Objective
Locate/Recall	Identify textually explicit information (such as definitions, facts, and supporting details) <i>and</i> make simple inferences within and across texts.	1. Identify definitions within and across texts and make simple inferences.
Locate/Recall	Identify textually explicit information (such as definitions, facts, and supporting details) <i>and</i> make simple inferences within and across texts.	2. Identify facts within and across texts and make simple inferences.
Locate/Recall	Identify textually explicit information (such as definitions, facts, and supporting details) <i>and</i> make simple inferences within and across texts.	3. Identify supporting details within and across texts and make simple inferences.
Locate/Recall	Identify textually explicit information (such as, topics sentences or main ideas, author's purpose, causal relations, information in graphics) within and across texts.	4. Identify topic sentences or main ideas within and across texts.
Locate/Recall	Identify textually explicit information (such as, topics sentences or main ideas, author's purpose, causal relations, information in graphics) within and across texts.	5. Identify author's purpose within and across texts.
Locate/Recall	Identify textually explicit information (such as, topics sentences or main ideas, author's purpose, causal relations, information in graphics) within and across texts.	6. Identify causal relations within and across texts.
Locate/Recall	Identify textually explicit information (such as, topics sentences or main ideas, author's purpose, causal relations, information in graphics) within and across texts.	7. Locate specific information in text or graphics.
Integrate/interpret	Make complex inferences within and across texts.	8. Make complex inferences within and across texts to describe problem and solution or cause an effect .
Integrate/interpret	Make complex inferences within and across texts.	9. Make complex inferences within and across texts to compare or connect ideas, problems, or situations .
Integrate/interpret	Make complex inferences within and across texts.	10. Make complex inferences within and across texts to determine unstated assumptions in an argument .
Integrate/interpret	Make complex inferences within and across texts.	11. Make complex inferences within and across texts to describe how an author uses text features.

Cognitive Target	Standard	Objective
Integrate/interpret	Make complex inferences within and across texts.	12. Make complex inferences within and across texts to summarize major ideas .
Integrate/interpret	Make complex inferences within and across texts.	13. Make complex inferences within and across texts to draw conclusions and provide supporting information .
Integrate/interpret	Make complex inferences within and across texts.	14. Make complex inferences within and across texts to find evidence in support of an argument .
Integrate/interpret	Make complex inferences within and across texts.	15. Make complex inferences within and across texts to distinguish facts from opinions .
Integrate/interpret	Make complex inferences within and across texts.	16. Make complex inferences within and across texts to determine the importance of information within and across texts .
Critique/evaluate	Consider text(s) critically.	17. Consider text(s) critically to judge author's craft and technique.
Critique/evaluate	Consider text(s) critically.	18. Consider text(s) critically to evaluate the author's perspective or point of view within or across texts .
Critique/evaluate	Consider text(s) critically.	19. Consider text(s) critically to take different perspectives in relation to a text .
Critique/evaluate	Consider text(s) critically.	20. Consider text(s) critically to analyze the presentation of information .
Critique/evaluate	Consider text(s) critically.	21. Consider text(s) critically to evaluate the way the author selects language to influence readers .
Critique/evaluate	Consider text(s) critically.	22. Consider text(s) critically to evaluate the strength and quality of evidence used by the author to support his or her position .
Critique/evaluate	Consider text(s) critically.	23. Consider text(s) critically to determine the quality of counterarguments within and across texts.
Critique/evaluate	Consider text(s) critically.	24. Consider text(s) critically to judge the coherence, logic, or credibility of an argument .

Appendix G: NAEP Grade 8 Mathematics Objectives

Content Area	Subtopic	Objectives
Number properties and operations (including computation and understanding of number concepts)	Number Sense	1. Use place value to model and describe integers and decimals.
Number properties and operations (including computation and understanding of number concepts)	Number Sense	2. Model or describe rational numbers or numerical relationships using number lines and diagrams.
Number properties and operations (including computation and understanding of number concepts)	Number Sense	3. Write or rename rational numbers.
Number properties and operations (including computation and understanding of number concepts)	Number Sense	4. Recognize, translate or apply multiple representations of rational numbers (fractions, decimals, and percents) in meaningful contexts.
Number properties and operations (including computation and understanding of number concepts)	Number Sense	5. Express or interpret numbers using scientific notation from real-life contexts.
Number properties and operations (including computation and understanding of number concepts)	Number Sense	6. Find or model absolute value or apply to problem situations.
Number properties and operations (including computation and understanding of number concepts)	Number Sense	7. Order or compare rational numbers (fractions, decimals, percents, or integers) using various models and representations (e.g., number line).
Number properties and operations (including computation and understanding of number concepts)	Number Sense	8. Order or compare rational numbers including very large and small integers, and decimals and fractions close to zero.
Number properties and operations (including computation and understanding of number concepts)	Estimation	9. Establish or apply benchmarks for rational numbers and common irrational numbers (e.g., π) in contexts.

Content Area	Subtopic	Objectives
Number properties and operations (including computation and understanding of number concepts)	Estimation	10. Make estimates appropriate to a given situation by: Identifying when estimation is appropriate, determining the level of accuracy needed, selecting the appropriate method of estimation, or analyzing the effect of an estimation method on the accuracy of results.
Number properties and operations (including computation and understanding of number concepts)	Estimation	11. Verify solutions or determine the reasonableness of results in a variety of situations, including calculator and computer results.
Number properties and operations (including computation and understanding of number concepts)	Estimation	12. Estimate square or cube roots of numbers less than 1,000 between two whole numbers.
Number properties and operations (including computation and understanding of number concepts)	Number operations	13. Perform computations with rational numbers.
Number properties and operations (including computation and understanding of number concepts)	Number operations	14. Describe the effect of multiplying and dividing by numbers including the effect of multiplying or dividing a rational number by: zero, or a number less than zero, or a number between zero and one, one, or a number greater than one.
Number properties and operations (including computation and understanding of number concepts)	Number operations	15. Interpret rational number operations (add, subtract, multiply, and divide) and the relationships between them.
Number properties and operations (including computation and understanding of number concepts)	Number operations	16. Solve application problems involving rational numbers and operations using exact answers or estimates as appropriate.
Number properties and operations (including computation and understanding of number concepts)	Ratios and Proportional Reasoning	17. Use ratios to describe problem situations.
Number properties and operations (including computation and understanding of number concepts)	Ratios and Proportional Reasoning	18. Use fractions to represent and express ratios and proportions.

Content Area	Subtopic	Objectives
Number properties and operations (including computation and understanding of number concepts)	Ratios and Proportional Reasoning	19. Use proportional reasoning to model and solve problems (including rates and scaling).
Number properties and operations (including computation and understanding of number concepts)	Ratios and Proportional Reasoning	20. Solve problems involving percentages (including percent increase and decrease, interest rates, tax, discount, tips, or part/whole relationships).
Number properties and operations (including computation and understanding of number concepts)	Properties of number and operations	21. Describe odd and even integers and how they behave under different operations.
Number properties and operations (including computation and understanding of number concepts)	Properties of number and operations	22. Recognize, find, or use factors, multiples, or prime factorization.
Number properties and operations (including computation and understanding of number concepts)	Properties of number and operations	23. Recognize or use prime and composite numbers to solve problems.
Number properties and operations (including computation and understanding of number concepts)	Properties of number and operations	24. Use divisibility or remainders in problem settings.
Number properties and operations (including computation and understanding of number concepts)	Properties of number and operations	25. Apply basic properties of operations.
Number properties and operations (including computation and understanding of number concepts)	Mathematical reasoning and using numbers	26. Explain or justify a mathematical concept or relationship (e.g., explain why 17 is prime).
Number properties and operations (including computation and understanding of number concepts)	Mathematical reasoning and using numbers	27. Provide a mathematical argument to explain operations with two or more fractions.
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Measuring physical attributes	28. Compare objects with respect to length, area, volume, angle measurement, weight, or mass.

Content Area	Subtopic	Objectives
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Measuring physical attributes	29. Estimate the size of an object with respect to a given measurement attribute (e.g., area).
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Measuring physical attributes	30. Select or use appropriate measurement instrument to determine or create a given length, area, volume, angle, weight, or mass.
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Measuring physical attributes	31. Solve mathematical or real-world problems involving perimeter or area of plane figures such as triangles, rectangles, circles, or composite figures.
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Measuring physical attributes	32. Solve problems involving volume or surface area of rectangular solids, cylinders, prisms, or composite shapes.
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Measuring physical attributes	33. Solve problems involving rates such as speed or population density.
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Systems of measurement	34. Select or use an appropriate type of unit for the attribute being measured such as length, area, angle, time, or volume.
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Systems of measurement	35. Solve problems involving conversions within the same measurement system such as conversions involving square inches and square feet.
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Systems of measurement	36. Estimate the measure of an object in one system given the measure of that object in another system and the approximate conversion factor. For example: Distance conversion: 1 kilometer is approximately $\frac{5}{8}$ of a mile. Money conversion: U.S. dollars to Canadian dollars. Temperature conversion: Fahrenheit to Celsius.
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Systems of measurement	37. Determine appropriate size of unit of measurement in problem situation involving such attributes as length, area, or volume.
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Systems of measurement	38. Determine appropriate accuracy of measurement in problem situations (e.g., the accuracy of each of several lengths needed to obtain a specified accuracy of a total length) and find the measure to that degree of accuracy.
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Measurement in triangles	39. Solve problems involving indirect measurement such as finding the height of a building by comparing its shadow with the height and shadow of a known object.

Content Area	Subtopic	Objectives
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	40. Draw or describe a path of shortest length between points to solve problems in context.
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	41. Identify a geometric object given a written description of its properties.
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	42. Identify, define, or describe geometric shapes in the plane and in three-dimensional space given a visual representation.
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	43. Draw or sketch from a written description polygons, circles, or semicircles.
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	44. Represent or describe a three-dimensional situation in a two-dimensional drawing from different views.
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	45. Demonstrate an understanding about the two- and three-dimensional shapes in our world through identifying, drawing, modeling, building, or taking apart.
Geometry (including spatial reasoning and applying geometric properties)	Transformation of shapes and preservation of properties	46. Identify lines of symmetry in plane figures or recognize and classify types of symmetries of plane figures.
Geometry (including spatial reasoning and applying geometric properties)	Transformation of shapes and preservation of properties	47. Recognize or informally describe the effect of a transformation on two-dimensional geometric shapes (reflections across lines of symmetry, rotations, translations, magnifications, and contractions).
Geometry (including spatial reasoning and applying geometric properties)	Transformation of shapes and preservation of properties	48. Predict results of combining, subdividing, and changing shapes of plane figures and solids (e.g., paper folding, tiling, cutting up and rearranging pieces).
Geometry (including spatial reasoning and applying geometric properties)	Transformation of shapes and preservation of properties	49. Justify relationships of congruence and similarity and apply these relationships using scaling and proportional reasoning.
Geometry (including spatial reasoning and applying geometric properties)	Transformation of shapes and preservation of properties	50. For similar figures, identify and use the relationships of conservation of angle and of proportionality of side length and perimeter.
Geometry (including spatial reasoning and applying geometric properties)	Relationships between geometric figures	51. Apply geometric properties and relationships in solving simple problems in two and three dimensions.
Geometry (including spatial reasoning and applying geometric properties)	Relationships between geometric figures	52. Represent problem situations with simple geometric models to solve mathematical or real-world problems.

Content Area	Subtopic	Objectives
Geometry (including spatial reasoning and applying geometric properties)	Relationships between geometric figures	53. Use the Pythagorean theorem to solve problems.
Geometry (including spatial reasoning and applying geometric properties)	Relationships between geometric figures	54. Describe or analyze simple properties of, or relationships between, triangles, quadrilaterals, and other polygonal plane figures.
Geometry (including spatial reasoning and applying geometric properties)	Relationships between geometric figures	55. Describe or analyze properties and relationships of parallel or intersecting lines.
Geometry (including spatial reasoning and applying geometric properties)	Position, direction, and coordinate geometry	56. Describe relative positions of points and lines using the geometric ideas of midpoint, points on common line through a common point, parallelism, or perpendicularity.
Geometry (including spatial reasoning and applying geometric properties)	Position, direction, and coordinate geometry	57. Describe the intersection of two or more geometric figures in the plane (e.g., intersection of a circle and a line).
Geometry (including spatial reasoning and applying geometric properties)	Position, direction, and coordinate geometry	58. Visualize or describe the cross section of a solid.
Geometry (including spatial reasoning and applying geometric properties)	Position, direction, and coordinate geometry	59. Represent geometric figures using rectangular coordinates on a plane.
Geometry (including spatial reasoning and applying geometric properties)	Mathematical reasoning in geometry	60. Make and test a geometric conjecture about regular polygons.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.)	61. Read or interpret data, including interpolating or extrapolating from data.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.)	62. For a given set of data, complete a graph and then solve a problem using the data in the graph (histograms, line graphs, scatterplots, circle graphs, and bar graphs).
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.)	63. Solve problems by estimating and computing with data from a single set or across sets of data.

Content Area	Subtopic	Objectives
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.)	64. Given a graph or a set of data, determine whether information is represented effectively and appropriately (histograms, line graphs, scatterplots, circle graphs, and bar graphs).
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.)	65. Compare and contrast the effectiveness of different representations of the same data.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Characteristics of data sets	66. Calculate, use, or interpret mean, median, mode, or range.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Characteristics of data sets	67. Describe how mean, median, mode, range, or interquartile ranges relate to distribution shape.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Characteristics of data sets	68. Identify outliers and determine their effect on mean, median, mode, or range.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Characteristics of data sets	69. Using appropriate statistical measures, compare two or more data sets describing the same characteristic for two different populations or subsets of the same population.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Characteristics of data sets	70. Visually choose the line that best fits given a scatterplot and informally explain the meaning of the line. Use the line to make predictions.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Experiments and samples	71. Given a sample, identify possible sources of bias in sampling.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Experiments and samples	72. Distinguish between a random and nonrandom sample.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Experiments and samples	73. Evaluate the design of an experiment.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	74. Analyze a situation that involves probability of an independent event.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	75. Determine the theoretical probability of simple and compound events in familiar contexts.

Content Area	Subtopic	Objectives
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	76. Estimate the probability of simple and compound events through experimentation or simulation.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	77. Use theoretical probability to evaluate or predict experimental outcomes.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	78. Determine the sample space for a given situation.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	79. Use a sample space to determine the probability of possible outcomes for an event.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	80. Represent the probability of a given outcome using fractions, decimals, and percents.
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	81. Determine the probability of independent and dependent events. (Dependent events should be limited to a small sample size.)
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	82. Interpret probabilities within a given context.
Algebra (including representations and relationships)	Patterns, relations, and functions	83. Recognize, describe, or extend numerical and geometric patterns using tables, graphs, words, or symbols.
Algebra (including representations and relationships)	Patterns, relations, and functions	84. Generalize a pattern appearing in a numerical sequence, table, or graph using words or symbols.
Algebra (including representations and relationships)	Patterns, relations, and functions	85. Analyze or create patterns, sequences, or linear functions given a rule.
Algebra (including representations and relationships)	Patterns, relations, and functions	86. Identify functions as linear or nonlinear or contrast distinguishing properties of functions from tables, graphs, or equations.
Algebra (including representations and relationships)	Patterns, relations, and functions	87. Interpret the meaning of slope or intercepts in linear functions.
Algebra (including representations and relationships)	Algebraic representations	88. Translate between different representations of linear expressions using symbols, graphs, tables, diagrams, or written descriptions.
Algebra (including representations and relationships)	Algebraic representations	89. Analyze or interpret linear relationships expressed in symbols, graphs, tables, diagrams, or written descriptions.
Algebra (including representations and relationships)	Algebraic representations	90. Graph or interpret points represented by ordered pairs of numbers on a rectangular coordinate system.

Content Area	Subtopic	Objectives
Algebra (including representations and relationships)	Algebraic representations	91. Solve problems involving coordinate pairs on the rectangular coordinate system.
Algebra (including representations and relationships)	Algebraic representations	92. Identify or represent functional relationships in meaningful contexts including proportional, linear, and common nonlinear (e.g., compound interest, bacterial growth) in tables, graphs, words, or symbols.
Algebra (including representations and relationships)	Variables, expressions, and operations	93. Write algebraic expressions, equations, or inequalities to represent a situation.
Algebra (including representations and relationships)	Variables, expressions, and operations	94. Perform basic operations, using appropriate tools, on linear algebraic expressions (including grouping and order of multiple operations involving basic operations, exponents, roots, simplifying, and expanding).
Algebra (including representations and relationships)	Equations and inequalities	95. Solve linear equations or inequalities (e.g., $ax + b = c$ or $ax + b = cx + d$ or $ax + b > c$).
Algebra (including representations and relationships)	Equations and inequalities	96. Interpret “=” as an equivalence between two expressions and use this interpretation to solve problems.
Algebra (including representations and relationships)	Equations and inequalities	97. Analyze situations or solve problems using linear equations and inequalities with rational coefficients symbolically or graphically (e.g., $ax + b = c$ or $ax + b = cx + d$).
Algebra (including representations and relationships)	Equations and inequalities	98. Interpret relationships between symbolic linear expressions and graphs of lines by identifying and computing slope and intercepts (e.g., know in $y = ax + b$, that a is the rate of change and b is the vertical intercept of the graph).
Algebra (including representations and relationships)	Equations and inequalities	99. Use and evaluate common formulas (e.g., relationship between a circle’s circumference and diameter [$C = \pi d$], distance and time under constant speed).
Algebra (including representations and relationships)	Mathematical reasoning and algebra	100. Make, validate, and justify conclusions and generalizations about linear relationships.

Appendix H: NAEP Grade 12 Mathematics Objectives

Content Area	Subtopic	Objectives
Number properties and operations	Number Sense	1. Represent, interpret, or compare expressions for real numbers, including expressions using exponents and logarithms.
Number properties and operations	Number Sense	2. Represent or interpret expressions involving very large or very small numbers in scientific notation.
Number properties and operations	Number Sense	3. Represent, interpret, or compare expressions or problem situations involving absolute values.
Number properties and operations	Number Sense	4. Order or compare real numbers, including very large and very small real numbers.
Number properties and operations	Estimation	5. Identify situations where estimation is appropriate, determine the needed degree of accuracy, and analyze the effect of the estimation method on the accuracy of results.
Number properties and operations	Estimation	6. Verify solutions or determine the reasonableness of results in a variety of situations.
Number properties and operations	Estimation	7. Estimate square or cube roots of numbers less than 1,000 between two whole numbers.
Number properties and operations	Number operations	8. Find integral or simple fractional powers of real numbers.
Number properties and operations	Number operations	9. Perform arithmetic operations with real numbers, including common irrational numbers.
Number properties and operations	Number operations	10. Perform arithmetic operations with expressions involving absolute value.
Number properties and operations	Number operations	11. Describe the effect of multiplying and dividing by numbers including the effect of multiplying or dividing a real number by: Zero, or a number less than zero, or a number between zero and one, or one, or a number greater than one.
Number properties and operations	Number operations	12. Solve application problems involving numbers, including rational and common irrationals.
Number properties and operations	Ratios and proportional reasoning	13. Use proportions to solve problems (including rates of change).
Number properties and operations	Ratios and proportional reasoning	14. Solve multistep problems involving percentages, including compound percentages.
Number properties and operations	Properties of numbers and operations	15. Solve problems using factors, multiples, or prime factorization.
Number properties and operations	Properties of numbers and operations	16. Use divisibility or remainders in problem settings.
Number properties and operations	Properties of numbers and operations	17. Apply basic properties of operations, including conventions about the order of operations.

Content Area	Subtopic	Objectives
Number properties and operations	Properties of numbers and operations	18. Recognize properties of the number system (whole numbers, integers, rational numbers, real numbers, and complex numbers) and how they are related to each other, and identify examples of each type of number.
Number properties and operations	Mathematical reasoning using numbers	19. Give a mathematical argument to establish the validity of a simple numerical property or relationship.
Number properties and operations	Mathematical reasoning using numbers	20. Analyze or interpret a proof by mathematical induction of a simple numerical relationship.
Measurement	Measuring physical attributes	21. Determine the effect of proportions and scaling on length, area, and volume.
Measurement	Measuring physical attributes	22. Estimate or compare perimeters or areas of two-dimensional geometric figures.
Measurement	Measuring physical attributes	23. Solve problems of angle measure, including those involving triangles or other polygons or parallel lines cut by a transversal.
Measurement	Measuring physical attributes	24. Solve problems involving perimeter or area of plane figures such as polygons, circles, or composite figures.
Measurement	Measuring physical attributes	25. Solve problems by determining, estimating, or comparing volumes or surface areas of three-dimensional figures.
Measurement	Measuring physical attributes	26. Solve problems involving rates such as speed, density, population density, or flow rates.
Measurement	Systems of measurement	27. Recognize that geometric measurements (length, area, perimeter, and volume) depend on the choice of a unit, and apply such units in expressions, equations, and problem solutions.
Measurement	Systems of measurement	28. Solve problems involving conversions within or between measurement systems, given the relationship between the units.
Measurement	Systems of measurement	29. Understand that numerical values associated with measurements of physical quantities are approximate, are subject to variation, and must be assigned units of measurement.
Measurement	Systems of measurement	30. Determine appropriate accuracy of measurement in problem situations (e.g., the accuracy of measurement of the dimensions to obtain a specified accuracy of area) and find the measure to that degree of accuracy.
Measurement	Systems of measurement	31. Construct or solve problems involving scale drawings.
Measurement	Measurement in triangles	32. Solve problems involving indirect measurement.
Measurement	Measurement in triangles	33. Solve problems using the fact that trigonometric ratios (sine, cosine, and tangent) stay constant in similar triangles.

