National Assessment Governing Board

National Assessment of Educational Progress Grade 12 Preparedness Research Project Job Training Programs Curriculum Study

Submitted: March 29, 2013

FINAL REPORT

Submitted to:
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This study was funded by the
National Assessment Governing Board
under Contract ED-NAG-10-C-0004.

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Executive Summary

Overview

This report describes the Job Training Programs Curriculum Study, which was commissioned by the National Assessment Governing Board (Governing Board) to analyze the content of course materials from five job training occupational areas and is part of a larger program of preparedness research projects that are being conducted for the Governing Board.

This study was designed to identify the knowledge, skills, and abilities (KSAs) that are prerequisite to and taught in entry-level job training programs; to describe the KSAs expected at the conclusion of job training programs; and to compare the prerequisite KSAs identified through analysis of job training course materials to KSAs identified as part of the Judgmental Standard Setting (JSS) study (WestEd & Measured Progress, 2011; Measured Progress & WestEd, 2012).

Artifacts from such courses included syllabi, assignments, examinations, reading/textbook passages, and textbook tables of contents. Teams of mathematics and reading content-area experts and occupational course instructors employed a convergent consensus model to analyze the artifacts in order to identify the minimal knowledge and skills required of students entering the courses. The KSAs identified were analyzed for job training programs within five occupational areas. These areas are: Automotive Master Technician; Computer Support Specialist; Heating, Ventilation, and Air Conditioning (HVAC); Licensed Practical and Licensed Vocational Nurse (LPN), and Pharmacy Technician (entry and concluding course level). Reviewers completed artifact analyses independently, and then were brought together in small groups to discuss the codings where they disagreed in order to resolve differences and reach consensus on the KSAs that are prerequisite for each of the job training programs.

The comprehensive mathematics and reading frameworks provided by the National Assessment of Educational Progress (NAEP) outline the structure for defining the KSAs. However, because the goal of the study was to identify all KSAs required of students entering job training programs, the analysis was not limited to the NAEP objectives; reviewers also recorded non-NAEP KSAs and identified parts of the existing NAEP frameworks that did not apply. This more inclusive process meets an important goal of the study: to develop rich text descriptions of what students need to know and be able to do overall, based on the evidence from course materials. After these group results were summarized across courses within programs, teams of NAEP framework experts compared them to the NAEP items that are associated with the borderline performance descriptions (BPDs) and cut scores from the Judgmental Standard Setting (JSS) study.

This study addresses the following research questions:

1. What mathematics and reading KSAs are prerequisite to the entry-level courses for the job training programs in each occupation, and what mathematics and reading KSAs are taught in these entry-level courses?
2. What mathematics and reading KSAs are students expected to have attained at the conclusion of the job training programs in each occupation?
3. How do the prerequisites for job training programs (KSA expectations for entry) in each occupation relate to descriptions of minimal academic preparedness on NAEP (as described by the BPDs from the JSS studies)?
4. How do the prerequisites for job training programs (KSA expectations for entry) in each occupation relate to the content assessed by NAEP (as determined by NAEP items representing minimal academic preparedness)?

Studies were conducted by the Educational Policy Improvement Center (EPIC), as subcontractors to WestEd and under the guidance of the Governing Board.

Summary of Findings

This study analyzed course artifacts from 122 institutions—85 courses were analyzed for mathematics content and 80 courses were analyzed for reading content. As noted, the courses were for job training programs in five occupational areas: Automotive Master Technician; Computer Support Specialist; Heating, Ventilation, and Air Conditioning (HVAC); Licensed Practical and Licensed Vocational Nurse (LPN), and Pharmacy Technician (entry and concluding level).

Key Findings Describing the Prerequisite KSAs

- The prerequisites are largely included in the grade 12 NAEP frameworks, but the full content of NAEP frameworks is much larger and broader. Course artifacts provided evidence of relatively few prerequisites that were not measured by NAEP.
- The job training programs studied have few prerequisite expectations in mathematics. The largest number of prerequisites across all occupational training programs are found in the Number Properties and Operations domain and the "Systems of measurement," "Variables, expressions, and operations," and "Equations and inequalities" standards. No programs had prerequisites in the Data Analysis, Statistics, and Probability domain, and few had prerequisites in the Geometry domain. The artifacts included no evidence of irrational numbers, exponents and logarithms, or absolute value as prerequisites.
- Across all programs, only the NAEP objectives identified as prerequisites for entry-level courses in all five areas were those related to reading informational texts. NAEP objectives in the areas of literary text and literary devices were not found to be present in any programs. Any part of an objective that was not relevant to any program was labeled as an "exclusion."