Content Area	Subtopic	Objectives
Measurement	Measurement in triangles	34. Use the definitions of sine, cosine, and tangent as ratios of sides in a right triangle to solve problems about length of sides and measure of angles.
Measurement	Measurement in triangles	35. Interpret and use the identity $\sin^2 q + \cos^2 q = 1$ for angles q between 0° and 90° ; recognize this identity as a special representation of the Pythagorean theorem.
Measurement	Measurement in triangles	36. Determine the radian measure of an angle and explain how radian measurement is related to a circle of radius 1.
Measurement	Measurement in triangles	37. Use trigonometric formulas such as addition and double angle formulas.
Measurement	Measurement in triangles	38. Use the law of cosines and the law of sines to find unknown sides and angles of a triangle.
Geometry	Dimension and shape	39. Give precise mathematical descriptions or definitions of geometric shapes in the plane and in three-dimensional space.
Geometry	Dimension and shape	40. Draw or sketch from a written description plane figures and planar images of three-dimensional figures.
Geometry	Dimension and shape	41. Use two-dimensional representations of three-dimensional objects to visualize and solve problems.
Geometry	Dimension and shape	42. Analyze properties of three-dimensional figures including spheres and hemispheres.
Geometry	Transformation of shapes and preservation of properties	43. Recognize or identify types of symmetries (e.g., point, line, rotational, self-congruence) of two- and three-dimensional figures.
Geometry	Transformation of shapes and preservation of properties	44. Give or recognize the precise mathematical relationship (e.g., congruence, similarity, orientation) between a figure and its image under a transformation.
Geometry	Transformation of shapes and preservation of properties	45. Perform or describe the effect of a single transformation on two- and three-dimensional geometric shapes (reflections across lines of symmetry, rotations, translations, and dilations).
Geometry	Transformation of shapes and preservation of properties	46. Identify transformations, combinations, or subdivisions of shapes that preserve the area of two-dimensional figures or the volume of three-dimensional figures.
Geometry	Transformation of shapes and preservation of properties	47. Justify relationships of congruence and similarity and apply these relationships using scaling and proportional reasoning.
Geometry	Transformation of shapes and preservation of properties	48. Perform or describe the effects of successive transformations.

Content Area	Subtopic	Objectives
Geometry	Relationships between geometric figures	49. Apply geometric properties and relationships to solve problems in two and three dimensions.
Geometry	Relationships between geometric figures	50. Represent problem situations with geometric models to solve mathematical or real-world problems.
Geometry	Relationships between geometric figures	51. Use the Pythagorean theorem to solve problems in two- or three-dimensional situations.
Geometry	Relationships between geometric figures	52. Recall and interpret definitions and basic properties of congruent and similar triangles, circles, quadrilaterals, polygons, parallel, perpendicular and intersecting lines, and associated angle relationships.
Geometry	Relationships between geometric figures	53. Analyze properties or relationships of triangles, quadrilaterals, and other polygonal plane figures.
Geometry	Relationships between geometric figures	54. Analyze properties and relationships of parallel, perpendicular, or intersecting lines including the angle relationships that arise in these cases.
Geometry	Relationships between geometric figures	55. Analyze properties of circles and the intersections of lines and circles (inscribed angles, central angles, tangents, secants, and chords).
Geometry	Position, direction, and coordinate geometry	56. Solve problems involving the coordinate plane such as the distance between two points, the midpoint of a segment, or slopes of perpendicular or parallel lines.
Geometry	Position, direction, and coordinate geometry	57. Describe the intersections of lines in the plane and in space, intersections of a line and a plane, or of two planes in space.
Geometry	Position, direction, and coordinate geometry	58. Describe or identify conic sections and other cross sections of solids.
Geometry	Position, direction, and coordinate geometry	59. Represent two-dimensional figures algebraically using coordinates and/or equations.
Geometry	Position, direction, and coordinate geometry	60. Use vectors to represent velocity and direction; multiply a vector by a scalar and add vectors both algebraically and graphically.
Geometry	Position, direction, and coordinate geometry	61. Find an equation of a circle given its center and radius and, given an equation of a circle, find its center and radius.
Geometry	Position, direction, and coordinate geometry	62. Graph ellipses and hyperbolas whose axes are parallel to the coordinate axes and demonstrate understanding of the relationship between their standard algebraic form and their graphical characteristics.
Geometry	Position, direction, and coordinate geometry	63. Represent situations and solve problems involving polar coordinates.
Geometry	Mathematical reasoning in geometry	64. Make, test, and validate geometric conjectures using a variety of methods including deductive reasoning and counterexamples.

Content Area	Subtopic	Objectives
Geometry	Mathematical reasoning in geometry	65. Determine the role of hypotheses, logical implications, and conclusion in proofs of geometric theorems.
Geometry	Mathematical reasoning in geometry	66. Analyze or explain a geometric argument by contradiction.
Geometry	Mathematical reasoning in geometry	67. Analyze or explain a geometric proof of the Pythagorean theorem.
Geometry	Mathematical reasoning in geometry	68. Prove basic theorems about congruent and similar triangles and circles.
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	69. Read or interpret graphical or tabular representations of data.
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	70. For a given set of data, complete a graph and solve a problem using the data in the graph (histograms, scatterplots, and line graphs).
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	71. Solve problems involving univariate or bivariate data.
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	72. Given a graphical or tabular representation of a set of data, determine whether information is represented effectively and appropriately.
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	73. Compare and contrast different graphical representations of univariate and bivariate data.
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	74. Organize and display data in a spreadsheet in order to recognize patterns and solve problems.

Content Area	Subtopic	Objectives
Data analysis, statistics, and probability	Characteristics of data	75. Calculate, interpret, or use summary statistics for distributions of data including measures of typical value (mean, median), position (quartiles, percentiles), and spread (range, interquartile range, variance, and standard deviation).
Data analysis, statistics, and probability	Characteristics of data	76. Recognize how linear transformations of one-variable data affect mean, median, mode, range, interquartile range, and standard deviation.
Data analysis, statistics, and probability	Characteristics of data	77. Determine the effect of outliers on mean, median, mode, range, interquartile range, or standard deviation.
Data analysis, statistics, and probability	Characteristics of data	78. Compare data sets using summary statistics (mean, median, mode, range, interquartile range, or standard deviation) describing the same characteristic for two different populations or subsets of the same population.
Data analysis, statistics, and probability	Characteristics of data	79. Approximate a trend line if a linear pattern is apparent in a scatterplot or use a graphing calculator to determine a least-squares regression line and use the line or equation to make predictions.
Data analysis, statistics, and probability	Characteristics of data	80. Recognize that the correlation coefficient is a number from -1 to $+1$ that measures the strength of the linear relationship between two variables; visually estimate the correlation coefficient (e.g., positive or negative, closer to 0, .5, or 1.0) of a scatterplot.
Data analysis, statistics, and probability	Characteristics of data	81. Know and interpret the key characteristics of a normal distribution such as shape, center (mean), and spread (standard deviation).
Data analysis, statistics, and probability	Experiments and samples	82. Identify possible sources of bias in sample surveys and describe how such bias can be controlled and reduced.
Data analysis, statistics, and probability	Experiments and samples	83. Recognize and describe a method to select a simple random sample.
Data analysis, statistics, and probability	Experiments and samples	84. Draw inferences from samples, such as estimates of proportions in a population, estimates of population means, or decisions about differences in means for two “treatments.”
Data analysis, statistics, and probability	Experiments and samples	85. Identify or evaluate the characteristics of a good survey or of a well-designed experiment.
Data analysis, statistics, and probability	Experiments and samples	86. Recognize the differences in design and in conclusions between randomized experiments and observational studies.

Content Area	Subtopic	Objectives
Data analysis, statistics, and probability	Probability	87. Recognize whether two events are independent or dependent.
Data analysis, statistics, and probability	Probability	88. Determine the theoretical probability of simple and compound events in familiar or unfamiliar contexts.
Data analysis, statistics, and probability	Probability	89. Given the results of an experiment or simulation, estimate the probability of simple or compound events in familiar or unfamiliar contexts.
Data analysis, statistics, and probability	Probability	90. Use theoretical probability to evaluate or predict experimental outcomes.
Data analysis, statistics, and probability	Probability	91. Determine the number of ways an event can occur using tree diagrams, formulas for combinations and permutations, or other counting techniques.
Data analysis, statistics, and probability	Probability	92. Determine the probability of independent and dependent events.
Data analysis, statistics, and probability	Probability	93. Determine conditional probability using two-way tables.
Data analysis, statistics, and probability	Probability	94. Interpret and apply probability concepts to practical situations.
Data analysis, statistics, and probability	Probability	95. Use the binomial theorem to solve problems.
Data analysis, statistics, and probability	Mathematical reasoning with data	96. Identify misleading uses of data in real-world settings and critique different ways of presenting and using information.
Data analysis, statistics, and probability	Mathematical reasoning with data	97. Distinguish relevant from irrelevant information, identify missing information, and either find what is needed or make appropriate approximations.
Data analysis, statistics, and probability	Mathematical reasoning with data	98. Recognize, use, and distinguish between the processes of mathematical (deterministic) and statistical modeling.
Data analysis, statistics, and probability	Mathematical reasoning with data	99. Recognize when arguments based on data confuse correlation with causation.
Data analysis, statistics, and probability	Mathematical reasoning with data	100. Recognize and explain the potential errors caused by extrapolating from data.

Content Area	Subtopic	Objectives
Algebra	Patterns, relations, and functions	101. Recognize, describe, or extend numerical patterns, including arithmetic and geometric progressions.
Algebra	Patterns, relations, and functions	102. Express linear and exponential functions in recursive and explicit form given a table, verbal description, or some terms of a sequence.
Algebra	Patterns, relations, and functions	103. Identify or analyze distinguishing properties of linear, quadratic, rational, exponential, or trigonometric functions from tables, graphs, or equations.
Algebra	Patterns, relations, and functions	104. Determine whether a relation, given in verbal, symbolic, tabular, or graphical form, is a function.
Algebra	Patterns, relations, and functions	105. Recognize and analyze the general forms of linear, quadratic, rational, exponential, or trigonometric functions.
Algebra	Patterns, relations, and functions	106. Determine the domain and range of functions given in various forms and contexts.
Algebra	Patterns, relations, and functions	107. Given a function, determine its inverse if it exists and explain the contextual meaning of the inverse for a given situation.
Algebra	Algebraic representations	108. Create and translate between different representations of algebraic expressions, equations, and inequalities (e.g., linear, quadratic, exponential, or trigonometric) using symbols, graphs, tables, diagrams, or written descriptions.
Algebra	Algebraic representations	109. Analyze or interpret relationships expressed in symbols, graphs, tables, diagrams (including Venn diagrams), or written descriptions and evaluate the relative advantages or disadvantages of different representations to answer specific questions.
Algebra	Algebraic representations	110. Perform or interpret transformations on the graphs of linear, quadratic, exponential, and trigonometric functions.
Algebra	Algebraic representations	111. Make inferences or predictions using an algebraic model of a situation.
Algebra	Algebraic representations	112. Given a real-world situation, determine if a linear, quadratic, rational, exponential, logarithmic, or trigonometric function fits the situation.
Algebra	Algebraic representations	113. Solve problems involving exponential growth and decay.
Algebra	Algebraic representations	114. Analyze properties of exponential, logarithmic, and rational functions.
Algebra	Variables, expressions, and operations	115. Write algebraic expressions, equations, or inequalities to represent a situation.

Content Area	Subtopic	Objectives
Algebra	Variables, expressions, and operations	116. Perform basic operations, using appropriate tools, on algebraic expressions including polynomial and rational expressions.
Algebra	Variables, expressions, and operations	117. Write equivalent forms of algebraic expressions, equations, or inequalities to represent and explain mathematical relationships.
Algebra	Variables, expressions, and operations	118. Evaluate algebraic expressions including polynomials and rational expressions.
Algebra	Variables, expressions, and operations	119. Use function notation to evaluate a function at a specified point in its domain and combine functions by addition, subtraction, multiplication, division, and composition.
Algebra	Variables, expressions, and operations	120. Determine the sum of finite and infinite arithmetic and geometric series.
Algebra	Variables, expressions, and operations	121. Use basic properties of exponents and logarithms to solve problems.
Algebra	Equations and inequalities	122. Solve linear, rational, or quadratic equations or inequalities, including those involving absolute value.
Algebra	Equations and inequalities	123. Analyze situations, develop mathematical models, or solve problems using linear, quadratic, exponential, or logarithmic equations or inequalities symbolically or graphically.
Algebra	Equations and inequalities	124. Solve (symbolically or graphically) a system of equations or inequalities and recognize the relationship between the analytical solution and graphical solution.
Algebra	Equations and inequalities	125. Solve problems involving special formulas such as: $A = P(I + r)t$ or $A = Pert$.
Algebra	Equations and inequalities	126. Solve an equation or formula involving several variables for one variable in terms of the others.
Algebra	Equations and inequalities	127. Solve quadratic equations with complex roots.
Algebra	Mathematical reasoning in algebra	128. Use algebraic properties to develop a valid mathematical argument.
Algebra	Mathematical reasoning in algebra	129. Determine the role of hypotheses, logical implications, and conclusions in algebraic argument.
Algebra	Mathematical reasoning in algebra	130. Explain the use of relational conjunctions (and, or) in algebraic arguments.

Appendix I:

Instructions and Guidelines for Making Linkage Ratings between NAEP Objectives and Training Performance Requirements

Purpose: The purpose of this activity is to identify which NAEP content (i.e., “objectives”) on the NAEP reading and mathematics assessments (grade 8 and grade 12) are relevant to the training performance requirements for this occupation.

Please carefully read *all* the instructions and guidelines contained within this document *before* you begin Step 1. **Pay particularly close attention to the Guidelines on page 2 of this document prior to beginning your ratings.**

Steps:

Step 1: Open the document labeled, “Task List.” Carefully read the job description and then read each task contained in this document. As you read over each task, think about whether you need to use reading and/or mathematics to effectively perform the task.

Step 2: Open the Excel spreadsheet. Save the worksheet (using “Save As” under the file menu) with your initials at the end of the document label (e.g., “objectives and tasks_als”). Be sure to save the document periodically during the course of working on it.

Step 3: There are three worksheets contained within the Excel spreadsheet: one labeled reading (*the reading assessments for grade 8 and grade 12 have identical objectives; consequently, there is only one worksheet for reading*); one for grade 8 mathematics; and one for grade 12 mathematics (see the lower left-hand corner of the document to locate the tab for each worksheet). **Start with the reading worksheet.** Orient yourself to the worksheet. Notice that the NAEP content is listed in rows and the training performance requirements (“tasks”) are listed in columns. For reading, there are three “types” of NAEP content. First, is the “Cognitive Target,” next is the “Standard,” and last is the “Objective.” Each is at a successively finer-grain level of detail such that the cognitive target is at the broadest level and the objective is at the most specific level. You will make your ratings at the level of the objective (i.e., at the most specific level of NAEP content).

Step 4: Ensure that your cursor is in the ‘D2’ cell in the worksheet (i.e., the cell that represents the intersection between the first objective on the list, which is in cell C2, and the first task on the list, which is in cell D1). First, read the cognitive target in row 2. Then, read the standard. Finally, read the objective. Reading the cognitive target and the standard first will give you the broader context within which the objective is located. Once you have read the objective, read the first task. Ask yourself, “Is this particular objective (skill) relevant to the performance of this task? **If the answer is “yes,” then enter a ‘y’ in the cell. If the answer is “no,” then leave the cell blank.** Note that if the objective uses the word “or” (for example, “Write *or* rename rational numbers.”), then if either is relevant to the task enter a ‘y’ in the cell. However, if the objective uses the word “and” (for example, “Make *and* test a geometric conjecture about regular polygons.”), then both ‘making’ and ‘testing’ must be relevant to the task in order to enter a ‘y’ in the cell. Once you have made the rating for the first objective and task #1, go on to task #2, and do the same thing. Do this until you have reached the last task in the worksheet so that you have answered the question, “is objective #1 relevant to performing this task?” for all of the tasks.

Step 5: Next, locate the second objective in the worksheet (in cell C3). Repeat Step 4 for objective #2 such that for objective #2 you'll have answered the question, "Is objective #2 relevant to the performance of this task?" for all tasks. Repeat this same process (i.e., rating each objective by each task) until you reach the last objective and last task in the worksheet.

Step 6: Once you have completed all ratings in the reading worksheet. Move to the "G8 Math" worksheet. The mathematics worksheets have the same structure as the reading worksheet. The only difference in mathematics is that the NAEP content is titled slightly differently (rather than "cognitive targets" and "standards" there are "content areas" and "subtopics"). Repeat Step 4 and Step 5 for grade 8 mathematics.

Step 7: Once you have completed grade 8 mathematics, move to the worksheet labeled, "G12 Math" and complete the same process for grade 12 Mathematics.

Step 8: Once you have completed all the ratings for all the objectives and tasks within each of the three worksheets ensure that you have saved your work, and email the file to the project director.

Step 9: In the email, please indicate if you felt there were important training performance requirements that require NAEP reading and/or mathematic objectives that were NOT captured on the task list.

Guidelines for Making Ratings:

- Do not spend too much time on any one rating. If there is not a clear connection between the objective and the task in question, then leave the cell blank and go to the next task.
- For some of the objectives, you'll notice that they appear in blue, underlined text. If you see an objective with blue, underlined text that means that the term(s) has been linked to a pop-up box that will define the key term(s) within the objective. Some of the NAEP objectives contain terminology that may not be familiar, or that possibly has not been used since high school (particularly for some of the mathematics terms). Consequently, we have inserted pop-up definitions for those kinds of terms (e.g., integers, factors, rational numbers, etc.). Note that these terms are defined in their first appearance within an objective, but not every time the term is used in an objective. Also note that some terms reflect complex mathematical concepts that cannot easily be defined or described within the confines of a pop-up box. Consequently, it was not feasible to define all terminology contained within the NAEP objectives. If you feel reasonably confident that, "finding the sum of infinite geometric series," for example, is something that might be relevant to a particular task, but before you can be certain you need to "brush up" on your knowledge of infinite geometric series, then you are encouraged to consult additional resources in order to help you make that determination.

Appendix J: List of O*NET KSAs for Inclusion

O*NET Descriptor	Description	Clarification of Description (if available)
1. Written Comprehension	The ability to read and understand information and ideas presented in writing.	Ideas presented in writing can include text, data, charts, graphs, and figures.
2. Written Expression	The ability to communicate information and ideas in writing so others will understand.	
3. Fluency of Ideas	The ability to come up with a number of ideas about a topic (the number of ideas is important, not their quality, correctness, or creativity).	
4. Originality	The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem.	
5. Problem Sensitivity	The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.	
6. Deductive Reasoning	The ability to apply general rules to specific problems to produce answers that make sense.	
7. Inductive Reasoning	The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).	
8. Information Ordering	The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).	
9. Category Flexibility	The ability to generate or use different sets of rules for combining or grouping things in different ways.	
10. Mathematical Reasoning ^a	The ability to choose the right mathematical methods or formulas to solve a problem.	
11. Number Facility ^a	The ability to add, subtract, multiply, or divide quickly and correctly.	

O*NET Descriptor	Description	Clarification of Description (if available)
12. Memorization	The ability to remember information such as words, numbers, pictures, and procedures.	The Level of Memorization required increases as the amount and complexity of information that is memorized increases. Consideration should be given to the amount of material that needs to be memorized and the time allotted to memorize that material (e.g., a lot of material and a short time to memorize, a lot of material and a long time to memorize, a small amount of material and a long time to memorize). Memorization does not cover general 'knowledge' of specific topic area.
13. Speed of Closure	The ability to quickly make sense of, combine, and organize information into meaningful patterns.	This involves forming patterns from various individual pieces of information that can vary in complexity. The key is the speed with which the information is organized and interpreted, e.g., a doctor might quickly organize physical symptoms into a category that fits with a particular illness.
14. Flexibility of Closure	The ability to identify or detect a known pattern (a figure, object, word, or sound) that is hidden in other distracting material.	This involves identifying a pattern that is masked or surrounded by other distracting information (i.e., there needs to be distracting material or something that "hides" the known pattern you must identify). The pattern may be one piece of information (i.e., a needle in a haystack) or several pieces of information (e.g., an announcement made over the loud speaker in a noisy department store, finding a word in a letter puzzle or intermingled with other distracting material). You should <u>not</u> consider the known pattern to be an error you must locate within a computer program or the conductor identifying a note played incorrectly by an orchestra member. This does not have to be done with speed.

O*NET Descriptor	Description	Clarification of Description (if available)
15. Visualization	The ability to imagine how something will look after it is moved around or when its parts are moved or rearranged.	Creating a mental image of how something will look after it has been rearranged or altered; more visualization would be required when the availability and accuracy of models or examples of the object is decreased and the complexity or number of reformations that must take place to get the object into its final state increases. The object moved around or rearranged needs to involve a physical object (not an abstract concept like an organizational structure after a reorganization).
16. Critical Thinking	Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.	
17. Active Learning	Understanding the implications of new information for both current and future problem-solving and decision-making.	
18. Complex Problem Solving	Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.	
19. Operations Analysis	Analyzing needs and product requirements to create a design.	Use broad interpretation of “design” (e.g., writing a Request for Proposal) and “product requirement” (e.g., services provided, methodologies, policies). This construct should not be exclusive to technology (e.g., include a gap analysis to design a training program). Do not have to create something new; may improve an existing design. Ensure that both parts of the definition are considered; do not rate based on the analyzing part of the definition alone. The analysis should lead to the creation of a design.
20. Quality Control Analysis	Conducting tests and inspections of products, services, or processes to evaluate quality or performance.	Monitoring, proofing, checking, and evaluating products, services or processes (e.g., food, computer systems, legal documents). The Level increases as the products, services, or processes become more thorough and complex. A low level of this skill involves proofing/editing written text for error and should not be considered primary to this skill.

O*NET Descriptor	Description	Clarification of Description (if available)
21. Judgment and Decision Making	Considering the relative costs and benefits of potential actions to choose the most appropriate one.	
22. Systems Analysis	Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.	A system contains interconnected parts where a change in one part (or element) affects other parts of the 'whole' or system. Two parts (or more) may make up a system.
23. 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.	This involves looking at the functionality of small pieces of a large process to evaluate the effectiveness of the entire system. Also, identifying ways to improve system performance based on evaluation results.
24. Mathematics ^a	Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.	A higher Level of math is required when the basic operations (count, add, subtract, multiply, and divide) are combined and used in a more complex manner (e.g., a mathematical model). Also, a person must know at least some math to perform basic operations on a calculator.
25. English Language	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.	

Note.^a These elements were expected to be relevant to the NAEP mathematics assessments, not the NAEP reading assessments.

Appendix K: Detailed Steps for Making KSA Ratings

Ratings on O*NET Elements for Linked NAEP Content and Job Training Content

The materials you will need for this activity are:

- Job Information Document
- Excel Rating Spreadsheets
- NAEP Frameworks (reading and mathematics)
- Linkages between NAEP and Job Training
- NAEP items (secure material)

Steps for Reading

1. Review the occupation. Before you begin making any ratings, open the document labeled “Job Information.” Review the occupation title, job description, generalized work activities, work context, and job zone to get a full picture of the occupation.

Clarification: This job information is to provide general background information on the occupation-- that is, to help get your "head into it." The ratings on the O*NET elements should be based on the set of training performance requirements (“tasks”) that are relevant to the particular NAEP assessment in question (as described in Step 7). The Job Information document may provide some insight to the training tasks, but ratings are to be based on the training tasks. Also, if any additional insight is obtained on the tasks (e.g., from job experts and/or internet search), then that information also factors into the ONET ratings.

2. Next, open the Excel rating form for your assigned occupation. **Save the Excel spreadsheet with your initials at the end and your assigned rater number (e.g., “Rating Sheet_ONetToNAEP_as1”).** Familiarize yourself with the form. Carefully, read each of the ONET element titles, their definitions, clarifications of the definition (if one is provided), and the Level scale anchors for each element. This will help you understand the construct and what behaviors are like that require only a little or a lot of the particular O*NET element.

3. Next, familiarize yourself with the NAEP reading assessment framework. Read through relevant sections of the NAEP 2013 reading framework (*We are focusing on Informational Text only; disregard Literary Text. We are also focusing on grade 8 and 12 only; disregard grade 4*).

4. Once you have familiarized yourself with the NAEP reading framework, open the Excel spreadsheet “Reading linkages” (for the job assigned to you) and find the worksheet labeled, “Rd obj linked to tasks.” Use this document to locate the NAEP reading objectives¹⁶ that are relevant to the tasks for this occupation. Carefully read through each of the linked reading objectives to gain an understanding of the objectives relevant to the occupation.

5. Once you have familiarized yourself with the relevant reading objectives and the Cognitive Targets to which they belong, open the pdf document containing the operational items for the NAEP grade 8 reading assessment (“2013READG8_OP_Items_20131029”). **This is secure material and should be treated as such.** Familiarize yourself with the item information at the front of this document. Once you have familiarized yourself with the item information, **review the items for the relevant Cognitive Targets (i.e., the ones that are “linked” in your linkage worksheet from Step 4).** Review this set of items in

¹⁶ Note that the NAEP reading objectives are the same for Grade 8 and Grade 12. Consequently, there is only one set of tasks linked to the reading objectives. Even though the Reading objectives are the same for the Grade 8 and Grade 12 assessments, there are differences in the items on the assessments. The Grade 12 items are at a more advanced level than the Grade 8 items.

conjunction with the linked *Reading Objectives*; this will help you “key in” to the items that are most closely aligned to the linked Reading Objectives. When reviewing this subset of items, pay particularly close attention to the cognitive target, achievement level and item type. Once you have reviewed the items, you are ready to return to the Excel rating spreadsheet to begin making ratings.

6. In the Excel rating spreadsheet, make the level ratings for each O*NET element for NAEP grade 8 reading (Column D). The question you will ask yourself is, “What level of this ONET element is needed to be proficient on this set of NAEP items?” Collectively consider the linked Cognitive Targets, Reading Objectives *and* the operational items. Be sure to refer to the operationalization of “Proficient” for grade 8 reading in Appendix B (p. 65) of the NAEP reading framework when making these ratings. (*Make ratings on all O*NET elements in Column D before going on to the next step*)

7. Next, make O*NET element ratings for the tasks linked to NAEP reading (Column E). The question you will ask yourself is, “What level of this ONET element is needed to qualify for placement into a job training program where trainees are prepared to perform this set of tasks? (*Make ratings on all O*NET elements in Column E before going on to the next step*).

When rating the level of an O*NET element needed for entry into job training, do NOT make ratings based on the average level of the O*NET element needed across all the tasks. Rather, make the rating based on the maximum amount of the O*NET element needed to be qualified for placement into job training (i.e., think of it as, ‘the trainee must have at least this much of the KSA to qualify for training’). Also, if you obtained additional insight on the job (e.g., from job expert, internet) that you used to help inform your ratings, then post that information here:

S:\Projects\NAGB_Job Preparedness Framework Eval\ONET Linkage Task_T3\Job Information\Additional job info obtained by raters

Then, send an email to your fellow raters (i.e., raters who’ve been assigned to the same occupation) to let them know new job training information is available. This will help to ensure that raters are making ratings from a common set of information.

8. Repeat this same process for NAEP grade 12 reading. For grade 12 reading, be sure to use the grade 12 definition of proficient (see p. 66 of the reading framework document). (Note that there is only one set of tasks to rate for NAEP reading—this is because NAEP Reading Objectives are the same for grade 8 and grade 12; this is not the case for the NAEP mathematics assessments for which there are separate objectives for grades 8 and 12.)

Steps for Mathematics

(note that Steps 1 and Steps 2 are exactly the same as for reading)

1. Review the occupation. Before you begin making any ratings, open the document labeled “Job Information.” Review the occupation title, job definition, generalized work activities, work context, and job zone to get a full picture of the occupation.
2. Next, open the Excel rating form for your assigned occupation. Familiarize yourself with the form. Carefully, read each of the ONET element titles, their definitions, clarifications of the definition (if one is provided), and the Level scale anchors for each element. This will help you understand the construct and what behaviors are like that require only a little or a lot of the particular O*NET element.
3. Next, familiarize yourself with the NAEP mathematics assessment framework (in project folder). *We are focusing on grade 8 and 12 only; disregard grade 4.*
4. Once you have familiarized yourself with the NAEP mathematics framework, open the Excel spreadsheet “G8MA linkages” (for the job assigned to you) and find the worksheet labeled, “G8MA obj linked to tasks.” Use this document to identify the NAEP grade 8 mathematics objectives that are relevant to the job training tasks for this occupation. Carefully read through each of the linked mathematics objectives to gain an understanding of the objectives relevant to the occupation.
5. Once you have identified the relevant grade 8 mathematics objectives, open the pdf document containing the operational items for the NAEP grade 8 mathematics assessment (“2013MATG8_OP_Items_20131029”). **This is secure material and should be treated as such.** Familiarize yourself with the item information in this document. Once you have familiarized yourself with the item information, **review the items for the relevant objectives¹⁷ ONLY.** When reviewing this subset of items, pay particularly close attention to objective, complexity level, achievement level, and item type. Once you have reviewed the items, you are ready to return to the Excel rating spreadsheet to begin making ratings.
6. In the Excel rating spreadsheet, make the level ratings for each O*NET element for NAEP grade 8 mathematics (Column G). The question you will ask yourself is, “What level of this ONET element is needed to be proficient on this set of NAEP items?” Collectively consider the linked Cognitive Targets, math objectives *and* the operational items. Be sure to refer to the operationalization of “Proficient” in Appendix A (p. 72) of the NAEP mathematics framework when making these ratings. *(Make ratings on all O*NET elements in Column G before going on to the next step)*
7. Next, make O*NET element ratings for the tasks linked to NAEP grade 8 mathematics (Column H). The question you will ask yourself is, “What level of this ONET element is needed to qualify for placement into a job training program where trainees are prepared to perform this set of tasks?” *(Make ratings on all O*NET elements in Column H before going on to the next step)*

When rating the level of an O*NET element needed for entry into job training, do NOT make ratings based on the average level of the O*NET element needed across all the tasks. Rather, make the rating based on the maximum amount of the O*NET element needed to be qualified for placement into job training.

Also, if you obtained additional insight on the job (e.g., from job expert, internet) that you used to help inform your ratings, then post that information here:

S:\Projects\NAGB_Job Preparedness Framework Eval\ONET Linkage Task_T3\Job Information\Additional job info obtained by raters

¹⁷ Unlike with Reading, the Math items are identified by objective.

Then, send an email to your fellow raters (i.e., raters who've been assigned to the same occupation) to let them know new job training information is available. This will help to ensure that raters are making ratings from a common set of information.

8. Repeat this same process for NAEP grade 12 mathematics. (Note that, unlike with reading, there are two sets of tasks to rate for NAEP mathematics—this is because there are different NAEP math objectives for grade 8 and grade 12 (although there is overlap in objectives—see Exhibits 3 -7 in mathematics framework document). In most cases, the tasks linked to grade 8 mathematics and grade 12 mathematics are very similar, if not the same. If the linked tasks are the same for grade 8 and grade 12, then the ratings on the O*NET elements for the tasks (Column H and Column J) should also be the same. However, if there are differences in the linked tasks for grade 8 and grade 12, then you should adjust your O*NET ratings accordingly. For grade 12, be sure to use the grade 12 definition of proficient found on pg. 74 of the Mathematics Framework document.

Rating Tips

- When making ratings on the O*NET elements, it is important to remember the following: Do not hesitate to use the extremes (1 and 7 on the Level scales) when assigning the ratings. If you avoid using the extremes, you reduce the scales to fewer levels than intended.
- Do not make all ratings at one end of the rating scale. Check yourself to ensure your ratings do not cluster only at the high end or only at the low end of the scale.
- Remember that all words in an O*NET element definition have equal weight. You should not focus on any one word more or less heavily than another, and you should not ignore any words/terms.
- Do not assume you remember what the definition is for a particular O*NET element. It is important to read it again and again as you complete your ratings.
- Rate O*NET elements independent of one another. That is, do not let your rating of one element influence the ratings of other elements within a given occupation. You should begin a new rating process with each O*NET element you rate.
- In addition, if you are rating more than one occupation, do not let your ratings from one occupation impact your ratings for another occupation.
- O*NET elements were included that might conceivably be relevant to NAEP. It is possible that elements may not be relevant to NAEP (or to job training). In that case, the rating for the O*NET element should be '0' for irrelevant.
- If a job expert provides input about a particular task or if you have insight about a particular task given experience with the occupation, then provide that information to the rest of the raters assigned to that occupation so that everyone is basing their judgments on a common set of material. Similarly, if you find information about a job training task(s) on the internet, share that link with the other raters assigned to the occupation. Raters should be rating on a common set of information.
- When making your ratings, keep in mind that grade 8 and grade 12 reading have the same cognitive targets and objectives. For mathematics, the objectives for grade 8 and grade 12 are not exactly the same, although there is overlap. However, there is also some new content (i.e., objectives) in grade 12 that does not appear in grade 8 (see Exhibits 3 – 7 in the mathematics framework document). As such, the relation between grade 8 mathematics and grade 12 mathematics is not as strong as the relation between grade 8 reading and grade 12 Reading.
- After you complete ratings for each set of content (i.e., each column), double check your ratings to ensure that they accurately reflect your judgments.

Appendix L: Relevant NAEP Reading Objectives across Occupations

Cognitive Target	Objective (Informational Text)	Occupation					Total Linked
		AMT	CSS	HVAC	LPN	PT	
<i>Locate/Recall</i>	1. Identify definitions within and across texts and make simple inferences.	X	X	X	X	X	5
<i>Locate/Recall</i>	2. Identify facts within and across texts and make simple inferences.	X	X	X	X	X	5
<i>Locate/Recall</i>	3. Identify supporting details within and across texts and make simple inferences.	X	X	X	X	X	5
<i>Locate/Recall</i>	4. Identify topic sentences or main ideas within and across texts.	X	X	X			3
<i>Locate/Recall</i>	5. Identify author's purpose within and across texts.	X	X	X			3
<i>Locate/Recall</i>	6. Identify causal relations within and across texts.	X	X	X	X		4
<i>Locate/Recall</i>	7. Locate specific information in text or graphics.	X	X	X	X	X	5
<i>Integrate/interpret</i>	8. Make complex inferences within and across texts to describe problem and solution or cause an effect.	X	X	X	X	X	5
<i>Integrate/interpret</i>	9. Make complex inferences within and across texts to compare or connect ideas, problems, or situations.	X	X	X	X	X	5
<i>Integrate/interpret</i>	10. Make complex inferences within and across texts to determine unstated assumptions in an argument.	X	X				2
<i>Integrate/interpret</i>	11. Make complex inferences within and across texts to describe how an author uses text features.			X			1
<i>Integrate/interpret</i>	12. Make complex inferences within and across texts to summarize major ideas.	X	X	X			3
<i>Integrate/interpret</i>	13. Make complex inferences within and across texts to draw conclusions and provide supporting information.	X	X	X	X		4
<i>Integrate/interpret</i>	14. Make complex inferences within and across texts to find evidence in support of an argument.	X	X	X	X		4
<i>Integrate/interpret</i>	15. Make complex inferences within and across texts to distinguish facts from opinions.	X	X	X	X		4
<i>Integrate/interpret</i>	16. Make complex inferences within and across texts to determine the importance of information within and across texts.	X	X	X	X		4
<i>Critique/evaluate</i>	17. Consider text(s) critically to judge author's craft and technique.						0

Cognitive Target	Objective (Informational Text)	Occupation					Total Linked
		AMT	CSS	HVAC	LPN	PT	
Critique/evaluate	18. Consider text(s) critically to evaluate the author's perspective or point of view within or across texts.			X			1
Critique/evaluate	19. Consider text(s) critically to take different perspectives in relation to a text.		X	X			2
Critique/evaluate	20. Consider text(s) critically to analyze the presentation of information.	X	X	X	X		4
Critique/evaluate	21. Consider text(s) critically to evaluate the way the author selects language to influence readers.						0
Critique/evaluate	22. Consider text(s) critically to evaluate the strength and quality of evidence used by the author to support his or her position.		X		X		2
Critique/evaluate	23. Consider text(s) critically to determine the quality of counterarguments within and across texts.		X				1
Critique/evaluate	24. Consider text(s) critically to judge the coherence, logic, or credibility of an argument.	X	X		X		3
Total Number of Objectives Linked		17	20	18	14	6	75
Percentage of Total Objectives Linked		70.8	83.3	75.0	58.3	25.0	62.5
Percentage of Locate/Recall Objectives Linked		100.0	100.0	100.0	71.4	57.1	85.7
Percentage of Integrate/Interpret Objectives Linked		88.8	88.8	88.8	66.7	22.2	71.1
Percentage of Critique/Evaluate Objectives Linked		25.0	62.5	37.5	37.5	0.0	32.5

Appendix M: Relevant NAEP Grade 8 Mathematics Objectives across Occupations

Content Area	Subtopic	Grade 8 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number Sense	1. Use place value to model and describe integers and decimals.	X	X	X	X	X	5
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number Sense	2. Model or describe rational numbers or numerical relationships using number lines and diagrams.	X		X	X	X	4
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number Sense	3. Write or rename rational numbers.	X	X	X	X	X	5
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number Sense	4. Recognize, translate or apply multiple representations of rational numbers (fractions, decimals, and percents) in meaningful contexts.	X	X	X	X	X	5
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number Sense	5. Express or interpret numbers using scientific notation from real-life contexts.					X	1
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number Sense	6. Find or model absolute value or apply to problem situations.						0
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number Sense	7. Order or compare rational numbers (fractions, decimals, percents, or integers) using various models and representations (e.g., number line).	X		X	X	X	4
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number Sense	8. Order or compare rational numbers including very large and small integers, and decimals and fractions close to zero.	X	X	X	X	X	5
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Estimation	9. Establish or apply benchmarks for rational numbers and common irrational numbers (e.g., π) in contexts.						0
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Estimation	10. Make estimates appropriate to a given situation by: Identifying when estimation is appropriate, determining the level of accuracy needed, selecting the appropriate method of estimation, or analyzing the effect of an estimation method on the accuracy of results.	X	X	X	X	X	5

Content Area	Subtopic	Grade 8 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Estimation	11. Verify solutions or determine the reasonableness of results in a variety of situations, including calculator and computer results.	X	X	X	X	X	5
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Estimation	12. Estimate square or cube roots of numbers less than 1,000 between two whole numbers.						0
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number operations	13. Perform computations with rational numbers.	X	X	X	X	X	5
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number operations	14. Describe the effect of multiplying and dividing by numbers including the effect of multiplying or dividing a rational number by: zero, or a number less than zero, or a number between zero and one, one, or a number greater than one.				X		1
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number operations	15. Interpret rational number operations (add, subtract, multiply, and divide) and the relationships between them.	X	X	X	X	X	5
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Number operations	16. Solve application problems involving rational numbers and operations using exact answers or estimates as appropriate.	X	X	X	X	X	5
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Ratios and Proportional Reasoning	17. Use ratios to describe problem situations.	X		X	X	X	4
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Ratios and Proportional Reasoning	18. Use fractions to represent and express ratios and proportions.	X		X	X	X	4
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Ratios and Proportional Reasoning	19. Use proportional reasoning to model and solve problems (including rates and scaling).	X	X	X	X	X	5
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Ratios and Proportional Reasoning	20. Solve problems involving percentages (including percent increase and decrease, interest rates, tax, discount, tips, or part/whole relationships).	X	X		X	X	4
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Properties of number and operations	21. Describe odd and even integers and how they behave under different operations.						0

Content Area	Subtopic	Grade 8 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Properties of number and operations	22. Recognize, find, or use factors, multiples, or prime factorization.		X		X	X	3
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Properties of number and operations	23. Recognize or use prime and composite numbers to solve problems.	X			X		2
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Properties of number and operations	24. Use divisibility or remainders in problem settings.	X	X	X	X	X	5
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Properties of number and operations	25. Apply basic properties of operations.	X		X	X		3
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Mathematical reasoning and using numbers	26. Explain or justify a mathematical concept or relationship (e.g., explain why 17 is prime).						0
Number properties and operations <i>(including computation and understanding of number concepts)</i>	Mathematical reasoning and using numbers	27. Provide a mathematical argument to explain operations with two or more fractions.						0
Measurement <i>(including use of instruments, application of processes, and concepts of area and volume)</i>	Measuring physical attributes	28. Compare objects with respect to length, area, volume, angle measurement, weight, or mass.	X		X	X		3
Measurement <i>(including use of instruments, application of processes, and concepts of area and volume)</i>	Measuring physical attributes	29. Estimate the size of an object with respect to a given measurement attribute (e.g., area).	X		X	X	X	4
Measurement <i>(including use of instruments, application of processes, and concepts of area and volume)</i>	Measuring physical attributes	30. Select or use appropriate measurement instrument to determine or create a given length, area, volume, angle, weight, or mass.	X		X	X	X	4
Measurement <i>(including use of instruments, application of processes, and concepts of area and volume)</i>	Measuring physical attributes	31. Solve mathematical or real-world problems involving perimeter or area of plane figures such as triangles, rectangles, circles, or composite figures.	X		X			2
Measurement <i>(including use of instruments, application of processes, and concepts of area and volume)</i>	Measuring physical attributes	32. Solve problems involving volume or surface area of rectangular solids, cylinders, prisms, or composite shapes.	X		X			2
Measurement <i>(including use of instruments, application of processes, and concepts of area and volume)</i>	Measuring physical attributes	33. Solve problems involving rates such as speed or population density.	X		X	X		3

Content Area	Subtopic	Grade 8 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Systems of measurement	34. Select or use an appropriate type of unit for the attribute being measured such as length, area, angle, time, or volume.	X		X	X	X	4
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Systems of measurement	35. Solve problems involving conversions within the same measurement system such as conversions involving square inches and square feet.	X		X	X	X	4
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Systems of measurement	36. Estimate the measure of an object in one system given the measure of that object in another system and the approximate conversion factor. For example: Distance conversion: 1 kilometer is approximately 5/8 of a mile. Money conversion: U.S. dollars to Canadian dollars. Temperature conversion: Fahrenheit to Celsius.	X		X	X	X	4
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Systems of measurement	37. Determine appropriate size of unit of measurement in problem situation involving such attributes as length, area, or volume.	X		X	X	X	4
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Systems of measurement	38. Determine appropriate accuracy of measurement in problem situations (e.g., the accuracy of each of several lengths needed to obtain a specified accuracy of a total length) and find the measure to that degree of accuracy.	X		X	X	X	4
Measurement (including use of instruments, application of processes, and concepts of area and volume)	Measurement in triangles	39. Solve problems involving indirect measurement such as finding the height of a building by comparing its shadow with the height and shadow of a known object.						0
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	40. Draw or describe a path of shortest length between points to solve problems in context.			X			1
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	41. Identify a geometric object given a written description of its properties.	X		X			2
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	42. Identify, define, or describe geometric shapes in the plane and in three-dimensional space given a visual representation.	X		X			2
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	43. Draw or sketch from a written description polygons, circles, or semicircles.	X		X			2
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	44. Represent or describe a three-dimensional situation in a two-dimensional drawing from different views.			X			1