Specific reading skills that are prerequisite to all five job training programs include "Locate or recall causal relations" and "Locate or recall organizing structures of texts, such as comparison/contrast, problem/solution, enumeration, etc."

- The mathematics exclusions removed much of the complex mathematics knowledge and skills that differentiate the grades 8 and 12 frameworks. As a result, some prerequisite KSAs appear to be better described by the grade 8 objectives.
- Mathematics prerequisites found in a small subset of courses but not assessed by NAEP include the following. The course in which they were found is in parentheses:
    - Boolean algebra, other number bases, and solution-driven algorithm design (Computer Support Specialist);
    - Interpreting mathematics symbols (LPN); and
    - Converting temperature and business mathematics (to understand profits and losses; entry-level Pharmacy Technician).
- Reading prerequisites evident in the course materials for specific courses, but not assessed by NAEP, include:
    - Comprehending and following written instructions, and writing documentation (Computer Support Specialist);
    - Comprehending and following written instructions, reading charts, graphs and diagrams, and conceptual understanding sufficient to apply scientific concepts (HVAC);
    - Identifying, recalling, and discussing information; applying knowledge; demonstrating evidence of and reflecting on one's knowledge; and conceptualizing and integrating (LPN); and
    - Reading materials on a computer screen rather than on paper, and deciphering text that includes spelling/grammatical errors in a context-appropriate way and without difficulty (entry-level Pharmacy Technician).
- Many grade 12 NAEP items were deemed not required for determining academic preparedness for job training programs.
    - The number of reading objectives not evident as prerequisite in any course within the five occupations ranged between 6 and 25 of the 37.
    - Between 83 and 101 of the 130 mathematics objectives were not evident as prerequisite in any course within the five occupations.

Key Findings in Relation to the JSS Study

- The prerequisites evident in the course artifacts do not match findings from the JSS study and are generally less rigorous than the BPDs.
- The objectives for which evidence was found were heavily concentrated in the Number Properties and Operations content domain of mathematics. This domain is generally considered to be easier and less challenging than the other content domains. Only 10% of the grade 12 NAEP mathematics item

pool includes this category of items (National Assessment Governing Board, 2008a).

- Mathematics prerequisites correspond to KSAs assessed by items falling below the Proficient level on the NAEP scale. All reading prerequisites correspond to KSAs assessed by items just above and just below the Proficient level on the NAEP scale (Measured Progress & WestEd, 2012).

Key Findings of Concluding-Level Course Prerequisites

- The Pharmacy Technician occupational area was the only one for which concluding-level courses were also analyzed in addition to entry-level courses. For mathematics, similar KSAs in entry-level and concluding-level Pharmacy Technician courses were identified as new material that would be taught in both courses. The most-taught KSAs include:
    - "Solve problems involving rates such as speed, density, population density, or flow rates" (evident as new material in 45% of the entry-level courses and 73% of the concluding-level courses);
    - "Solve problems involving conversions within or between measurement systems, given the relationship between the units" (evident as new material in 40% of the entry-level courses and 60% of the concluding-level courses);
    - "Write algebraic expressions, equations, or inequalities to represent a situation" (evident as new material in 30% of the entry-level courses and 47% of the concluding-level courses);
    - "Solve problems involving special formulas such as: $A = P(I + r)^t$, $A = Pe^{rt}$" (evident as new material in 40% of the entry-level courses and 47% of the concluding-level courses); and
    - "Use proportions to solve problems, including rates of change" (evident as new material in 40% of the entry-level courses and 47% of the concluding-level courses).
- No evidence of grade 12 NAEP reading objectives taught in the concluding-level Pharmacy Technician courses was found in the course artifacts.
- Slightly more NAEP mathematics objectives are prerequisite to entry-level Pharmacy Technician courses (9 objectives rated as prerequisite in at least 20% of courses) than to concluding-level courses (8 objectives rated as prerequisite in at least 20% of courses).