Content Area	Subtopic	Grade 8 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Geometry (including spatial reasoning and applying geometric properties)	Dimension and shape	45. Demonstrate an understanding about the two- and three-dimensional shapes in our world through identifying, drawing, modeling, building, or taking apart.	X		X			2
Geometry (including spatial reasoning and applying geometric properties)	Transformation of shapes and preservation of properties	46. Identify lines of symmetry in plane figures or recognize and classify types of symmetries of plane figures.			X			1
Geometry (including spatial reasoning and applying geometric properties)	Transformation of shapes and preservation of properties	47. Recognize or informally describe the effect of a transformation on two-dimensional geometric shapes (reflections across lines of symmetry, rotations, translations, magnifications, and contractions).			X			1
Geometry (including spatial reasoning and applying geometric properties)	Transformation of shapes and preservation of properties	48. Predict results of combining, subdividing, and changing shapes of plane figures and solids (e.g., paper folding, tiling, cutting up and rearranging pieces).	X		X			2
Geometry (including spatial reasoning and applying geometric properties)	Transformation of shapes and preservation of properties	49. Justify relationships of congruence and similarity and apply these relationships using scaling and proportional reasoning.						0
Geometry (including spatial reasoning and applying geometric properties)	Transformation of shapes and preservation of properties	50. For similar figures, identify and use the relationships of conservation of angle and of proportionality of side length and perimeter.			X			1
Geometry (including spatial reasoning and applying geometric properties)	Relationships between geometric figures	51. Apply geometric properties and relationships in solving simple problems in two and three dimensions.			X			1
Geometry (including spatial reasoning and applying geometric properties)	Relationships between geometric figures	52. Represent problem situations with simple geometric models to solve mathematical or real-world problems.			X			1
Geometry (including spatial reasoning and applying geometric properties)	Relationships between geometric figures	53. Use the Pythagorean theorem to solve problems.			X			1
Geometry (including spatial reasoning and applying geometric properties)	Relationships between geometric figures	54. Describe or analyze simple properties of, or relationships between, triangles, quadrilaterals, and other polygonal plane figures.			X			1
Geometry (including spatial reasoning and applying geometric properties)	Relationships between geometric figures	55. Describe or analyze properties and relationships of parallel or intersecting lines.	X		X			2
Geometry (including spatial reasoning and applying geometric properties)	Position, direction, and coordinate geometry	56. Describe relative positions of points and lines using the geometric ideas of midpoint, points on common line through a common point, parallelism, or perpendicularity.	X		X			2

Content Area	Subtopic	Grade 8 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Geometry (including spatial reasoning and applying geometric properties)	Position, direction, and coordinate geometry	57. Describe the intersection of two or more geometric figures in the plane (e.g., intersection of a circle and a line).			X			1
Geometry (including spatial reasoning and applying geometric properties)	Position, direction, and coordinate geometry	58. Visualize or describe the cross section of a solid.			X			1
Geometry (including spatial reasoning and applying geometric properties)	Position, direction, and coordinate geometry	59. Represent geometric figures using rectangular coordinates on a plane.						0
Geometry (including spatial reasoning and applying geometric properties)	Mathematical reasoning in geometry	60. Make and test a geometric conjecture about regular polygons.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.)	61. Read or interpret data, including interpolating or extrapolating from data.	X	X	X	X	X	5
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.)	62. For a given set of data, complete a graph and then solve a problem using the data in the graph (histograms, line graphs, scatterplots, circle graphs, and bar graphs).		X				1
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.)	63. Solve problems by estimating and computing with data from a single set or across sets of data.		X	X	X	X	4
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.)	64. Given a graph or a set of data, determine whether information is represented effectively and appropriately (histograms, line graphs, scatterplots, circle graphs, and bar graphs).		X	X			2

Content Area	Subtopic	Grade 8 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.)	65. Compare and contrast the effectiveness of different representations of the same data.			X			1
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Characteristics of data sets	66. Calculate, use, or interpret mean, median, mode, or range.		X	X	X		3
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Characteristics of data sets	67. Describe how mean, median, mode, range, or interquartile ranges relate to distribution shape.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Characteristics of data sets	68. Identify outliers and determine their effect on mean, median, mode, or range.		X				1
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Characteristics of data sets	69. Using appropriate statistical measures, compare two or more data sets describing the same characteristic for two different populations or subsets of the same population.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Characteristics of data sets	70. Visually choose the line that best fits given a scatterplot and informally explain the meaning of the line. Use the line to make predictions.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Experiments and samples	71. Given a sample, identify possible sources of bias in sampling.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Experiments and samples	72. Distinguish between a random and nonrandom sample.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Experiments and samples	73. Evaluate the design of an experiment.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	74. Analyze a situation that involves probability of an independent event.	X		X	X		3
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	75. Determine the theoretical probability of simple and compound events in familiar contexts.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	76. Estimate the probability of simple and compound events through experimentation or simulation.						0

Content Area	Subtopic	Grade 8 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	77. Use theoretical probability to evaluate or predict experimental outcomes.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	78. Determine the sample space for a given situation.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	79. Use a sample space to determine the probability of possible outcomes for an event.						0
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	80. Represent the probability of a given outcome using fractions, decimals, and percents.				X		1
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	81. Determine the probability of independent and dependent events. (Dependent events should be limited to a small sample size.)				X		1
Data Analysis, Statistics, and Probability (including graphical displays and statistics)	Probability	82. Interpret probabilities within a given context.		X				1
Algebra (including representations and relationships)	Patterns, relations, and functions	83. Recognize, describe, or extend numerical and geometric patterns using tables, graphs, words, or symbols.			X			1
Algebra (including representations and relationships)	Patterns, relations, and functions	84. Generalize a pattern appearing in a numerical sequence, table, or graph using words or symbols.	X					1
Algebra (including representations and relationships)	Patterns, relations, and functions	85. Analyze or create patterns, sequences, or linear functions given a rule.			X			1
Algebra (including representations and relationships)	Patterns, relations, and functions	86. Identify functions as linear or nonlinear or contrast distinguishing properties of functions from tables, graphs, or equations.						0
Algebra (including representations and relationships)	Patterns, relations, and functions	87. Interpret the meaning of slope or intercepts in linear functions.						0
Algebra (including representations and relationships)	Algebraic representations	88. Translate between different representations of linear expressions using symbols, graphs, tables, diagrams, or written descriptions.				X		1
Algebra (including representations and relationships)	Algebraic representations	89. Analyze or interpret linear relationships expressed in symbols, graphs, tables, diagrams, or written descriptions.	X			X		2
Algebra (including representations and relationships)	Algebraic representations	90. Graph or interpret points represented by ordered pairs of numbers on a rectangular coordinate system.						0
Algebra (including representations and relationships)	Algebraic representations	91. Solve problems involving coordinate pairs on the rectangular coordinate system.						0

Content Area	Subtopic	Grade 8 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Algebra (including representations and relationships)	Algebraic representations	92. Identify or represent functional relationships in meaningful contexts including proportional, linear, and common nonlinear (e.g., compound interest, bacterial growth) in tables, graphs, words, or symbols.				X		1
Algebra (including representations and relationships)	Variables, expressions, and operations	93. Write algebraic expressions, equations, or inequalities to represent a situation.				X		1
Algebra (including representations and relationships)	Variables, expressions, and operations	94. Perform basic operations, using appropriate tools, on linear algebraic expressions (including grouping and order of multiple operations involving basic operations, exponents, roots, simplifying, and expanding).				X		1
Algebra (including representations and relationships)	Equations and inequalities	95. Solve linear equations or inequalities (e.g., $ax + b = c$ or $ax + b = cx + d$ or $ax + b > c$).				X		1
Algebra (including representations and relationships)	Equations and inequalities	96. Interpret “=” as an equivalence between two expressions and use this interpretation to solve problems.			X	X		2
Algebra (including representations and relationships)	Equations and inequalities	97. Analyze situations or solve problems using linear equations and inequalities with rational coefficients symbolically or graphically (e.g., $ax + b = c$ or $ax + b = cx + d$).						0
Algebra (including representations and relationships)	Equations and inequalities	98. Interpret relationships between symbolic linear expressions and graphs of lines by identifying and computing slope and intercepts (e.g., know in $y = ax + b$, that a is the rate of change and b is the vertical intercept of the graph).						0
Algebra (including representations and relationships)	Equations and inequalities	99. Use and evaluate common formulas (e.g., relationship between a circle’s circumference and diameter [$C = \pi d$], distance and time under constant speed).			X			1
Algebra (including representations and relationships)	Mathematical reasoning and algebra	100. Make, validate, and justify conclusions and generalizations about linear relationships.			X	X		2
Total Number of Objectives Linked			40	20	56	43	27	186
% of Total Objectives Linked			40.0	20.0	56.0	43.0	27.0	37.2
% of Number Properties & Operations Objectives Linked			66.7	48.1	59.3	74.1	66.7	63.0
% of Measurement Objectives Linked			91.7	0.0	91.7	75.0	58.3	63.3
% of Geometry Objectives Linked			33.3	0.0	85.7	0.0	0.0	23.8
% of Data Analysis, Statistics & Probability Objectives Linked			9.1	31.8	27.3	27.3	9.1	20.9
% of Algebra Objectives Linked			11.1	0.0	27.8	44.4	0.0	16.7

Appendix N: Relevant NAEP Grade 12 Mathematics Objectives across Occupations

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Number properties and operations	Number Sense	1. Represent, interpret, or compare expressions for real numbers, including expressions using exponents and logarithms.				X		1
Number properties and operations	Number Sense	2. Represent or interpret expressions involving very large or very small numbers in scientific notation.					X	1
Number properties and operations	Number Sense	3. Represent, interpret, or compare expressions or problem situations involving absolute values.						0
Number properties and operations	Number Sense	4. Order or compare real numbers, including very large and very small real numbers.	X	X	X	X	X	5
Number properties and operations	Estimation	5. Identify situations where estimation is appropriate, determine the needed degree of accuracy, and analyze the effect of the estimation method on the accuracy of results.	X	X	X	X	X	5
Number properties and operations	Estimation	6. Verify solutions or determine the reasonableness of results in a variety of situations.	X	X	X	X	X	5
Number properties and operations	Estimation	7. Estimate square or cube roots of numbers less than 1,000 between two whole numbers.						0
Number properties and operations	Number operations	8. Find integral or simple fractional powers of real numbers.				X		1
Number properties and operations	Number operations	9. Perform arithmetic operations with real numbers, including common irrational numbers.	X		X			2
Number properties and operations	Number operations	10. Perform arithmetic operations with expressions involving absolute value.						0
Number properties and operations	Number operations	11. Describe the effect of multiplying and dividing by numbers including the effect of multiplying or dividing a real number by: Zero, or a number less than zero, or a number between zero and one, or one, or a number greater than one.				X		1
Number properties and operations	Number operations	12. Solve application problems involving numbers, including rational and common irrationals.			X			1

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Number properties and operations	Ratios and proportional reasoning	13. Use proportions to solve problems (including rates of change).		X		X	X	3
Number properties and operations	Ratios and proportional reasoning	14. Solve multistep problems involving percentages, including compound percentages.					X	1
Number properties and operations	Properties of numbers and operations	15. Solve problems using factors, multiples, or prime factorization.				X		1
Number properties and operations	Properties of numbers and operations	16. Use divisibility or remainders in problem settings.	X	X	X	X	X	5
Number properties and operations	Properties of numbers and operations	17. Apply basic properties of operations, including conventions about the order of operations.	X			X		2
Number properties and operations	Properties of numbers and operations	18. Recognize properties of the number system (whole numbers, integers, rational numbers, real numbers, and complex numbers) and how they are related to each other, and identify examples of each type of number.						0
Number properties and operations	Mathematical reasoning using numbers	19. Give a mathematical argument to establish the validity of a simple numerical property or relationship.			X			1
Number properties and operations	Mathematical reasoning using numbers	20. Analyze or interpret a proof by mathematical induction of a simple numerical relationship.						0
Measurement	Measuring physical attributes	21. Determine the effect of proportions and scaling on length, area, and volume.			X			1
Measurement	Measuring physical attributes	22. Estimate or compare perimeters or areas of two-dimensional geometric figures.	X		X			2
Measurement	Measuring physical attributes	23. Solve problems of angle measure, including those involving triangles or other polygons or parallel lines cut by a transversal.	X		X			2
Measurement	Measuring physical attributes	24. Solve problems involving perimeter or area of plane figures such as polygons, circles, or composite figures.	X		X			2
Measurement	Measuring physical attributes	25. Solve problems by determining, estimating, or comparing volumes or surface areas of three-dimensional figures.	X		X			2
Measurement	Measuring physical attributes	26. Solve problems involving rates such as speed, density, population density, or flow rates.	X		X	X		3

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Measurement	Systems of measurement	27. Recognize that geometric measurements (length, area, perimeter, and volume) depend on the choice of a unit, and apply such units in expressions, equations, and problem solutions.	X		X			2
Measurement	Systems of measurement	28. Solve problems involving conversions within or between measurement systems, given the relationship between the units.	X		X	X	X	4
Measurement	Systems of measurement	29. Understand that numerical values associated with measurements of physical quantities are approximate, are subject to variation, and must be assigned units of measurement.	X		X	X	X	4
Measurement	Systems of measurement	30. Determine appropriate accuracy of measurement in problem situations (e.g., the accuracy of measurement of the dimensions to obtain a specified accuracy of area) and find the measure to that degree of accuracy.	X		X	X	X	4
Measurement	Systems of measurement	31. Construct or solve problems involving scale drawings.			X			1
Measurement	Measurement in triangles	32. Solve problems involving indirect measurement.			X			1
Measurement	Measurement in triangles	33. Solve problems using the fact that trigonometric ratios (sine, cosine, and tangent) stay constant in similar triangles.			X			1
Measurement	Measurement in triangles	34. Use the definitions of sine, cosine, and tangent as ratios of sides in a right triangle to solve problems about length of sides and measure of angles.			X			1
Measurement	Measurement in triangles	35. Interpret and use the identity $\sin^2 q + \cos^2 q = 1$ for angles q between 0° and 90° ; recognize this identity as a special representation of the Pythagorean theorem.						0
Measurement	Measurement in triangles	36. Determine the radian measure of an angle and explain how radian measurement is related to a circle of radius 1.						0
Measurement	Measurement in triangles	37. Use trigonometric formulas such as addition and double angle formulas.						0

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Measurement	Measurement in triangles	38. Use the law of cosines and the law of sines to find unknown sides and angles of a triangle.						0
Geometry	Dimension and shape	39. Give precise mathematical descriptions or definitions of geometric shapes in the plane and in three-dimensional space.						0
Geometry	Dimension and shape	40. Draw or sketch from a written description plane figures and planar images of three-dimensional figures.			X			1
Geometry	Dimension and shape	41. Use two-dimensional representations of three-dimensional objects to visualize and solve problems.			X			1
Geometry	Dimension and shape	42. Analyze properties of three-dimensional figures including spheres and hemispheres.						0
Geometry	Transformation of shapes and preservation of properties	43. Recognize or identify types of symmetries (e.g., point, line, rotational, self-congruence) of two- and three-dimensional figures.			X			1
Geometry	Transformation of shapes and preservation of properties	44. Give or recognize the precise mathematical relationship (e.g., congruence, similarity, orientation) between a figure and its image under a transformation.			X			1
Geometry	Transformation of shapes and preservation of properties	45. Perform or describe the effect of a single transformation on two- and three-dimensional geometric shapes (reflections across lines of symmetry, rotations, translations, and dilations).						0
Geometry	Transformation of shapes and preservation of properties	46. Identify transformations, combinations, or subdivisions of shapes that preserve the area of two-dimensional figures or the volume of three-dimensional figures.						0
Geometry	Transformation of shapes and preservation of properties	47. Justify relationships of congruence and similarity and apply these relationships using scaling and proportional reasoning.						0
Geometry	Transformation of shapes and preservation of properties	48. Perform or describe the effects of successive transformations.						0
Geometry	Relationships between geometric figures	49. Apply geometric properties and relationships to solve problems in two and three dimensions.			X			1

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Geometry	Relationships between geometric figures	50. Represent problem situations with geometric models to solve mathematical or real-world problems.			X			1
Geometry	Relationships between geometric figures	51. Use the Pythagorean theorem to solve problems in two- or three-dimensional situations.			X			1
Geometry	Relationships between geometric figures	52. Recall and interpret definitions and basic properties of congruent and similar triangles, circles, quadrilaterals, polygons, parallel, perpendicular and intersecting lines, and associated angle relationships.			X			1
Geometry	Relationships between geometric figures	53. Analyze properties or relationships of triangles, quadrilaterals, and other polygonal plane figures.			X			1
Geometry	Relationships between geometric figures	54. Analyze properties and relationships of parallel, perpendicular, or intersecting lines including the angle relationships that arise in these cases.			X			1
Geometry	Relationships between geometric figures	55. Analyze properties of circles and the intersections of lines and circles (inscribed angles, central angles, tangents, secants, and chords).			X			1
Geometry	Position, direction, and coordinate geometry	56. Solve problems involving the coordinate plane such as the distance between two points, the midpoint of a segment, or slopes of perpendicular or parallel lines.			X			1
Geometry	Position, direction, and coordinate geometry	57. Describe the intersections of lines in the plane and in space, intersections of a line and a plane, or of two planes in space.						0
Geometry	Position, direction, and coordinate geometry	58. Describe or identify conic sections and other cross sections of solids.			X			1
Geometry	Position, direction, and coordinate geometry	59. Represent two-dimensional figures algebraically using coordinates and/or equations.						0
Geometry	Position, direction, and coordinate geometry	60. Use vectors to represent velocity and direction; multiply a vector by a scalar and add vectors both algebraically and graphically.						0

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Geometry	Position, direction, and coordinate geometry	61. Find an equation of a circle given its center and radius and, given an equation of a circle, find its center and radius.			X			1
Geometry	Position, direction, and coordinate geometry	62. Graph ellipses and hyperbolas whose axes are parallel to the coordinate axes and demonstrate understanding of the relationship between their standard algebraic form and their graphical characteristics.						0
Geometry	Position, direction, and coordinate geometry	63. Represent situations and solve problems involving polar coordinates.			X			1
Geometry	Mathematical reasoning in geometry	64. Make, test, and validate geometric conjectures using a variety of methods including deductive reasoning and counterexamples.						0
Geometry	Mathematical reasoning in geometry	65. Determine the role of hypotheses, logical implications, and conclusion in proofs of geometric theorems.						0
Geometry	Mathematical reasoning in geometry	66. Analyze or explain a geometric argument by contradiction.						0
Geometry	Mathematical reasoning in geometry	67. Analyze or explain a geometric proof of the Pythagorean theorem.						0
Geometry	Mathematical reasoning in geometry	68. Prove basic theorems about congruent and similar triangles and circles.						0
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	69. Read or interpret graphical or tabular representations of data.	X	X	X	X	X	5
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	70. For a given set of data, complete a graph and solve a problem using the data in the graph (histograms, scatterplots, and line graphs).		X				1

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	71. Solve problems involving univariate or bivariate data.						0
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	72. Given a graphical or tabular representation of a set of data, determine whether information is represented effectively and appropriately.		X	X			2
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	73. Compare and contrast different graphical representations of univariate and bivariate data.						0
Data analysis, statistics, and probability	Data representation (Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables, including two-way tables.)	74. Organize and display data in a spreadsheet in order to recognize patterns and solve problems.		X			X	2
Data analysis, statistics, and probability	Characteristics of data	75. Calculate, interpret, or use summary statistics for distributions of data including measures of typical value (mean, median), position (quartiles, percentiles), and spread (range, interquartile range, variance, and standard deviation).		X				1
Data analysis, statistics, and probability	Characteristics of data	76. Recognize how linear transformations of one-variable data affect mean, median, mode, range, interquartile range, and standard deviation.						0
Data analysis, statistics, and probability	Characteristics of data	77. Determine the effect of outliers on mean, median, mode, range, interquartile range, or standard deviation.		X				1

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Data analysis, statistics, and probability	Characteristics of data	78. Compare data sets using summary statistics (mean, median, mode, range, interquartile range, or standard deviation) describing the same characteristic for two different populations or subsets of the same population.						0
Data analysis, statistics, and probability	Characteristics of data	79. Approximate a trend line if a linear pattern is apparent in a scatterplot or use a graphing calculator to determine a least-squares regression line and use the line or equation to make predictions.						0
Data analysis, statistics, and probability	Characteristics of data	80. Recognize that the correlation coefficient is a number from -1 to $+1$ that measures the strength of the linear relationship between two variables; visually estimate the correlation coefficient (e.g., positive or negative, closer to 0, .5, or 1.0) of a scatterplot.						0
Data analysis, statistics, and probability	Characteristics of data	81. Know and interpret the key characteristics of a normal distribution such as shape, center (mean), and spread (standard deviation).						0
Data analysis, statistics, and probability	Experiments and samples	82. Identify possible sources of bias in sample surveys and describe how such bias can be controlled and reduced.						0
Data analysis, statistics, and probability	Experiments and samples	83. Recognize and describe a method to select a simple random sample.						0
Data analysis, statistics, and probability	Experiments and samples	84. Draw inferences from samples, such as estimates of proportions in a population, estimates of population means, or decisions about differences in means for two "treatments."						0
Data analysis, statistics, and probability	Experiments and samples	85. Identify or evaluate the characteristics of a good survey or of a well-designed experiment.						0
Data analysis, statistics, and probability	Experiments and samples	86. Recognize the differences in design and in conclusions between randomized experiments and observational studies.				X		1
Data analysis, statistics, and probability	Probability	87. Recognize whether two events are independent or dependent.	X	X	X	X		4

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Data analysis, statistics, and probability	Probability	88. Determine the theoretical probability of simple and compound events in familiar or unfamiliar contexts.						0
Data analysis, statistics, and probability	Probability	89. Given the results of an experiment or simulation, estimate the probability of simple or compound events in familiar or unfamiliar contexts.						0
Data analysis, statistics, and probability	Probability	90. Use theoretical probability to evaluate or predict experimental outcomes.						0
Data analysis, statistics, and probability	Probability	91. Determine the number of ways an event can occur using tree diagrams, formulas for combinations and permutations, or other counting techniques.						0
Data analysis, statistics, and probability	Probability	92. Determine the probability of independent and dependent events.				X		1
Data analysis, statistics, and probability	Probability	93. Determine conditional probability using two-way tables.						0
Data analysis, statistics, and probability	Probability	94. Interpret and apply probability concepts to practical situations.		X		X		2
Data analysis, statistics, and probability	Probability	95. Use the binomial theorem to solve problems.						0
Data analysis, statistics, and probability	Mathematical reasoning with data	96. Identify misleading uses of data in real-world settings and critique different ways of presenting and using information.			X			1
Data analysis, statistics, and probability	Mathematical reasoning with data	97. Distinguish relevant from irrelevant information, identify missing information, and either find what is needed or make appropriate approximations.		X	X	X		3
Data analysis, statistics, and probability	Mathematical reasoning with data	98. Recognize, use, and distinguish between the processes of mathematical (deterministic) and statistical modeling.						0
Data analysis, statistics, and probability	Mathematical reasoning with data	99. Recognize when arguments based on data confuse correlation with causation.				X		1
Data analysis, statistics, and probability	Mathematical reasoning with data	100. Recognize and explain the potential errors caused by extrapolating from data.			X			1
Algebra	Patterns, relations, and functions	101. Recognize, describe, or extend numerical patterns, including arithmetic and geometric progressions.						0

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Algebra	Patterns, relations, and functions	102. Express linear and exponential functions in recursive and explicit form given a table, verbal description, or some terms of a sequence.						0
Algebra	Patterns, relations, and functions	103. Identify or analyze distinguishing properties of linear, quadratic, rational, exponential, or trigonometric functions from tables, graphs, or equations.						0
Algebra	Patterns, relations, and functions	104. Determine whether a relation, given in verbal, symbolic, tabular, or graphical form, is a function.				X		1
Algebra	Patterns, relations, and functions	105. Recognize and analyze the general forms of linear, quadratic, rational, exponential, or trigonometric functions.						0
Algebra	Patterns, relations, and functions	106. Determine the domain and range of functions given in various forms and contexts.						0
Algebra	Patterns, relations, and functions	107. Given a function, determine its inverse if it exists and explain the contextual meaning of the inverse for a given situation.						0
Algebra	Algebraic representations	108. Create and translate between different representations of algebraic expressions, equations, and inequalities (e.g., linear, quadratic, exponential, or trigonometric) using symbols, graphs, tables, diagrams, or written descriptions.				X		1
Algebra	Algebraic representations	109. Analyze or interpret relationships expressed in symbols, graphs, tables, diagrams (including Venn diagrams), or written descriptions and evaluate the relative advantages or disadvantages of different representations to answer specific questions.						0
Algebra	Algebraic representations	110. Perform or interpret transformations on the graphs of linear, quadratic, exponential, and trigonometric functions.						0
Algebra	Algebraic representations	111. Make inferences or predictions using an algebraic model of a situation.						0

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Algebra	Algebraic representations	112. Given a real-world situation, determine if a linear, quadratic, rational, exponential, logarithmic, or trigonometric function fits the situation.				X		1
Algebra	Algebraic representations	113. Solve problems involving exponential growth and decay.						0
Algebra	Algebraic representations	114. Analyze properties of exponential, logarithmic, and rational functions.						0
Algebra	Variables, expressions, and operations	115. Write algebraic expressions, equations, or inequalities to represent a situation.				X		1
Algebra	Variables, expressions, and operations	116. Perform basic operations, using appropriate tools, on algebraic expressions including polynomial and rational expressions.				X		1
Algebra	Variables, expressions, and operations	117. Write equivalent forms of algebraic expressions, equations, or inequalities to represent and explain mathematical relationships.						0
Algebra	Variables, expressions, and operations	118. Evaluate algebraic expressions including polynomials and rational expressions.						0
Algebra	Variables, expressions, and operations	119. Use function notation to evaluate a function at a specified point in its domain and combine functions by addition, subtraction, multiplication, division, and composition.						0
Algebra	Variables, expressions, and operations	120. Determine the sum of finite and infinite arithmetic and geometric series.						0
Algebra	Variables, expressions, and operations	121. Use basic properties of exponents and logarithms to solve problems.						0
Algebra	Equations and inequalities	122. Solve linear, rational, or quadratic equations or inequalities, including those involving absolute value.						0
Algebra	Equations and inequalities	123. Analyze situations, develop mathematical models, or solve problems using linear, quadratic, exponential, or logarithmic equations or inequalities symbolically or graphically.						0
Algebra	Equations and inequalities	124. Solve (symbolically or graphically) a system of equations or inequalities and recognize the relationship between the analytical solution and graphical solution.						0

Content Area	Subtopic	Grade 12 Math Objectives	AMT	CSS	HVAC	LPN	PT	Total Linked
Algebra	Equations and inequalities	125. Solve problems involving special formulas such as: $A = P(1 + r)t$ or $A = Pert$.				X		1
Algebra	Equations and inequalities	126. Solve an equation or formula involving several variables for one variable in terms of the others.						0
Algebra	Equations and inequalities	127. Solve quadratic equations with complex roots.						0
Algebra	Mathematical reasoning in algebra	128. Use algebraic properties to develop a valid mathematical argument.				X		1
Algebra	Mathematical reasoning in algebra	129. Determine the role of hypotheses, logical implications, and conclusions in algebraic argument.						0
Algebra	Mathematical reasoning in algebra	130. Explain the use of relational conjunctions (and, or) in algebraic arguments.						0
Total Number of Objectives Linked			17	14	42	38	12	113
% of Total Objectives Linked			13.1	10.8	32.2	29.2	9.2	18.9
% of Number Properties & Operations Objectives Linked			30.0	25.0	35.0	50.0	35.0	35.0
% of Measurement Objectives Linked			50.0	0.0	77.7	22.2	16.7	33.3
% of Geometry Objectives Linked			0.0	0.0	50.0	0.0	0.0	10.0
% of Data Analysis, Statistics & Probability Objectives Linked			6.3	28.1	18.8	21.9	6.3	16.3
% of Algebra Objectives Linked			0.0	3.3	10.0	30.0	0.0	8.7

Appendix O: Descriptive Statistics

Automotive Master Technician

O*NET Descriptors	Grade 8 Reading			Tasks Linked to Reading			Grade 12 Reading			Grade 8 Math			Tasks Linked to Grade 8 Math			Grade 12 Math			Tasks Linked to Grade 12 Math		
	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD
Written Comprehension	3.50	0.19	0.53	3.25	0.16	0.46	4.25	0.25	0.71	3.00	0.00	0.00	3.25	0.16	0.46	3.38	0.18	0.52	3.25	0.16	0.46
Written Expression	3.00	0.27	0.76	2.25	0.25	0.71	3.50	0.27	0.76	2.00	0.27	0.76	2.25	0.25	0.71	2.50	0.33	0.93	2.25	0.25	0.71
Fluency of Ideas	1.38	0.26	0.74	3.13	0.35	0.99	2.25	0.37	1.04	1.25	0.16	0.46	3.13	0.35	0.99	1.63	0.26	0.74	3.13	0.35	0.99
Originality	1.50	0.19	0.53	2.00	0.27	0.76	2.38	0.32	0.92	1.50	0.27	0.76	2.00	0.27	0.76	1.75	0.25	0.71	2.00	0.27	0.76
Problem Sensitivity	2.50	0.33	0.93	3.63	0.42	1.19	2.75	0.25	0.71	2.38	0.26	0.74	3.63	0.42	1.19	2.75	0.37	1.04	3.63	0.42	1.19
Deductive Reasoning	2.88	0.23	0.64	3.75	0.25	0.71	3.63	0.18	0.52	3.25	0.16	0.46	3.75	0.25	0.71	3.75	0.25	0.71	3.75	0.25	0.71
Inductive Reasoning	3.13	0.13	0.35	3.00	0.33	0.93	3.63	0.32	0.92	3.13	0.35	0.99	3.00	0.33	0.93	2.88	0.23	0.64	3.00	0.33	0.93
Information Ordering	2.38	0.32	0.92	3.25	0.37	1.04	2.63	0.26	0.74	3.38	0.26	0.74	3.25	0.37	1.04	3.88	0.30	0.83	3.25	0.37	1.04
Category Flexibility	2.75	0.31	0.89	2.63	0.18	0.52	2.63	0.32	0.92	3.25	0.25	0.71	2.63	0.18	0.52	3.25	0.31	0.89	2.63	0.18	0.52
Mathematical Reasoning	0.25	0.16	0.46	2.38	0.32	0.92	0.25	0.16	0.46	4.13	0.13	0.35	2.38	0.32	0.92	4.25	0.25	0.71	2.38	0.32	0.92
Number Facility	0.13	0.13	0.35	2.38	0.26	0.74	0.13	0.13	0.35	4.63	0.26	0.74	2.38	0.26	0.74	4.75	0.16	0.46	2.38	0.26	0.74
Memorization	1.88	0.30	0.83	2.88	0.40	1.13	2.50	0.33	0.93	2.25	0.31	0.89	2.88	0.40	1.13	2.25	0.31	0.89	2.88	0.40	1.13
Speed of Closure	1.50	0.19	0.53	2.63	0.46	1.30	2.13	0.35	0.99	3.25	0.41	1.16	2.63	0.46	1.30	3.00	0.19	0.53	2.63	0.46	1.30
Flexibility of Closure	2.25	0.45	1.28	3.75	0.25	0.71	2.63	0.42	1.19	3.38	0.38	1.06	3.75	0.25	0.71	3.25	0.53*	1.49	3.75	0.25	0.71
Visualization	0.13	0.13	0.35	3.88	0.23	0.64	0.25	0.16	0.46	3.38	0.32	0.92	3.88	0.23	0.64	3.25	0.37	1.04	3.88	0.23	0.64
Critical Thinking	3.38	0.32	0.92	3.00	0.27	0.76	4.38	0.18	0.52	3.50	0.33	0.93	3.00	0.27	0.76	3.75	0.37	1.04	3.00	0.27	0.76
Active Learning	2.88	0.30	0.83	2.50	0.27	0.76	3.63	0.26	0.74	1.88	0.23	0.64	2.50	0.27	0.76	2.38	0.32	0.92	2.50	0.27	0.76
Complex Problem Solving	1.50	0.33	0.93	3.25	0.37	1.04	2.25	0.45	1.28	3.00	0.38	1.07	3.25	0.37	1.04	3.38	0.42	1.19	3.25	0.37	1.04
Judgment and Decision Making	2.13	0.30	0.83	2.13	0.30	0.83	2.88	0.35	0.99	2.13	0.30	0.83	2.13	0.30	0.83	2.13	0.30	0.83	2.13	0.30	0.83
Mathematics	0.25	0.16	0.46	2.88	0.30	0.83	0.25	0.16	0.46	4.00	0.19	0.53	2.88	0.30	0.83	4.88	0.30	0.83	2.88	0.30	0.83
English Language	3.25	0.16	0.46	2.25	0.16	0.46	4.00	0.19	0.53	2.38	0.26	0.74	2.25	0.16	0.46	3.13	0.35	0.99	2.25	0.16	0.46

Note. * Highlighted text flagged for SEm greater than 0.51, an indication of insufficient interrater agreement.

Computer Support Specialist Descriptive Statistics

O*NET Descriptors	Grade 8 Reading			Tasks Linked to Reading			Grade 12 Reading			Grade 8 Math			Tasks Linked to Grade 8 Math			Grade 12 Math			Tasks Linked to Grade 12 Math		
	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD
Written Comprehension	3.25	0.16	0.46	3.88	0.30	0.83	4.00	0.19	0.53	3.13	0.13	0.35	3.50	0.27	0.76	3.50	0.19	0.53	3.50	0.27	0.76
Written Expression	2.75	0.25	0.71	3.38	0.18	0.52	3.50	0.19	0.53	2.00	0.33	0.93	2.50	0.19	0.53	2.25	0.31	0.89	2.50	0.19	0.53
Fluency of Ideas	2.00	0.19	0.53	2.75	0.31	0.89	2.63	0.18	0.52	1.00	0.33	0.93	2.63	0.26	0.74	1.25	0.37	1.04	2.50	0.27	0.76
Originality	1.13	0.23	0.64	2.13	0.23	0.64	1.38	0.26	0.74	1.00	0.27	0.76	2.63	0.26	0.74	0.88	0.23	0.64	2.63	0.26	0.74
Problem Sensitivity	2.00	0.27	0.76	3.00	0.33	0.93	2.25	0.16	0.46	1.88	0.30	0.83	3.25	0.31	0.89	2.25	0.37	1.04	3.38	0.32	0.92
Deductive Reasoning	2.63	0.26	0.74	2.88	0.30	0.83	3.38	0.26	0.74	3.50	0.27	0.76	3.00	0.38	1.07	3.50	0.27	0.76	3.00	0.38	1.07
Inductive Reasoning	2.88	0.13	0.35	3.25	0.31	0.89	3.50	0.27	0.76	3.13	0.23	0.64	3.13	0.35	0.99	3.50	0.33	0.93	3.13	0.35	0.99
Information Ordering	1.88	0.23	0.64	2.75	0.31	0.89	2.88	0.40	1.13	3.00	0.38	1.07	3.13	0.40	1.13	3.63	0.26	0.74	3.13	0.40	1.13
Category Flexibility	2.13	0.23	0.64	2.75	0.25	0.71	2.88	0.23	0.64	3.13	0.13	0.35	2.75	0.16	0.46	3.25	0.31	0.89	2.75	0.16	0.46
Mathematical Reasoning	0.13	0.13	0.35	1.25	0.25	0.71	0.25	0.16	0.46	3.63	0.18	0.52	1.63	0.38	1.06	4.25	0.16	0.46	1.63	0.38	1.06
Number Facility	0.13	0.13	0.35	1.25	0.41	1.16	0.25	0.16	0.46	4.25	0.16	0.46	2.13	0.40	1.13	4.38	0.18	0.52	2.13	0.40	1.13
Memorization	1.75	0.25	0.71	2.88	0.30	0.83	2.38	0.26	0.74	1.50	0.33	0.93	2.38	0.26	0.74	2.13	0.35	0.99	2.50	0.27	0.76
Speed of Closure	1.38	0.32	0.92	3.13	0.30	0.83	2.50	0.42	1.20	2.13	0.40	1.13	3.25	0.37	1.04	2.38	0.18	0.52	3.25	0.37	1.04
Flexibility of Closure	3.00	0.33	0.93	3.13	0.13	0.35	3.50	0.19	0.53	3.13	0.23	0.64	3.50	0.27	0.76	4.00	0.19	0.53	3.38	0.26	0.74
Visualization	0.25	0.16	0.46	2.50	0.27	0.76	0.25	0.16	0.46	2.25	0.53	1.49	2.50	0.27	0.76	2.50	0.68	1.93	2.50	0.27	0.76
Critical Thinking	3.25	0.16	0.46	3.38	0.26	0.74	4.25	0.16	0.46	3.25	0.31	0.89	3.00	0.33	0.93	3.88	0.23	0.64	3.25	0.25	0.71
Active Learning	2.25	0.16	0.46	2.75	0.37	1.04	2.75	0.25	0.71	1.25	0.37	1.04	3.00	0.27	0.76	2.13	0.44	1.25	3.00	0.27	0.76
Complex Problem Solving	1.88	0.44	1.25	2.75	0.31	0.89	2.38	0.53	1.51	3.00	0.19	0.53	3.00	0.38	1.07	3.75	0.25	0.71	3.00	0.38	1.07
Judgment and Decision Making	2.00	0.33	0.93	2.88	0.30	0.83	3.00	0.42	1.20	2.00	0.38	1.07	2.88	0.35	0.99	2.38	0.32	0.92	2.75	0.37	1.04
Mathematics	0.13	0.13	0.35	1.25	0.41	1.16	0.13	0.13	0.35	4.13	0.13	0.35	2.13	0.40	1.13	4.50	0.19	0.53	2.13	0.40	1.13
English Language	3.25	0.16	0.46	3.13	0.13	0.35	4.00	0.19	0.53	2.50	0.19	0.53	2.88	0.13	0.35	3.25	0.16	0.46	2.88	0.13	0.35

HVAC Descriptive Statistics

O*NET Descriptors	Grade 8 Reading			Tasks Linked to Reading			Grade 12 Reading			Grade 8 Math			Tasks Linked to Grade 8 Math			Grade 12 Math			Tasks Linked to Grade 12 Math		
	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD
Written Comprehension	3.38	0.18	0.52	3.75	0.37	1.04	4.00	0.19	0.53	3.00	0.19	0.53	3.38	0.18	0.52	3.63	0.18	0.52	3.50	0.19	0.53
Written Expression	2.50	0.33	0.93	2.38	0.18	0.52	3.75	0.25	0.71	2.13	0.40	1.13	2.38	0.26	0.74	2.50	0.42	1.20	2.38	0.26	0.74
Fluency of Ideas	1.63	0.18	0.52	2.63	0.38	1.06	2.50	0.27	0.76	0.88	0.35	0.99	3.00	0.38	1.07	0.88	0.40	1.13	3.00	0.38	1.07
Originality	1.00	0.33	0.93	2.25	0.37	1.04	2.00	0.42	1.20	1.00	0.42	1.20	2.88	0.35	0.99	1.25	0.56*	1.58	3.13	0.35	0.99
Problem Sensitivity	2.88	0.35	0.99	3.63	0.38	1.06	3.50	0.38	1.07	1.88	0.35	0.99	4.00	0.42	1.20	3.00	0.33	0.93	4.38	0.38	1.06
Deductive Reasoning	3.63	0.38	1.06	3.00	0.27	0.76	3.88	0.35	0.99	3.88	0.23	0.64	3.13	0.40	1.13	4.63	0.26	0.74	3.88	0.35	0.99
Inductive Reasoning	3.38	0.26	0.74	3.63	0.32	0.92	3.75	0.45	1.28	3.38	0.26	0.74	3.88	0.30	0.83	4.00	0.33	0.93	3.88	0.30	0.83
Information Ordering	1.38	0.53*	1.51	4.13	0.30	0.83	2.00	0.38	1.07	3.38	0.26	0.74	4.13	0.35	0.99	4.25	0.25	0.71	4.50	0.27	0.76
Category Flexibility	2.25	0.37	1.04	2.13	0.30	0.83	2.25	0.45	1.28	3.25	0.16	0.46	2.88	0.23	0.64	3.75	0.25	0.71	2.88	0.40	1.13
Mathematical Reasoning	0.13	0.13	0.35	2.00	0.19	0.53	0.38	0.38	1.06	4.13	0.35	0.99	2.63	0.18	0.52	4.63	0.26	0.74	3.00	0.19	0.53
Number Facility	0.38	0.18	0.52	2.75	0.25	0.71	0.63	0.38	1.06	4.25	0.41	1.16	3.50	0.19	0.53	5.13	0.23	0.64	3.75	0.25	0.71
Memorization	1.75	0.37	1.04	3.50	0.33	0.93	2.38	0.32	0.92	2.25	0.31	0.89	3.13	0.23	0.64	2.75	0.37	1.04	3.50	0.19	0.53
Speed of Closure	1.13	0.30	0.83	3.13	0.40	1.13	1.38	0.26	0.74	2.38	0.38	1.06	3.63	0.32	0.92	3.50	0.60*	1.69	3.75	0.25	0.71
Flexibility of Closure	2.50	0.19	0.53	3.50	0.33	0.93	3.13	0.30	0.83	3.13	0.44	1.25	4.00	0.27	0.76	3.75	0.31	0.89	3.88	0.30	0.83
Visualization	0.00	0.00	0.00	4.13	0.30	0.83	0.00	0.00	0.00	3.13	0.44	1.25	4.50	0.19	0.53	4.25	0.49	1.39	4.75	0.25	0.71
Critical Thinking	3.63	0.32	0.92	2.75	0.37	1.04	4.25	0.31	0.89	3.38	0.32	0.92	3.00	0.42	1.20	4.00	0.38	1.07	3.88	0.35	0.99
Active Learning	2.13	0.58*	1.64	2.25	0.31	0.89	1.88	0.40	1.13	1.13	0.23	0.64	2.88	0.30	0.83	1.75	0.45	1.28	2.88	0.30	0.83
Complex Problem Solving	2.75	0.41	1.16	3.13	0.23	0.64	3.25	0.41	1.16	2.88	0.30	0.83	3.00	0.27	0.76	4.25	0.41	1.16	3.63	0.32	0.92
Judgment and Decision Making	2.00	0.33	0.93	2.63	0.26	0.74	2.75	0.31	0.89	2.50	0.50	1.41	2.88	0.13	0.35	3.13	0.58*	1.64	3.13	0.23	0.64
Mathematics	0.13	0.13	0.35	3.00	0.00	0.00	0.13	0.13	0.35	4.63	0.26	0.74	3.00	0.00	0.00	5.38	0.26	0.74	3.13	0.23	0.64
English Language	3.38	0.38	1.06	2.13	0.13	0.35	3.75	0.16	0.46	2.38	0.32	0.92	1.88	0.30	0.83	3.13	0.40	1.13	2.00	0.19	0.53

Note. * Highlighted text flagged for SEm greater than 0.51, an indication of insufficient interrater agreement.