Introduction

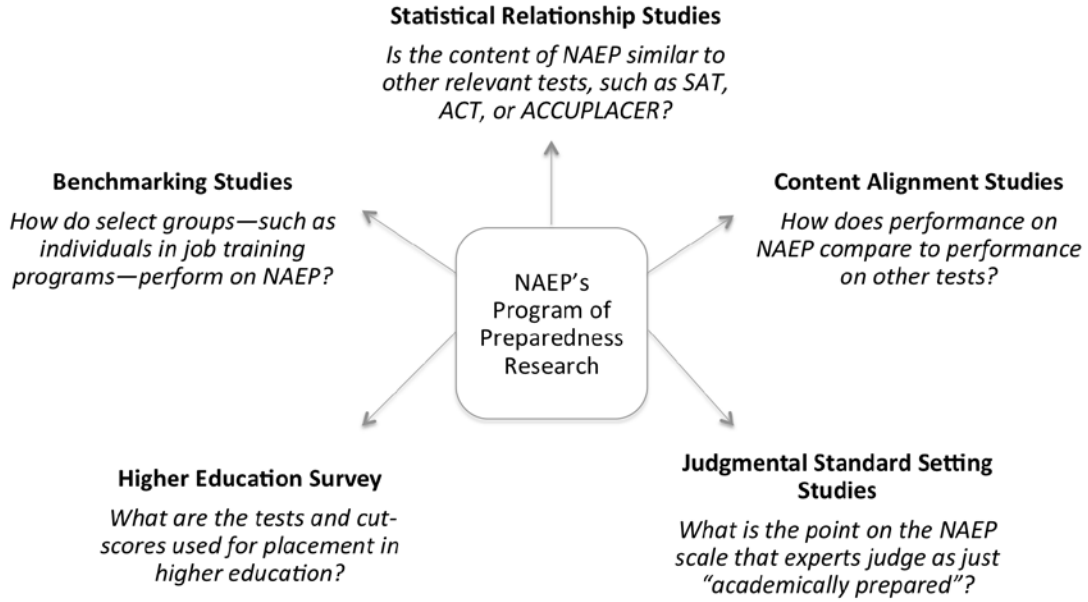
Grade 12 Preparedness

The National Assessment Governing Board (Governing Board) sets policy and provides general oversight and direction for the National Assessment of Educational Progress (NAEP). NAEP is authorized and funded by Congress, and its results are referred to as *The Nation's Report Card*. NAEP is the only nationally representative and continuing assessment of what American students know and can do in 11 academic subjects in grades 4, 8, and 12.

In 2004, the Governing Board began to explore NAEP as a means to assess students' academic preparedness for entry into postsecondary education or job training programs. In 2009, the Technical Panel on 12th Grade Preparedness Research, formed to assist the Governing Board in planning relevant research and validity studies, recommended a multi-method approach to explore the feasibility of reporting postsecondary preparedness on the 2009 grade 12 NAEP scale for mathematics and reading (National Assessment Governing Board, 2009b).

Figure 1 graphically summarizes the NAEP Preparedness Research Studies.

Figure 1. NAEP Preparedness Research Studies



Source: National Assessment Governing Board (n.d.)

The Governing Board adopted a program of preparedness research that included judgmental standard setting (JSS) studies for the grade 12 NAEP. These studies produced preparedness reference points on the NAEP scale for entry into job

training programs and for placement in college credit-bearing courses, representing the academic knowledge and skills required for postsecondary course and job training program placement. A total of 180-job training programs in five occupations were represented in the JSS studies.

The Governing Board requested additional research to examine the validity of findings obtained from the JSS studies and to identify the knowledge, skills, and abilities (KSAs) necessary for entry- and concluding-level coursework in designated occupational programs. By reviewing course artifacts such as syllabi, textbooks, and assignments, this study will help to determine if the KSAs required of students in the job training programs are appropriately represented by the borderline preparedness descriptions (BPDs) developed in the JSS research, and by the 2009 grade 12 NAEP items in the scale score ranges identified by panelists in the JSS studies.

Project Overview

This study was designed to follow upon and triangulate the results of the JSS studies (Measured Progress & WestEd, 2012). The study design was well implemented; however, the results did not match those from other studies that were a part of the grade 12 NAEP preparedness research. The challenges faced during the JSS studies and the recommendations for further research based on those studies are the basis for the research questions addressed in this study.

The Governing Board commissioned this study to analyze the content of course materials from job training programs in five occupational areas that had been identified for study in the 2009 program of NAEP preparedness research. Artifacts from such programs included course syllabi, assignments, exams, reading/textbook passages, and textbook tables of contents. Teams of mathematics and reading content-area experts and occupational course instructors analyzed these artifacts in order to document the KSAs that are evident in the entry-level courses within the five occupational areas, determine which are consistent with which NAEP measures and which are different, and determine which seem to be prerequisite to the entry-level courses and which are taught as new material.

An important goal of the study was to develop rich text descriptions of what students need to know and be able to do overall, based on the evidence from the course materials. In order to identify and document the prerequisite KSAs in the course materials, reviewers used a rating scheme designed to elicit the information necessary to meet this goal. Only artifacts from complete course packets were analyzed.