LPN Descriptive Statistics

O*NET Descriptors	Grade 8 Reading			Tasks Linked to Reading			Grade 12 Reading			Grade 8 Math			Tasks Linked to Grade 8 Math			Grade 12 Math			Tasks Linked to Grade 12 Math		
	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD
Written Comprehension	3.38	0.18	0.52	3.63	0.18	0.52	4.13	0.23	0.64	3.25	0.16	0.46	3.50	0.19	0.53	3.50	0.27	0.76	3.50	0.19	0.53
Written Expression	2.63	0.26	0.74	2.63	0.18	0.52	3.63	0.18	0.52	2.00	0.33	0.93	2.50	0.33	0.93	2.25	0.45	1.28	2.50	0.33	0.93
Fluency of Ideas	1.38	0.18	0.52	1.38	0.18	0.52	2.38	0.32	0.92	1.25	0.25	0.71	1.75	0.16	0.46	1.63	0.26	0.74	1.75	0.16	0.46
Originality	0.25	0.16	0.46	1.38	0.42	1.19	0.75	0.41	1.16	0.75	0.25	0.71	1.50	0.19	0.53	1.13	0.40	1.13	1.50	0.19	0.53
Problem Sensitivity	2.25	0.16	0.46	4.25	0.25	0.71	3.13	0.30	0.83	2.25	0.37	1.04	4.00	0.27	0.76	2.88	0.55*	1.55	4.00	0.27	0.76
Deductive Reasoning	2.38	0.26	0.74	2.88	0.23	0.64	3.13	0.40	1.13	4.38	0.18	0.52	3.00	0.19	0.53	4.88	0.23	0.64	3.00	0.19	0.53
Inductive Reasoning	2.88	0.23	0.64	3.50	0.27	0.76	4.25	0.16	0.46	3.38	0.38	1.06	3.38	0.26	0.74	4.00	0.38	1.07	3.38	0.26	0.74
Information Ordering	1.38	0.32	0.92	3.75	0.16	0.46	2.38	0.38	1.06	3.75	0.16	0.46	3.75	0.16	0.46	4.25	0.25	0.71	3.75	0.16	0.46
Category Flexibility	2.50	0.27	0.76	2.75	0.25	0.71	2.63	0.26	0.74	2.63	0.32	0.92	2.75	0.31	0.89	3.38	0.60*	1.69	2.75	0.31	0.89
Mathematical Reasoning	0.00	0.00	0.00	2.25	0.25	0.71	0.00	0.00	0.00	4.00	0.19	0.53	2.63	0.18	0.52	4.88	0.35	0.99	2.63	0.18	0.52
Number Facility	0.25	0.16	0.46	3.38	0.18	0.52	0.25	0.16	0.46	4.88	0.23	0.64	3.75	0.16	0.46	5.63	0.18	0.52	3.75	0.16	0.46
Memorization	1.38	0.18	0.52	3.13	0.44	1.25	2.00	0.33	0.93	2.13	0.35	0.99	3.50	0.46	1.31	2.63	0.38	1.06	3.50	0.46	1.31
Speed of Closure	1.13	0.23	0.64	3.50	0.33	0.93	2.13	0.30	0.83	2.50	0.53*	1.51	3.50	0.27	0.76	3.50	0.68*	1.93	3.50	0.27	0.76
Flexibility of Closure	3.00	0.00	0.00	3.50	0.38	1.07	3.75	0.31	0.89	3.00	0.42	1.20	3.63	0.18	0.52	3.75	0.53*	1.49	3.63	0.18	0.52
Visualization	0.13	0.13	0.35	2.75	0.31	0.89	0.13	0.13	0.35	2.75	0.37	1.04	2.50	0.27	0.76	3.25	0.45	1.28	2.50	0.27	0.76
Critical Thinking	3.38	0.18	0.52	3.50	0.27	0.76	4.50	0.19	0.53	3.50	0.19	0.53	3.38	0.26	0.74	4.00	0.33	0.93	3.38	0.26	0.74
Active Learning	2.38	0.26	0.74	3.13	0.40	1.13	2.75	0.45	1.28	2.88	0.48	1.36	2.88	0.40	1.13	3.13	0.40	1.13	2.88	0.40	1.13
Complex Problem Solving	1.88	0.30	0.83	2.63	0.26	0.74	3.13	0.23	0.64	3.25	0.25	0.71	2.88	0.30	0.83	4.00	0.27	0.76	2.88	0.30	0.83
Judgment and Decision Making	2.38	0.18	0.52	2.50	0.19	0.53	2.88	0.23	0.64	2.00	0.33	0.93	2.25	0.37	1.04	2.63	0.46	1.30	2.25	0.37	1.04
Mathematics	0.00	0.00	0.00	2.50	0.19	0.53	0.00	0.00	0.00	4.50	0.19	0.53	3.13	0.13	0.35	5.50	0.27	0.76	3.13	0.13	0.35
English Language	3.38	0.18	0.52	2.63	0.18	0.52	4.13	0.23	0.64	2.38	0.32	0.92	2.50	0.19	0.53	2.38	0.32	0.92	2.50	0.19	0.53

Note. * Highlighted text flagged for SEm greater than 0.51, an indication of insufficient interrater agreement.

Pharmacy Technician Descriptive Statistics

O*NET Descriptors	Grade 8 Reading			Tasks Linked to Reading			Grade 12 Reading			Grade 8 Math			Tasks Linked to Grade 8 Math			Grade 12 Math			Tasks Linked to Grade 12 Math		
	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD	M	SEm	SD
Written Comprehension	3.50	0.19	0.53	3.75	0.16	0.46	4.25	0.16	0.46	3.00	0.19	0.53	3.50	0.19	0.53	3.50	0.27	0.76	3.50	0.19	0.53
Written Expression	2.50	0.19	0.53	3.13	0.13	0.35	3.25	0.25	0.71	1.88	0.35	0.99	2.63	0.18	0.52	2.00	0.33	0.93	2.75	0.16	0.46
Fluency of Ideas	1.00	0.33	0.93	0.88	0.23	0.64	1.88	0.48	1.36	0.63	0.26	0.74	0.75	0.25	0.71	0.63	0.32	0.92	0.75	0.25	0.71
Originality	0.63	0.26	0.74	1.38	0.26	0.74	1.13	0.35	0.99	0.38	0.18	0.52	1.25	0.31	0.89	0.38	0.18	0.52	1.13	0.30	0.83
Problem Sensitivity	1.63	0.38	1.06	3.75	0.25	0.71	2.63	0.26	0.74	2.13	0.40	1.13	3.75	0.25	0.71	2.38	0.46	1.30	3.63	0.26	0.74
Deductive Reasoning	2.38	0.38	1.06	3.38	0.32	0.92	3.25	0.37	1.04	3.63	0.26	0.74	3.13	0.23	0.64	4.25	0.25	0.71	3.25	0.16	0.46
Inductive Reasoning	3.13	0.23	0.64	2.38	0.32	0.92	3.75	0.16	0.46	2.88	0.30	0.83	2.25	0.31	0.89	3.50	0.27	0.76	2.38	0.32	0.92
Information Ordering	1.75	0.37	1.04	3.38	0.42	1.19	2.38	0.38	1.06	3.13	0.44	1.25	2.75	0.37	1.04	3.38	0.46	1.30	2.63	0.46	1.30
Category Flexibility	2.63	0.42	1.19	3.13	0.30	0.83	3.13	0.23	0.64	3.13	0.30	0.83	3.00	0.27	0.76	3.25	0.25	0.71	3.13	0.30	0.83
Mathematical Reasoning	0.00	0.00	0.00	2.50	0.57*	1.60	0.00	0.00	0.00	3.38	0.38	1.06	3.13	0.40	1.13	4.25	0.31	0.89	3.13	0.40	1.13
Number Facility	0.13	0.13	0.35	3.38	0.26	0.74	0.13	0.13	0.35	3.75	0.31	0.89	3.75	0.25	0.71	4.63	0.18	0.52	3.75	0.25	0.71
Memorization	1.38	0.42	1.19	2.88	0.30	0.83	1.63	0.32	0.92	1.88	0.44	1.25	2.50	0.33	0.93	1.75	0.45	1.28	2.75	0.37	1.04
Speed of Closure	1.50	0.27	0.76	2.88	0.35	0.99	2.00	0.27	0.76	1.88	0.44	1.25	2.75	0.25	0.71	2.25	0.53*	1.49	2.38	0.32	0.92
Flexibility of Closure	2.50	0.57*	1.60	3.38	0.26	0.74	3.25	0.37	1.04	2.25	0.37	1.04	2.88	0.35	0.99	3.13	0.44	1.25	2.88	0.44	1.25
Visualization	0.13	0.13	0.35	1.63	0.18	0.52	0.13	0.13	0.35	2.88	0.40	1.13	1.75	0.31	0.89	3.00	0.50	1.41	1.63	0.26	0.74
Critical Thinking	2.38	0.38	1.06	2.50	0.38	1.07	3.13	0.52*	1.46	2.38	0.42	1.19	2.50	0.27	0.76	3.00	0.42	1.20	2.50	0.27	0.76
Active Learning	1.88	0.44	1.25	2.88	0.23	0.64	2.25	0.49	1.39	0.88	0.23	0.64	2.75	0.31	0.89	1.00	0.33	0.93	2.75	0.25	0.71
Complex Problem Solving	1.50	0.42	1.20	2.13	0.13	0.35	2.25	0.49	1.39	2.88	0.23	0.64	2.13	0.13	0.35	3.50	0.33	0.93	2.25	0.16	0.46
Judgment and Decision Making	2.13	0.40	1.13	1.88	0.23	0.64	2.63	0.38	1.06	1.63	0.42	1.19	1.88	0.13	0.35	2.00	0.46	1.31	1.88	0.13	0.35
Mathematics	0.00	0.00	0.00	2.50	0.42	1.20	0.38	0.38	1.06	3.63	0.26	0.74	3.00	0.27	0.76	4.63	0.26	0.74	3.00	0.27	0.76
English Language	3.13	0.13	0.35	3.25	0.16	0.46	3.75	0.16	0.46	2.13	0.30	0.83	2.75	0.16	0.46	2.25	0.37	1.04	2.88	0.23	0.64

Note. *Highlighted text flagged for SEM greater than 0.51, an indication of insufficient interrater agreement.

Appendix P: Effect Size Analysis

AMT: Reading Grade 8 Effect Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G8 RD <i>M</i>	Training Tasks Linked to RD <i>M</i>	NAEP G8 RD <i>SD</i>	Training Tasks Linked to RD <i>SD</i>	Effect Size <i>d</i>
Written Comprehension	3.50	3.25	0.53	0.46	0.50
Critical Thinking	3.38	3.00	0.92	0.76	0.45
English Language	3.25	2.25	0.46	0.46	2.16
Inductive Reasoning	3.13	3.00	0.35	0.93	0.18
Written Expression	3.00	2.25	0.76	0.71	1.02
Deductive Reasoning	2.88	3.75	0.64	0.71	-1.30
Active Learning	2.88	2.50	0.83	0.76	0.47
Category Flexibility	2.75	2.63	0.89	0.52	0.17
Problem Sensitivity	2.50	3.63	0.93	1.19	-1.06
Information Ordering	2.38	3.25	0.92	1.04	-0.90
Flexibility of Closure	2.25	3.75	1.28	0.71	-1.45
Judgment and Decision Making	2.13	2.13	0.83	0.83	0.00
Memorization	1.88	2.88	0.83	1.13	-1.01
Quality Control Analysis*	1.75	2.88	1.16	1.13	-0.98
Systems Analysis*	1.63	3.00	1.51	1.07	-1.05
Originality	1.50	2.00	0.53	0.76	-0.76
Speed of Closure	1.50	2.63	0.53	1.30	-1.13
Complex Problem Solving	1.50	3.25	0.93	1.04	-1.78
Fluency of Ideas	1.38	3.13	0.74	0.99	-2.00
Systems Evaluation*	0.88	2.63	1.13	1.06	-1.60
Operations Analysis*	0.25	2.00	0.46	0.93	-2.39
Mathematical Reasoning*	0.25	2.38	0.46	0.92	-2.93
Mathematics*	0.25	2.88	0.46	0.83	-3.89
Number Facility*	0.13	2.38	0.35	0.74	-3.86
Visualization*	0.13	3.88	0.35	0.64	-7.25

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP reading.

AMT: Reading Grade 12 Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G12 RD <i>M</i>	Training Tasks Linked to RD <i>M</i>	NAEP G12 RD <i>SD</i>	Training Tasks Linked to RD <i>SD</i>	Effect Size <i>d</i>
Critical Thinking	4.38	3.00	0.52	0.76	2.12
Written Comprehension	4.25	3.25	0.71	0.46	1.67
English Language	4.00	2.25	0.53	0.46	3.50
Deductive Reasoning	3.63	3.75	0.52	0.71	-0.20
Active Learning	3.63	2.50	0.74	0.76	1.50
Inductive Reasoning	3.63	3.00	0.92	0.93	0.68
Written Expression	3.50	2.25	0.76	0.71	1.71
Judgment and Decision Making	2.88	2.13	0.99	0.83	0.82
Problem Sensitivity	2.75	3.63	0.71	1.19	-0.90
Information Ordering	2.63	3.25	0.74	1.04	-0.69
Category Flexibility	2.63	2.63	0.92	0.52	0.00
Flexibility of Closure	2.63	3.75	1.19	0.71	-1.15
Memorization	2.50	2.88	0.93	1.13	-0.36
Originality	2.38	2.00	0.92	0.76	0.45
Fluency of Ideas	2.25	3.13	1.04	0.99	-0.86
Complex Problem Solving	2.25	3.25	1.28	1.04	-0.86
Speed of Closure	2.13	2.63	0.99	1.30	-0.43
Quality Control Analysis*	2.00	2.88	1.31	1.13	-0.72
Systems Analysis*	1.75	3.00	1.67	1.07	-0.89
Systems Evaluation*	1.38	2.63	1.60	1.06	-0.92
Operations Analysis*	0.75	2.00	1.39	0.93	-1.06
Mathematical Reasoning*	0.25	2.38	0.46	0.92	-2.93
Visualization*	0.25	3.88	0.46	0.64	-6.48
Mathematics*	0.25	2.88	0.46	0.83	-3.89
Number Facility*	0.13	2.38	0.35	0.74	-3.86

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP reading.

AMT: Mathematics Grade 8 Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G8 MA <i>M</i>	Training Tasks Linked to G8 MA <i>M</i>	NAEP G8 MA <i>SD</i>	Training Tasks Linked to G8 MA <i>SD</i>	Effect Size <i>d</i>
Number Facility	4.63	2.38	0.74	0.74	3.02
Mathematical Reasoning	4.13	2.38	0.35	0.92	2.52
Mathematics	4.00	2.88	0.53	0.83	1.61
Critical Thinking	3.50	3.00	0.93	0.76	0.59
Visualization	3.38	3.88	0.92	0.64	-0.63
Information Ordering	3.38	3.25	0.74	1.04	0.14
Flexibility of Closure	3.38	3.75	1.06	0.71	-0.42
Deductive Reasoning	3.25	3.75	0.46	0.71	-0.84
Category Flexibility	3.25	2.63	0.71	0.52	1.01
Speed of Closure	3.25	2.63	1.16	1.30	0.51
Inductive Reasoning	3.13	3.00	0.99	0.93	0.13
Written Comprehension	3.00	3.25	0.00	0.46	-0.76
Complex Problem Solving	3.00	3.25	1.07	1.04	-0.24
Problem Sensitivity	2.38	3.63	0.74	1.19	-1.26
English Language	2.38	2.25	0.74	0.46	0.20
Memorization	2.25	2.88	0.89	1.13	-0.62
Judgment and Decision Making	2.13	2.13	0.83	0.83	0.00
Written Expression	2.00	2.25	0.76	0.71	-0.34
Active Learning	1.88	2.50	0.64	0.76	-0.89
Systems Analysis*	1.75	3.00	1.16	1.07	-1.12
Originality	1.50	2.00	0.76	0.76	-0.66
Quality Control Analysis*	1.50	2.88	1.07	1.13	-1.25
Fluency of Ideas	1.25	3.13	0.46	0.99	-2.42
Operations Analysis*	1.25	2.00	1.04	0.93	-0.76
Systems Evaluation*	1.13	2.63	0.64	1.06	-1.71

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP mathematics.

AMT: Mathematics Grade 12 Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G12 MA <i>M</i>	Training Tasks Linked to G12 MA <i>M</i>	NAEP G12 MA <i>SD</i>	Training Tasks Linked to G12 MA <i>SD</i>	Effect Size <i>d</i>
Mathematics	4.88	2.88	0.83	0.83	2.40
Number Facility	4.75	2.38	0.46	0.74	3.83
Mathematical Reasoning	4.25	2.38	0.71	0.92	2.29
Information Ordering	3.88	3.25	0.83	1.04	0.66
Critical Thinking	3.75	3.00	1.04	0.76	0.83
Deductive Reasoning	3.75	3.75	0.71	0.71	0.00
Written Comprehension	3.38	3.25	0.52	0.46	0.25
Complex Problem Solving	3.38	3.25	1.19	1.04	0.11
Visualization	3.25	3.88	1.04	0.64	-0.73
Category Flexibility	3.25	2.63	0.89	0.52	0.86
Flexibility of Closure	3.25	3.75	1.49	0.71	-0.43
English Language	3.13	2.25	0.99	0.46	1.13
Speed of Closure	3.00	2.63	0.53	1.30	0.38
Inductive Reasoning	2.88	3.00	0.64	0.93	-0.16
Problem Sensitivity	2.75	3.63	1.04	1.19	-0.79
Written Expression	2.50	2.25	0.93	0.71	0.30
Systems Analysis*	2.38	3.00	0.92	1.07	-0.63
Active Learning	2.38	2.50	0.92	0.76	-0.15
Memorization	2.25	2.88	0.89	1.13	-0.62
Quality Control Analysis*	2.13	2.88	1.25	1.13	-0.63
Judgment and Decision Making	2.13	2.13	0.83	0.83	0.00
Originality	1.75	2.00	0.71	0.76	-0.34
Fluency of Ideas	1.63	3.13	0.74	0.99	-1.71
Operations Analysis*	1.25	2.00	1.28	0.93	-0.67
Systems Evaluation*	1.25	2.63	0.89	1.06	-1.41

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP mathematics.

CSS: Grade 8 Reading Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G8 RD <i>M</i>	Training Tasks Linked to RD <i>M</i>	NAEP G8 RD <i>SD</i>	Training Tasks Linked to RD <i>SD</i>	Effect Size <i>d</i>
Written Comprehension	3.25	3.88	0.46	0.83	-0.93
Critical Thinking	3.25	3.38	0.46	0.74	-0.20
English Language	3.25	3.13	0.46	0.35	0.30
Flexibility of Closure	3.00	3.13	0.93	0.35	-0.18
Inductive Reasoning	2.88	3.25	0.35	0.89	-0.56
Written Expression	2.75	3.38	0.71	0.52	-1.01
Deductive Reasoning	2.63	2.88	0.74	0.83	-0.32
Active Learning	2.25	2.75	0.46	1.04	-0.62
Category Flexibility	2.13	2.75	0.64	0.71	-0.93
Fluency of Ideas	2.00	2.75	0.53	0.89	-1.02
Problem Sensitivity	2.00	3.00	0.76	0.93	-1.18
Judgment and Decision Making	2.00	2.88	0.93	0.83	-0.99
Information Ordering	1.88	2.75	0.64	0.89	-1.13
Complex Problem Solving	1.88	2.75	1.25	0.89	-0.81
Quality Control Analysis*	1.88	3.13	1.13	0.99	-1.18
Memorization	1.75	2.88	0.71	0.83	-1.45
Speed of Closure	1.38	3.13	0.92	0.83	-2.00
Originality	1.13	2.13	0.64	0.64	-1.56
Systems Analysis*	0.88	2.75	0.83	1.04	-1.99
Systems Evaluation*	0.63	2.88	0.74	0.99	-2.57
Operations Analysis*	0.38	2.63	0.74	0.74	-3.02
Visualization*	0.25	2.50	0.46	0.76	-3.59
Mathematical Reasoning*	0.13	1.25	0.35	0.71	-2.01
Number Facility*	0.13	1.25	0.35	1.16	-1.31
Mathematics*	0.13	1.25	0.35	1.16	-1.31

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP reading.

CSS: Reading Grade 12 Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G12 RD <i>M</i>	Training Tasks Linked to RD <i>M</i>	NAEP G12 RD <i>SD</i>	Training Tasks Linked to RD <i>SD</i>	Effect Size <i>d</i>
Critical Thinking	4.25	3.38	0.46	0.74	1.41
Written Comprehension	4.00	3.88	0.53	0.83	0.18
English Language	4.00	3.13	0.53	0.35	1.93
Written Expression	3.50	3.38	0.53	0.52	0.24
Inductive Reasoning	3.50	3.25	0.76	0.89	0.30
Flexibility of Closure	3.50	3.13	0.53	0.35	0.83
Deductive Reasoning	3.38	2.88	0.74	0.83	0.63
Judgment and Decision Making	3.00	2.88	1.20	0.83	0.12
Information Ordering	2.88	2.75	1.13	0.89	0.12
Category Flexibility	2.88	2.75	0.64	0.71	0.19
Quality Control Analysis*	2.88	3.13	1.13	0.99	-0.24
Active Learning	2.75	2.75	0.71	1.04	0.00
Fluency of Ideas	2.63	2.75	0.52	0.89	-0.17
Speed of Closure	2.50	3.13	1.20	0.83	-0.61
Memorization	2.38	2.88	0.74	0.83	-0.63
Complex Problem Solving	2.38	2.75	1.51	0.89	-0.30
Problem Sensitivity	2.25	3.00	0.46	0.93	-1.02
Systems Analysis*	1.75	2.75	1.67	1.04	-0.72
Originality	1.38	2.13	0.74	0.64	-1.08
Systems Evaluation*	1.13	2.88	1.36	0.99	-1.47
Operations Analysis*	0.63	2.63	1.19	0.74	-2.02
Mathematical Reasoning*	0.25	1.25	0.46	0.71	-1.67
Number Facility*	0.25	1.25	0.46	1.16	-1.13
Visualization*	0.25	2.50	0.46	0.76	-3.59
Mathematics*	0.13	1.25	0.35	1.16	-1.31

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP reading.

CSS: Mathematics Grade 8 Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G8 MA <i>M</i>	Training Tasks Linked to G8 MA <i>M</i>	NAEP G8 MA <i>SD</i>	Training Tasks Linked to G8 MA <i>SD</i>	Effect Size <i>d</i>
Number Facility	4.25	2.13	0.46	1.13	2.47
Mathematics	4.13	2.13	0.35	1.13	2.40
Mathematical Reasoning	3.63	1.63	0.52	1.06	2.40
Deductive Reasoning	3.50	3.00	0.76	1.07	0.54
Critical Thinking	3.25	3.00	0.89	0.93	0.28
Written Comprehension	3.13	3.50	0.35	0.76	-0.64
Inductive Reasoning	3.13	3.13	0.64	0.99	0.00
Category Flexibility	3.13	2.75	0.35	0.46	0.91
Flexibility of Closure	3.13	3.50	0.64	0.76	-0.54
Information Ordering	3.00	3.13	1.07	1.13	-0.11
Complex Problem Solving	3.00	3.00	0.53	1.07	0.00
Quality Control Analysis*	2.63	2.88	0.74	0.64	-0.36
English Language	2.50	2.88	0.53	0.35	-0.83
Visualization	2.25	2.50	1.49	0.76	-0.21
Speed of Closure	2.13	3.25	1.13	1.04	-1.04
Written Expression	2.00	2.50	0.93	0.53	-0.66
Judgment and Decision Making	2.00	2.88	1.07	0.99	-0.85
Problem Sensitivity	1.88	3.25	0.83	0.89	-1.60
Memorization	1.50	2.38	0.93	0.74	-1.04
Active Learning	1.25	3.00	1.04	0.76	-1.93
Systems Analysis*	1.25	3.13	1.49	0.99	-1.48
Operations Analysis*	1.13	2.75	1.13	1.28	-1.35
Fluency of Ideas	1.00	2.63	0.93	0.74	-1.93
Originality	1.00	2.63	0.76	0.74	-2.17
Systems Evaluation*	1.00	3.00	1.20	0.76	-2.00

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP mathematics.

CSS: Mathematics Grade 12 Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G12 MA <i>M</i>	Training Tasks Linked to G12 MA <i>M</i>	NAEP G12 MA <i>SD</i>	Training Tasks Linked to G12 MA <i>SD</i>	Effect Size <i>d</i>
Mathematics	4.50	2.13	0.53	1.13	2.69
Number Facility	4.38	2.13	0.52	1.13	2.57
Mathematical Reasoning	4.25	1.63	0.46	1.06	3.21
Flexibility of Closure	4.00	3.38	0.53	0.74	0.96
Critical Thinking	3.88	3.25	0.64	0.71	0.93
Complex Problem Solving	3.75	3.00	0.71	1.07	0.83
Information Ordering	3.63	3.13	0.74	1.13	0.52
Written Comprehension	3.50	3.50	0.53	0.76	0.00
Deductive Reasoning	3.50	3.00	0.76	1.07	0.54
Inductive Reasoning	3.50	3.13	0.93	0.99	0.39
Category Flexibility	3.25	2.75	0.89	0.46	0.71
English Language	3.25	2.88	0.46	0.35	0.91
Visualization	2.50	2.50	1.93	0.76	0.00
Quality Control Analysis*	2.50	2.88	0.76	0.64	-0.54
Speed of Closure	2.38	3.25	0.52	1.04	-1.07
Judgment and Decision Making	2.38	2.75	0.92	1.04	-0.38
Written Expression	2.25	2.50	0.89	0.53	-0.34
Problem Sensitivity	2.25	3.38	1.04	0.92	-1.15
Memorization	2.13	2.50	0.99	0.76	-0.43
Active Learning	2.13	3.00	1.25	0.76	-0.85
Fluency of Ideas	1.25	2.50	1.04	0.76	-1.38
Operations Analysis*	1.25	2.75	1.16	1.16	-1.29
Systems Evaluation*	1.13	3.00	1.13	0.76	-1.96
Systems Analysis*	1.00	3.13	0.93	0.99	-2.22
Originality	0.88	2.63	0.64	0.74	-2.52

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP mathematics.

HVAC: Reading Grade 8 Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G8 RD <i>M</i>	Training Tasks Linked to RD <i>M</i>	NAEP G8 RD <i>SD</i>	Training Tasks Linked to RD <i>SD</i>	Effect Size <i>d</i>
Deductive Reasoning	3.63	3.00	1.06	0.76	0.68
Critical Thinking	3.63	2.75	0.92	1.04	0.90
Inductive Reasoning	3.38	3.63	0.74	0.92	-0.30
Written Comprehension	3.38	3.75	0.52	1.04	-0.46
English Language	3.38	2.13	1.06	0.35	1.58
Problem Sensitivity	2.88	3.63	0.99	1.06	-0.73
Complex Problem Solving	2.75	3.13	1.16	0.64	-0.40
Written Expression	2.50	2.38	0.93	0.52	0.17
Flexibility of Closure	2.50	3.50	0.53	0.93	-1.32
Category Flexibility	2.25	2.13	1.04	0.83	0.13
Active Learning	2.13	2.25	1.64	0.89	-0.09
Quality Control Analysis*	2.13	4.50	0.99	0.93	-2.48
Judgment and Decision Making	2.00	2.63	0.93	0.74	-0.74
Memorization	1.75	3.50	1.04	0.93	-1.78
Fluency of Ideas	1.63	2.63	0.52	1.06	-1.20
Information Ordering	1.38	4.13	1.51	0.83	-2.26
Speed of Closure	1.13	3.13	0.83	1.13	-2.02
Originality	1.00	2.25	0.93	1.04	-1.27
Number Facility*	0.38	2.75	0.52	0.71	-3.83
Operations Analysis*	0.38	2.13	0.52	1.64	-1.44
Systems Analysis*	0.25	3.00	0.46	1.31	-2.80
Mathematical Reasoning*	0.13	2.00	0.35	0.53	-4.14
Mathematics*	0.13	3.00	0.35	0.00	-11.50
Systems Evaluation*	0.13	4.63	0.35	1.30	-4.72
Visualization*	0.00	4.13	0.00	0.83	-6.99

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP reading.

HVAC: Reading Grade 12 Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G12 RD <i>M</i>	Training Tasks Linked to RD <i>M</i>	NAEP G12 RD <i>SD</i>	Training Tasks Linked to RD <i>SD</i>	Effect Size <i>d</i>
Critical Thinking	4.25	2.75	0.89	1.04	1.56
Written Comprehension	4.00	3.75	0.53	1.04	0.30
Deductive Reasoning	3.88	3.00	0.99	0.76	0.99
Inductive Reasoning	3.75	3.63	1.28	0.92	0.11
Written Expression	3.75	2.38	0.71	0.52	2.22
English Language	3.75	2.13	0.46	0.35	3.95
Problem Sensitivity	3.50	3.63	1.07	1.06	-0.12
Complex Problem Solving	3.25	3.13	1.16	0.64	0.13
Flexibility of Closure	3.13	3.50	0.83	0.93	-0.43
Quality Control Analysis*	2.88	4.50	0.83	0.93	-1.84
Judgment and Decision Making	2.75	2.63	0.89	0.74	0.15
Fluency of Ideas	2.50	2.63	0.76	1.06	-0.14
Memorization	2.38	3.50	0.92	0.93	-1.22
Category Flexibility	2.25	2.13	1.28	0.83	0.12
Information Ordering	2.00	4.13	1.07	0.83	-2.22
Originality	2.00	2.25	1.20	1.04	-0.22
Active Learning	1.88	2.25	1.13	0.89	-0.37
Speed of Closure	1.38	3.13	0.74	1.13	-1.83
Number Facility*	0.63	2.75	1.06	0.71	-2.36
Operations Analysis*	0.50	2.13	0.53	1.64	-1.33
Mathematical Reasoning*	0.38	2.00	1.06	0.53	-1.93
Systems Analysis*	0.25	3.00	0.46	1.31	-2.80
Mathematics*	0.13	3.00	0.35	0.00	-11.50
Systems Evaluation*	0.13	4.63	0.35	1.30	-4.72
Visualization*	0.00	4.13	0.00	0.83	-6.99

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP reading.

HVAC: Grade 8 Mathematics Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G8 MA M	Training Tasks Linked to G8 MA M	NAEP G8 MA SD	Training Tasks Linked to G8 MA SD	Effect Size d
Mathematics	4.63	3.00	0.74	0.00	3.09
Number Facility	4.25	3.50	1.16	0.53	0.83
Mathematical Reasoning	4.13	2.63	0.99	0.52	1.90
Deductive Reasoning	3.88	3.13	0.64	1.13	0.82
Information Ordering	3.38	4.13	0.74	0.99	-0.86
Inductive Reasoning	3.38	3.88	0.74	0.83	-0.63
Critical Thinking	3.38	3.00	0.92	1.20	0.35
Category Flexibility	3.25	2.88	0.46	0.64	0.67
Flexibility of Closure	3.13	4.00	1.25	0.76	-0.85
Visualization	3.13	4.50	1.25	0.53	-1.43
Written Comprehension	3.00	3.38	0.53	0.52	-0.71
Complex Problem Solving	2.88	3.00	0.83	0.76	-0.16
Judgment and Decision Making	2.50	2.88	1.41	0.35	-0.36
Speed of Closure	2.38	3.63	1.06	0.92	-1.26
English Language	2.38	1.88	0.92	0.83	0.57
Memorization	2.25	3.13	0.89	0.64	-1.13
Written Expression	2.13	2.38	1.13	0.74	-0.26
Problem Sensitivity	1.88	4.00	0.99	1.20	-1.94
Quality Control Analysis*	1.38	4.38	0.92	0.92	-3.27
Operations Analysis*	1.25	2.25	1.04	1.49	-0.78
Active Learning	1.13	2.88	0.64	0.83	-2.35
Systems Analysis*	1.13	2.88	1.46	0.99	-1.40
Originality	1.00	2.88	1.20	0.99	-1.71
Fluency of Ideas	0.88	3.00	0.99	1.07	-2.06
Systems Evaluation*	0.25	4.00	0.46	1.20	-4.14

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP mathematics.

HVAC: Mathematics Grade 12 Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G12 MA <i>M</i>	Training Tasks Linked to G12 MA <i>M</i>	NAEP G12 MA <i>SD</i>	Training Tasks Linked to G12 MA <i>SD</i>	Effect Size <i>d</i>
Mathematics	5.38	3.13	0.74	0.64	3.24
Number Facility	5.13	3.75	0.64	0.71	2.04
Deductive Reasoning	4.63	3.88	0.74	0.99	0.86
Mathematical Reasoning	4.63	3.00	0.74	0.53	2.51
Information Ordering	4.25	4.50	0.71	0.76	-0.34
Visualization	4.25	4.75	1.39	0.71	-0.45
Complex Problem Solving	4.25	3.63	1.16	0.92	0.60
Inductive Reasoning	4.00	3.88	0.93	0.83	0.14
Critical Thinking	4.00	3.88	1.07	0.99	0.12
Flexibility of Closure	3.75	3.88	0.89	0.83	-0.15
Category Flexibility	3.75	2.88	0.71	1.13	0.93
Written Comprehension	3.63	3.50	0.52	0.53	0.24
Speed of Closure	3.50	3.75	1.69	0.71	-0.19
Judgment and Decision Making	3.13	3.13	1.64	0.64	0.00
English Language	3.13	2.00	1.13	0.53	1.28
Problem Sensitivity	3.00	4.38	0.93	1.06	-1.38
Memorization	2.75	3.50	1.04	0.53	-0.91
Written Expression	2.50	2.38	1.20	0.74	0.13
Active Learning	1.75	2.88	1.28	0.83	-1.04
Quality Control Analysis*	1.63	3.88	1.06	0.99	-2.19
Operations Analysis*	1.50	2.75	1.07	1.39	-1.01
Originality	1.25	3.13	1.58	0.99	-1.42
Systems Analysis*	1.13	2.88	1.55	1.25	-1.24
Fluency of Ideas	0.88	3.00	1.13	1.07	-1.94
Systems Evaluation*	0.38	4.25	0.74	1.28	-3.70

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP mathematics.

LPN: Grade 8 Reading Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G8 RD <i>M</i>	Training Tasks Linked to RD <i>M</i>	NAEP G8 RD <i>SD</i>	Training Tasks Linked to RD <i>SD</i>	Effect Size <i>d</i>
Written Comprehension	3.38	3.63	0.52	0.52	-0.48
Critical Thinking	3.38	3.50	0.52	0.76	-0.19
English Language	3.38	2.63	0.52	0.52	1.45
Flexibility of Closure	3.00	3.50	0.00	1.07	-0.66
Inductive Reasoning	2.88	3.50	0.64	0.76	-0.89
Written Expression	2.63	2.63	0.74	0.52	0.00
Category Flexibility	2.50	2.75	0.76	0.71	-0.34
Deductive Reasoning	2.38	2.88	0.74	0.64	-0.72
Active Learning	2.38	3.13	0.74	1.13	-0.79
Judgment and Decision Making	2.38	2.50	0.52	0.53	-0.24
Problem Sensitivity	2.25	4.25	0.46	0.71	-3.35
Complex Problem Solving	1.88	2.63	0.83	0.74	-0.95
Quality Control Analysis*	1.88	3.13	0.64	0.64	-1.95
Systems Analysis*	1.50	2.13	1.07	0.35	-0.78
Fluency of Ideas	1.38	1.38	0.52	0.52	0.00
Information Ordering	1.38	3.75	0.92	0.46	-3.27
Memorization	1.38	3.13	0.52	1.25	-1.83
Speed of Closure	1.13	3.50	0.64	0.93	-2.98
Systems Evaluation*	1.13	2.88	0.83	0.83	-2.10
Operations Analysis*	0.75	1.88	0.46	0.64	-2.01
Originality	0.25	1.38	0.46	1.19	-1.25
Number Facility*	0.25	3.38	0.46	0.52	-6.36
Visualization*	0.13	2.75	0.35	0.89	-3.89
Mathematical Reasoning*	0.00	2.25	0.00	0.71	-4.50
Mathematics*	0.00	2.50	0.00	0.53	-6.61

Note *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP reading.

LPN: Grade 12 Reading Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G12 RD <i>M</i>	Training Tasks Linked to RD <i>M</i>	NAEP G12 RD <i>SD</i>	Training Tasks Linked to RD <i>SD</i>	Effect Size <i>d</i>
Critical Thinking	4.50	3.50	0.53	0.76	1.53
Inductive Reasoning	4.25	3.50	0.46	0.76	1.20
Written Comprehension	4.13	3.63	0.64	0.52	0.86
English Language	4.13	2.63	0.64	0.52	2.58
Flexibility of Closure	3.75	3.50	0.89	1.07	0.25
Written Expression	3.63	2.63	0.52	0.52	1.93
Deductive Reasoning	3.13	2.88	1.13	0.64	0.27
Complex Problem Solving	3.13	2.63	0.64	0.74	0.72
Problem Sensitivity	3.13	4.25	0.83	0.71	-1.45
Judgment and Decision Making	2.88	2.50	0.64	0.53	0.64
Quality Control Analysis*	2.88	3.13	0.64	0.64	-0.39
Active Learning	2.75	3.13	1.28	1.13	-0.31
Category Flexibility	2.63	2.75	0.74	0.71	-0.17
Fluency of Ideas	2.38	1.38	0.92	0.52	1.34
Information Ordering	2.38	3.75	1.06	0.46	-1.68
Speed of Closure	2.13	3.50	0.83	0.93	-1.56
Memorization	2.00	3.13	0.93	1.25	-1.02
Systems Analysis*	1.50	2.13	1.07	0.35	-0.78
Systems Evaluation*	1.38	2.88	1.06	0.83	-1.57
Operations Analysis*	0.88	1.88	0.64	0.64	-1.56
Originality	0.75	1.38	1.16	1.19	-0.53
Number Facility*	0.25	3.38	0.46	0.52	-6.36
Visualization*	0.13	2.75	0.35	0.89	-3.89
Mathematical Reasoning*	0.00	2.25	0.00	0.71	-4.50
Mathematics*	0.00	2.50	0.00	0.53	-6.61

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP reading.

LPN: Grade 8 Mathematics Effect Size Comparisons

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G8 MA <i>M</i>	Training Tasks Linked to G8 MA <i>M</i>	NAEP G8 MA <i>SD</i>	Training Tasks Linked to G8 MA <i>SD</i>	Effect Size <i>d</i>
Number Facility	4.88	3.75	0.64	0.46	2.01
Mathematics	4.50	3.13	0.53	0.35	3.03
Deductive Reasoning	4.38	3.00	0.52	0.53	2.61
Mathematical Reasoning	4.00	2.63	0.53	0.52	2.61
Information Ordering	3.75	3.75	0.46	0.46	0.00
Critical Thinking	3.50	3.38	0.53	0.74	0.19
Inductive Reasoning	3.38	3.38	1.06	0.74	0.00
Written Comprehension	3.25	3.50	0.46	0.53	-0.50
Complex Problem Solving	3.25	2.88	0.71	0.83	0.48
Flexibility of Closure	3.00	3.63	1.20	0.52	-0.68
Active Learning	2.88	2.88	1.36	1.13	0.00
Visualization	2.75	2.50	1.04	0.76	0.28
Category Flexibility	2.63	2.75	0.92	0.89	-0.14
Quality Control Analysis*	2.63	3.25	0.92	0.71	-0.76
Speed of Closure	2.50	3.50	1.51	0.76	-0.84
English Language	2.38	2.50	0.92	0.53	-0.17
Problem Sensitivity	2.25	4.00	1.04	0.76	-1.93
Memorization	2.13	3.50	0.99	1.31	-1.18
Judgment and Decision Making	2.00	2.25	0.93	1.04	-0.25
Written Expression	2.00	2.50	0.93	0.93	-0.54
Systems Analysis*	1.50	2.25	1.20	0.89	-0.71
Fluency of Ideas	1.25	1.75	0.71	0.46	-0.84
Operations Analysis*	1.13	2.25	0.99	1.16	-1.04
Systems Evaluation*	1.00	2.25	0.76	0.71	-1.71
Originality	0.75	1.50	0.71	0.53	-1.20

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP mathematics.

LPN: Grade 12 Mathematics Effect Size Comparison

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G12 MA M	Training Tasks Linked to G12 MA M	NAEP G12 MA SD	Training Tasks Linked to G12 MA SD	Effect Size d
Number Facility	5.63	3.75	0.52	0.46	3.82
Mathematics	5.50	3.13	0.76	0.35	4.02
Deductive Reasoning	4.88	3.00	0.64	0.53	3.18
Mathematical Reasoning	4.88	2.63	0.99	0.52	2.85
Information Ordering	4.25	3.75	0.71	0.46	0.84
Inductive Reasoning	4.00	3.38	1.07	0.74	0.68
Critical Thinking	4.00	3.38	0.93	0.74	0.74
Complex Problem Solving	4.00	2.88	0.76	0.83	1.41
Flexibility of Closure	3.75	3.63	1.49	0.52	0.11
Written Comprehension	3.50	3.50	0.76	0.53	0.00
Speed of Closure	3.50	3.50	1.93	0.76	0.00
Category Flexibility	3.38	2.75	1.69	0.89	0.46
Visualization	3.25	2.50	1.28	0.76	0.71
Active Learning	3.13	2.88	1.13	1.13	0.22
Quality Control Analysis*	3.13	3.25	1.13	0.71	-0.13
Problem Sensitivity	2.88	4.00	1.55	0.76	-0.92
Memorization	2.63	3.50	1.06	1.31	-0.73
Judgment and Decision Making	2.63	2.25	1.30	1.04	0.32
English Language	2.38	2.50	0.92	0.53	-0.17
Written Expression	2.25	2.50	1.28	0.93	-0.22
Systems Analysis*	1.75	2.25	1.58	0.89	-0.39
Fluency of Ideas	1.63	1.75	0.74	0.46	-0.20
Operations Analysis*	1.38	2.25	1.06	1.16	-0.79
Systems Evaluation*	1.25	2.25	0.89	0.71	-1.25
Originality	1.13	1.50	1.13	0.53	-0.43

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP mathematics.

PT: Grade 8 Reading Effect Size Comparison

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G8 RD <i>M</i>	Training Tasks Linked to RD <i>M</i>	NAEP G8 RD <i>SD</i>	Training Tasks Linked to RD <i>SD</i>	Effect Size <i>d</i>
Written Comprehension	3.50	3.75	0.53	0.46	-0.50
English Language	3.13	3.25	0.35	0.46	-0.30
Inductive Reasoning	3.13	2.38	0.64	0.92	0.95
Category Flexibility	2.63	3.13	1.19	0.83	-0.49
Written Expression	2.50	3.13	0.53	0.35	-1.38
Flexibility of Closure	2.50	3.38	1.60	0.74	-0.70
Deductive Reasoning	2.38	3.38	1.06	0.92	-1.01
Critical Thinking	2.38	2.50	1.06	1.07	-0.12
Judgment and Decision Making	2.13	1.88	1.13	0.64	0.27
Active Learning	1.88	2.88	1.25	0.64	-1.01
Information Ordering	1.75	3.38	1.04	1.19	-1.46
Systems Analysis*	1.75	1.50	1.58	1.31	0.17
Problem Sensitivity	1.63	3.75	1.06	0.71	-2.36
Speed of Closure	1.50	2.88	0.76	0.99	-1.56
Complex Problem Solving	1.50	2.13	1.20	0.35	-0.71
Memorization	1.38	2.88	1.19	0.83	-1.46
Systems Evaluation*	1.25	1.50	0.89	1.31	-0.22
Quality Control Analysis*	1.13	3.50	1.13	0.76	-2.48
Fluency of Ideas	1.00	0.88	0.93	0.64	0.16
Originality	0.63	1.38	0.74	0.74	-1.01
Operations Analysis*	0.38	1.75	0.74	1.28	-1.31
Number Facility*	0.13	3.38	0.35	0.74	-5.58
Visualization*	0.13	1.63	0.35	0.52	-3.38
Mathematical Reasoning*	0.00	2.50	0.00	1.60	-2.20
Mathematics*	0.00	2.50	0.00	1.20	-2.96

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP reading.