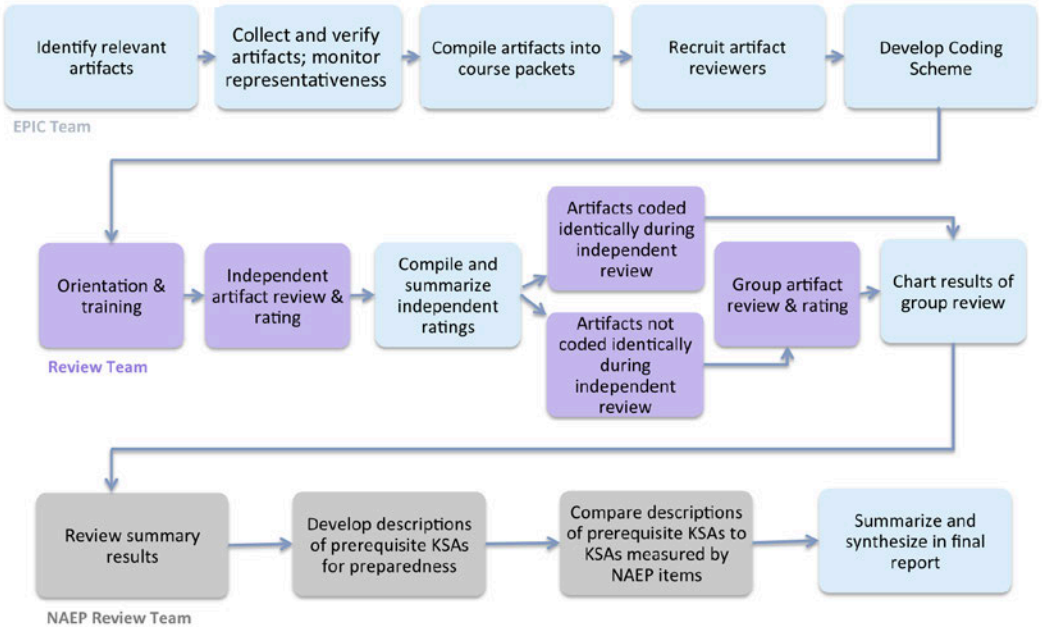
NAEP's mathematics and reading frameworks define the KSAs required for NAEP. Reviewers completed analyses of these frameworks independently, and then were brought together in small groups to reach agreement on how to code evidence of KSAs in artifacts. After these group results were summarized across courses within

programs, teams of NAEP framework experts compared them to the NAEP items that are associated with the BPDs and cut scores from the JSS studies. The BPDs are short narrative descriptions of the KSAs that a student would need to be minimally prepared for a job training program. The NAEP framework experts identified the content of NAEP items that corresponds to the specific prerequisite KSAs for each occupation.

Educational Policy Improvement Center (EPIC) staff conducted a pilot study, using one occupational area, to test the process and methods designed for this study. The results of the pilot were used to refine the overall study design and methods for analyzing the other four occupational areas that were reviewed in the operational study. These revisions were documented in a design document (*Job Training Program Curriculum Study: Design Document*, n.d.) and approved by the Governing Board prior to implementation.

Figure 2 summarizes the process followed for the operational study.

Figure 2. Job Training Program Study Process



The Governing Board commissioned a study of concluding courses for one occupational area in order to evaluate the extent to which NAEP content objectives are reflected in concluding courses and compare the evidence to that found for entry-level courses. Expert panels analyzed these artifacts to determine the mathematics and reading content knowledge that students are expected to be able to demonstrate at the conclusion of this job training program.

This study addresses the following research questions:

1. What mathematics and reading KSAs are prerequisite to the entry-level

courses for the job training programs in each occupation, and what mathematics and reading KSAs are taught in these entry-level courses?

2. What mathematics and reading KSAs are students expected to have attained at the conclusion of the job training programs in each occupation?

3. How do the prerequisites for job training programs (KSA expectations for entry) in each occupation relate to descriptions of minimal academic preparedness on NAEP (as described by the BPDs from the JSS studies)?

4. How do the prerequisites for job training programs (KSA expectations for entry) in each occupation relate to the content assessed by NAEP (as determined by NAEP items representing minimal academic preparedness)?

The following sections summarize study findings, compare the findings to those from the JSS research, and describe specific limitations, implications, and recommendations of the findings. Results of this study will support the Governing Board in determining the extent to which the prerequisite KSAs that are necessary for entry into job training programs are captured by current NAEP frameworks.

Methods

Pilot Study

Pilot Study processes and results are described in the *Job Training Programs Curriculum Study Report*.