PT: Grade 12 Reading Effect Size Comparison

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G12 RD <i>M</i>	Training Tasks Linked to RD <i>M</i>	NAEP G12 RD <i>SD</i>	Training Tasks Linked to RD <i>SD</i>	Effect Size <i>d</i>
Written Comprehension	4.25	3.75	0.46	0.46	1.08
Inductive Reasoning	3.75	2.38	0.46	0.92	1.89
English Language	3.75	3.25	0.46	0.46	1.08
Written Expression	3.25	3.13	0.71	0.35	0.22
Deductive Reasoning	3.25	3.38	1.04	0.92	-0.13
Flexibility of Closure	3.25	3.38	1.04	0.74	-0.14
Category Flexibility	3.13	3.13	0.64	0.83	0.00
Critical Thinking	3.13	2.50	1.46	1.07	0.49
Problem Sensitivity	2.63	3.75	0.74	0.71	-1.55
Judgment and Decision Making	2.63	1.88	1.06	0.64	0.86
Information Ordering	2.38	3.38	1.06	1.19	-0.89
Active Learning	2.25	2.88	1.39	0.64	-0.58
Complex Problem Solving	2.25	2.13	1.39	0.35	0.12
Speed of Closure	2.00	2.88	0.76	0.99	-0.99
Systems Analysis*	2.00	1.50	1.77	1.31	0.32
Fluency of Ideas	1.88	0.88	1.36	0.64	0.94
Memorization	1.63	2.88	0.92	0.83	-1.43
Quality Control Analysis*	1.50	3.50	1.07	0.76	-2.16
Systems Evaluation*	1.25	1.50	0.89	1.31	-0.22
Originality	1.13	1.38	0.99	0.74	-0.29
Operations Analysis*	0.38	1.75	0.74	1.28	-1.31
Mathematics*	0.38	2.50	1.06	1.20	-1.88
Number Facility*	0.13	3.38	0.35	0.74	-5.58
Visualization*	0.13	1.63	0.35	0.52	-3.38
Mathematical Reasoning*	0.00	2.50	0.00	1.60	-2.20

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP reading.

PT: Grade 8 Mathematics Effect Size Comparison

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G8 MA <i>M</i>	Training Tasks Linked to G8 MA <i>M</i>	NAEP G8 MA <i>SD</i>	Training Tasks Linked to G8 MA <i>SD</i>	Effect Size <i>d</i>
Number Facility	3.75	3.75	0.89	0.71	0.00
Mathematics	3.63	3.00	0.74	0.76	0.83
Deductive Reasoning	3.63	3.13	0.74	0.64	0.72
Mathematical Reasoning	3.38	3.13	1.06	1.13	0.23
Category Flexibility	3.13	3.00	0.83	0.76	0.16
Information Ordering	3.13	2.75	1.25	1.04	0.33
Written Comprehension	3.00	3.50	0.53	0.53	-0.94
Inductive Reasoning	2.88	2.25	0.83	0.89	0.73
Visualization	2.88	1.75	1.13	0.89	1.11
Complex Problem Solving	2.88	2.13	0.64	0.35	1.45
Critical Thinking	2.38	2.50	1.19	0.76	-0.13
Flexibility of Closure	2.25	2.88	1.04	0.99	-0.62
Problem Sensitivity	2.13	3.75	1.13	0.71	-1.73
English Language	2.13	2.75	0.83	0.46	-0.93
Written Expression	1.88	2.63	0.99	0.52	-0.95
Memorization	1.88	2.50	1.25	0.93	-0.57
Speed of Closure	1.88	2.75	1.25	0.71	-0.86
Judgment and Decision Making	1.63	1.88	1.19	0.35	-0.29
Quality Control Analysis*	1.25	3.38	0.89	1.19	-2.03
Active Learning	0.88	2.75	0.64	0.89	-2.42
Fluency of Ideas	0.63	0.75	0.74	0.71	-0.17
Operations Analysis*	0.63	2.13	1.06	0.99	-1.46
Systems Analysis*	0.50	1.88	0.76	0.99	-1.56
Systems Evaluation*	0.50	1.88	0.53	1.13	-1.56
Originality	0.38	1.25	0.52	0.89	-1.21

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP mathematics.

PT: Grade 12 Mathematics Effect Size Comparison

O*NET Descriptors (sorted in descending order by mean ratings for NAEP)	NAEP G12 MA <i>M</i>	Training Tasks Linked to G12 MA <i>M</i>	NAEP G12 MA <i>SD</i>	Training Tasks Linked to G12 MA <i>SD</i>	Effect Size <i>d</i>
Mathematics	4.63	3.00	0.74	0.76	2.17
Number Facility	4.63	3.75	0.52	0.71	1.41
Deductive Reasoning	4.25	3.25	0.71	0.46	1.67
Mathematical Reasoning	4.25	3.13	0.89	1.13	1.11
Written Comprehension	3.50	3.50	0.76	0.53	0.00
Inductive Reasoning	3.50	2.38	0.76	0.92	1.34
Complex Problem Solving	3.50	2.25	0.93	0.46	1.71
Information Ordering	3.38	2.63	1.30	1.30	0.58
Category Flexibility	3.25	3.13	0.71	0.83	0.16
Flexibility of Closure	3.13	2.88	1.25	1.25	0.20
Critical Thinking	3.00	2.50	1.20	0.76	0.50
Visualization	3.00	1.63	1.41	0.74	1.22
Problem Sensitivity	2.38	3.63	1.30	0.74	-1.18
Speed of Closure	2.25	2.38	1.49	0.92	-0.10
English Language	2.25	2.88	1.04	0.64	-0.73
Written Expression	2.00	2.75	0.93	0.46	-1.02
Judgment and Decision Making	2.00	1.88	1.31	0.35	0.13
Memorization	1.75	2.75	1.28	1.04	-0.86
Quality Control Analysis*	1.63	3.50	0.92	1.07	-1.88
Active Learning	1.00	2.75	0.93	0.71	-2.12
Operations Analysis*	1.00	2.13	1.07	0.99	-1.09
Systems Analysis*	0.63	2.13	0.74	0.83	-1.90
Fluency of Ideas	0.63	0.75	0.92	0.71	-0.15
Systems Evaluation*	0.50	2.00	0.53	1.07	-1.77
Originality	0.38	1.13	0.52	0.83	-1.08

Note. *Shaded rows denote O*NET KSA descriptors not included in the results section of the report due to their lack of relevance to NAEP mathematics.

Appendix Q: Comparisons of Levels of KSAs Needed for NAEP and for Training Performance Requirements

Automotive Master Technician

O*NET Descriptors	Level Needed for G8 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content	Match?	Level Needed for G12 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content ^a	Match?	Level Needed for G8 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G8 NAEP MA Content	Match?	Level Needed for G12 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G12 NAEP MA Content	Match?
Written Comprehension	Mod	Mod	Yes	M/High	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes
Written Expression	Mod	M/Low	No	Mod	M/Low	No	M/Low	M/Low	Yes	M/Low	M/Low	Yes
Fluency of Ideas	Low	Mod	No	M/Low	Mod	No	Low	Mod	No	Low	Mod	No
Originality	Low	M/Low	No	M/Low	M/Low	Yes	Low	M/Low	No	Low	M/Low	No
Problem Sensitivity	M/Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No
Deductive Reasoning	M/Low	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes	Mod	Mod	Yes
Inductive Reasoning	Mod	Mod	Yes	Mod	Mod	Yes	Mod	Mod	Yes	M/Low	Mod	No
Information Ordering	M/Low	Mod	No	M/Low	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes
Category Flexibility	M/Low	M/Low	Yes	M/Low	M/Low	Yes	Mod	M/Low	No	Mod	M/Low	No
Mathematical Reasoning	-- ^b	--	--	--	--	--	M/High	M/Low	No	M/High	M/Low	No
Number Facility	--	--	--	--	--	--	High	M/Low	No	High	M/Low	No
Memorization	Low	M/Low	No	M/Low	M/Low	Yes	M/Low	M/Low	Yes	M/Low	M/Low	Yes
Speed of Closure	Low	M/Low	No	M/Low	M/Low	Yes	Mod	M/Low	No	Mod	M/Low	No
Flexibility of Closure	M/Low	Mod	No	M/Low	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes
Visualization	--	--	--	--	--	--	Mod	Mod	Yes	Mod	Mod	Yes
Critical Thinking	Mod	Mod	Yes	M/High	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes
Active Learning	M/Low	M/Low	Yes	Mod	M/Low	No	Low	M/Low	No	M/Low	M/Low	Yes
Complex Problem Solving	Low	Mod	No	M/Low	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes
Judgment and Decision Making	M/Low	M/Low	Yes	M/Low	M/Low	Yes	M/Low	M/Low	Yes	M/Low	M/Low	Yes
Mathematics	--	--	--	--	--	--	M/High	M/Low	No	High	M/Low	No
English Language	Mod	M/Low	No	M/High	M/Low	No	M/Low	M/Low	Yes	Mod	M/Low	No

Note. ^aTasks (i.e., training performance requirements) were linked to NAEP objectives. Because NAEP objectives are the same for the NAEP reading assessments in grades 8 and 12, the tasks linked to NAEP reading content are the same for both grade 8 and grade 12. ^b The project analysts rated these descriptors as irrelevant to NAEP reading. M/Low = Moderate/Low; M/High = Moderate/High

Computer Support Specialist

O*NET Descriptors	Level Needed for G8 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content	Match?	Level Needed for G12 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content ^a	Match?	Level Needed for G8 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G8 NAEP MA Content	Match?	Level Needed for G12 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G12 NAEP MA Content	Match?
Written Comprehension	Mod	Mod	Yes	M/High	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes
Written Expression	M/Low	Mod	No	Mod	Mod	Yes	M/Low	M/Low	Yes	M/Low	M/Low	Yes
Fluency of Ideas	M/Low	M/Low	Yes	M/Low	M/Low	Yes	Low	M/Low	No	Low	M/Low	No
Originality	Low	M/Low	No	Low	M/Low	No	Low	M/Low	No	Low	M/Low	No
Problem Sensitivity	M/Low	Mod	No	M/Low	Mod	No	Low	Mod	No	M/Low	Mod	No
Deductive Reasoning	M/Low	M/Low	Yes	Mod	M/Low	No	Mod	Mod	Yes	Mod	Mod	Yes
Inductive Reasoning	M/Low	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes	Mod	Mod	Yes
Information Ordering	Low	M/Low	No	M/Low	M/Low	Yes	Mod	Mod	Yes	Mod	Mod	Yes
Category Flexibility	M/Low	M/Low	Yes	M/Low	M/Low	Yes	Mod	M/Low	No	Mod	M/Low	No
Mathematical Reasoning	-- ^b	--	--	--	--	--	Mod	Low	No	M/High	Low	No
Number Facility	--	--	--	--	--	--	M/High	M/Low	No	M/High	M/Low	No
Memorization	Low	M/Low	No	M/Low	M/Low	Yes	Low	M/Low	No	M/Low	M/Low	Yes
Speed of Closure	Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No
Flexibility of Closure	Mod	Mod	Yes	Mod	Mod	Yes	Mod	Mod	Yes	M/High	Mod	No
Visualization	--	--	--	--	--	--	M/Low	M/Low	Yes	M/Low	M/Low	Yes
Critical Thinking	Mod	Mod	Yes	M/High	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes
Active Learning	M/Low	M/Low	Yes	M/Low	M/Low	Yes	Low	Mod	No	M/Low	Mod	No
Complex Problem Solving	Low	M/Low	No	M/Low	M/Low	Yes	Mod	Mod	Yes	Mod	Mod	Yes
Judgment and Decision Making	M/Low	M/Low	Yes	Mod	M/Low	No	M/Low	M/Low	Yes	M/Low	M/Low	Yes
Mathematics	--	--	--	--	--	--	M/High	M/Low	No	High	M/Low	No
English Language	Mod	Mod	Yes	M/High	Mod	No	M/Low	M/Low	Yes	Mod	M/Low	No

Note. ^aTasks (i.e., training performance requirements) were linked to NAEP objectives. Because NAEP objectives are the same for the NAEP reading assessments in grades 8 and 12, the tasks linked to NAEP reading content are the same for both grade 8 and grade 12. ^b The project analysts rated these descriptors as irrelevant to NAEP reading. M/Low = Moderate/Low; M/High = Moderate/High

HVAC

O*NET Descriptors	Level Needed for G8 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content	Match?	Level Needed for G12 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content ^a	Match?	Level Needed for G8 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G8 NAEP MA Content	Match?	Level Needed for G12 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G12 NAEP MA Content	Match?
Written Comprehension	Mod	Mod	Yes	M/High	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes
Written Expression	M/Low	M/Low	Yes	Mod	M/Low	No	M/Low	M/Low	Yes	M/Low	M/Low	Yes
Fluency of Ideas	Low	M/Low	No	M/Low	M/Low	Yes	Low	Mod	No	Low	Mod	No
Originality	Low	M/Low	No	M/Low	M/Low	Yes	Low	M/Low	No	Low	Mod	No
Problem Sensitivity	M/Low	Mod	No	Mod	Mod	Yes	Low	M/High	No	Mod	M/High	No
Deductive Reasoning	Mod	Mod	Yes	Mod	Mod	Yes	Mod	Mod	Yes	High	Mod	No
Inductive Reasoning	Mod	Mod	Yes	Mod	Mod	Yes	Mod	Mod	Yes	M/High	Mod	No
Information Ordering	Low	M/High	No	M/Low	M/High	No	Mod	M/High	No	M/High	High	No
Category Flexibility	M/Low	M/Low	Yes	M/Low	M/Low	Yes	Mod	M/Low	No	Mod	M/Low	No
Mathematical Reasoning	-- ^b	--	--	--	--		M/High	M/Low	No	High	Mod	No
Number Facility	--	--	--	--	--		M/High	Mod	No	High	Mod	No
Memorization	Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No
Speed of Closure	Low	Mod	No	Low	Mod	No	M/Low	Mod	No	Mod	Mod	Yes
Flexibility of Closure	M/Low	Mod	No	Mod	Mod	Yes	Mod	M/High	No	Mod	Mod	Yes
Visualization	--	--	--	--	--	--	Mod	High	No	M/High	High	No
Critical Thinking	Mod	M/Low	No	M/High	M/Low	No	Mod	Mod	Yes	M/High	Mod	No
Active Learning	M/Low	M/Low	Yes	Low	M/Low	No	Low	M/Low	No	Low	M/Low	No
Complex Problem Solving	M/Low	Mod	No	Mod	Mod	Yes	M/Low	Mod	No	M/High	Mod	No
Judgment and Decision Making	M/Low	M/Low	Yes	M/Low	M/Low	Yes	M/Low	M/Low	Yes	Mod	Mod	Yes
Mathematics	--	--	--	--	--	--	High	Mod	No	High	Mod	No
English Language	Mod	M/Low	No	Mod	M/Low	No	M/Low	Low	No	Mod	M/Low	No

Note. ^aTasks (i.e., training performance requirements) were linked to NAEP objectives. Because NAEP objectives are the same for the NAEP reading assessments in grades 8 and 12, the tasks linked to NAEP reading content are the same for both grade 8 and grade 12.

^b The project analysts rated these descriptors as irrelevant to NAEP reading. M/Low = Moderate/Low; M/High = Moderate/High

LPN

O*NET Descriptors	Level Needed for G8 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content	Match?	Level Needed for G12 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content ^a	Match?	Level Needed for G8 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G8 NAEP MA Content	Match?	Level Needed for G12 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G12 NAEP MA Content	Match?
Written Comprehension	Mod	Mod	Yes	M/High	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes
Written Expression	M/Low	M/Low	Yes	Mod	M/Low	No	M/Low	M/Low	Yes	M/Low	M/Low	Yes
Fluency of Ideas	Low	Low	Yes	M/Low	Low	No	Low	Low	Yes	Low	Low	Yes
Originality	Low	Low	Yes	Low	Low	Yes	Low	Low	Yes	Low	Low	Yes
Problem Sensitivity	M/Low	M/High	No	Mod	M/High	No	M/Low	M/High	No	M/Low	M/High	No
Deductive Reasoning	M/Low	M/Low	Yes	Mod	M/Low	No	M/High	Mod	No	High	Mod	No
Inductive Reasoning	M/Low	Mod	No	M/High	Mod	No	Mod	Mod	Yes	M/High	Mod	No
Information Ordering	Low	Mod	No	M/Low	Mod	No	Mod	Mod	Yes	M/High	Mod	No
Category Flexibility	M/Low	M/Low	Yes	M/Low	M/Low	Yes	M/Low	M/Low	Yes	Mod	M/Low	No
Mathematical Reasoning	-- ^b	--	--	--	--	--	M/High	M/Low	No	High	M/Low	No
Number Facility	--	--	--	--	--	--	High	Mod	No	High	Mod	No
Memorization	Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No
Speed of Closure	Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No	Mod	Mod	Yes
Flexibility of Closure	Mod	Mod	Yes	Mod	Mod	Yes	Mod	Mod	Yes	Mod	Mod	Yes
Visualization	--	--	--	--	--	--	M/Low	M/Low	Yes	Mod	M/Low	No
Critical Thinking	Mod	Mod	Yes	High	Mod	No	Mod	Mod	Yes	M/High	Mod	No
Active Learning	M/Low	Mod	No	M/Low	Mod	No	M/Low	M/Low	Yes	Mod	M/Low	No
Complex Problem Solving	Low	M/Low	No	Mod	M/Low	No	Mod	M/Low	No	M/High	M/Low	No
Judgment and Decision Making	M/Low	M/Low	Yes	M/Low	M/Low	Yes	M/Low	M/Low	Yes	M/Low	M/Low	Yes
Mathematics	--	--	--	--	--	--	High	Mod	No	High	Mod	No
English Language	Mod	M/Low	No	M/High	M/Low	No	M/Low	M/Low	Yes	M/Low	M/Low	Yes

Note. ^aTasks (i.e., training performance requirements) were linked to NAEP objectives. Because NAEP objectives are the same for the NAEP reading assessments in grades 8 and 12, the tasks linked to NAEP reading content are the same for both grade 8 and grade 12.

^b The project analysts rated these descriptors as irrelevant to NAEP reading. M/Low = Moderate/Low; M/High = Moderate/High

Pharmacy Technician

O*NET Descriptors	Level Needed for G8 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content	Match?	Level Needed for G12 NAEP RD Content Linked to Training Tasks	Level Needed for Training Tasks Linked to NAEP RD Content ^a	Match?	Level Needed for G8 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G8 NAEP MA Content	Match?	Level Needed for G12 NAEP MA Content Linked to Training Tasks	Level Needed for Training Tasks Linked to G12 NAEP MA Content	Match?
Written Comprehension	Mod	Mod	Yes	M/High	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes
Written Expression	M/Low	Mod	No	Mod	Mod	Yes	Low	M/Low	No	M/Low	M/Low	Yes
Fluency of Ideas	Low	Low	Yes	Low	Low	Yes	Low	Low	Yes	Low	Low	Yes
Originality	Low	Low	Yes	Low	Low	Yes	Low	Low	Yes	Low	Low	Yes
Problem Sensitivity	Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No	M/Low	Mod	No
Deductive Reasoning	M/Low	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes	M/High	Mod	No
Inductive Reasoning	Mod	M/Low	No	Mod	M/Low	No	M/Low	M/Low	Yes	Mod	M/Low	No
Information Ordering	Low	Mod	No	M/Low	Mod	No	Mod	M/Low	No	Mod	M/Low	No
Category Flexibility	M/Low	Mod	No	Mod	Mod	Yes	Mod	Mod	Yes	Mod	Mod	Yes
Mathematical Reasoning	-- ^b	--	--	--	--	--	Mod	Mod	Yes	M/High	Mod	No
Number Facility	--	--	--	--	--	--	Mod	Mod	Yes	High	Mod	No
Memorization	Low	M/Low	No	Low	M/Low	No	Low	M/Low	No	Low	M/Low	No
Speed of Closure	Low	M/Low	No	M/Low	M/Low	Yes	Low	M/Low	No	M/Low	M/Low	Yes
Flexibility of Closure	M/Low	Mod	No	Mod	Mod	Yes	M/Low	M/Low	Yes	Mod	M/Low	No
Visualization	--	--	--	--	--	--	M/Low	Low	No	Mod	Low	No
Critical Thinking	M/Low	M/Low	Yes	Mod	M/Low	No	M/Low	M/Low	Yes	Mod	M/Low	No
Active Learning	Low	M/Low	No	M/Low	M/Low	Yes	Low	M/Low	No	Low	M/Low	No
Complex Problem Solving	Low	M/Low	No	M/Low	M/Low	Yes	M/Low	M/Low	Yes	Mod	M/Low	No
Judgment and Decision Making	M/Low	Low	No	M/Low	Low	No	Low	Low	Yes	M/Low	Low	No
Mathematics	--	--	--	--	--	--	Mod	Mod	Yes	High	Mod	No
English Language	Mod	Mod	Yes	Mod	Mod	Yes	M/Low	M/Low	Yes	M/Low	M/Low	Yes

Note. ^aTasks (i.e., training performance requirements) were linked to NAEP objectives. Because NAEP objectives are the same for the NAEP reading assessments in grades 8 and 12, the tasks linked to NAEP reading content are the same for both Grade 8 and Grade 12. ^b The project analysts rated these descriptors as irrelevant to NAEP reading. M/Low = Moderate/Low; M/High = Moderate/Hi