Occupational Areas

The training programs evaluated in this study were carefully selected by the Governing Board to represent a broad range of occupations in different sectors of the economy that have a high potential for employment in the future and a large segment of the current labor force. Each of these occupations requires postsecondary training of at least three months, but does not require a bachelor's degree. In order to be included in the study, the training programs must allow students with a high school diploma to be eligible for entry without a prior apprenticeship. In addition, because another goal of the study is to examine preparedness for the military, occupations selected for the study must have available job training programs in the military. Perhaps most importantly, the occupations selected for evaluation are known and easily identified by most people.

Both the JSS studies conducted in 2010 by WestEd and Measured Progress (WestEd & Measured Progress, 2011; Measured Progress & WestEd, 2012) and this study used the same five occupational areas. The five occupations ultimately selected by the Governing Board for evaluation in these studies are:

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

Job Training Programs

The Judgmental Standard Setting studies located and identified institutions that offered programs of study within each occupational area; these institutions provided the population of programs within each occupational area from which to obtain course artifacts. To develop the population of programs for the JSS studies, WestEd consulted and collaborated with national certifying organizations for each occupation to identify programs from which to recruit job training course instructors. These included:

- 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)
- Partnership for Air-Conditioning, Heating, Refrigeration Accreditation (PAHRA)

Also consulted were two databases: CareerOneStop, sponsored by the U.S. Department of Labor's Employment and Training Administration,[1] and the U.S. Department of Education's Integrated Postsecondary Education Data System (IPEDS).

Course Selection

Project staff established contact with job training program instructors in each of the five occupational areas to identify entry-level (and, for the Pharmacy Technician occupation, concluding-level) courses that best illustrate the mathematics and reading knowledge and skills necessary for their program. When the instructors were not interested in or available to participate, EPIC staff contacted an institutional administrator to identify other relevant courses and then contacted those courses. Different courses and artifacts were analyzed for the job training programs in each content area.

Although the original study design required analysis of concluding-level course materials for all five occupations, the design was changed to include analysis of concluding-level course materials for one occupation. Preliminary analysis of syllabi, curriculum sequences, and course lists within all of the identified job training programs indicated that Pharmacy Technician programs provided the most evidence of skill building and included more concluding-level, job-specific mathematics and reading courses than those for the other occupations (Job Training Programs Curriculum Study Report, n.d.). As a result, only Pharmacy Technician training programs were included in the concluding-level course analysis.

Entry-level course artifacts were analyzed in order to identify the mathematics and reading KSAs that are prerequisite to the entry-level courses for each occupation. Concluding-level course artifacts describe the mathematics and reading KSAs that students are expected to have attained at the conclusion of the job training programs for the Pharmacy Technician occupation.

Artifact Collection

Course artifacts were collected from faculty teaching courses that had been identified

[1] http://www.careerinfonet.org/edutraining/Default.aspx?searchMode=occupation

for each program. Course artifacts were submitted via a web-based upload tool, email, facsimile, or physical mail, and included the following for each course:

1. Course syllabus that provides clear course objectives/expectations
2. Textbook title(s) (with author and ISBN)
3. Table of contents for primary course textbook
4. Course assignment that is representative of coursework
5. Text-based (reading) assignment, with corresponding text, that demonstrates students' expected reading level
6. Course quiz, midterm examination, final examination, or project worth a large percentage of course grade, and
7. A stand-alone assignment such as a lab, worksheet, problem sheet, essay, or group project.

Pharmacy Technician course instructors submitted entry-level and concluding-level course packets separately. In addition, each participating course instructor was asked to (1) identify foundational textbooks for her/his program; (2) verify key institutional and program characteristics; and (3) submit course artifacts for at least one reading or mathematics course that best exemplified the reading or mathematics KSAs required for entrance into the program.

Complete sets of artifacts from individual courses were compiled into course packets. Artifact submission was not considered complete for a course until a syllabus, and at least one textbook table of contents, assignment, text assignment, and exam was provided. Only complete course packets were analyzed for this study. When submissions were incomplete, project staff followed up with instructors to obtain the missing artifacts and complete the packet for that course. Few participating programs uploaded a table of contents for the primary course textbook, so project staff obtained them from publisher websites and added them to the packets. Appendix A lists the individual course titles for the courses that provided complete course packets analyzed in the study.

The recruitment goal was set at identifying and including 20 courses per program for each occupation and content area. Course recruitment and submission remained open until either (1) complete course packets were obtained from a minimum of 20 programs within each occupation, or (2) the pool of job training programs from which to recruit was exhausted and no additional artifacts could be obtained. Increased difficulty in obtaining complete course packets from job training programs, combined with the small pool of potential participating programs, resulted in fewer complete packets being obtained than had been the goal. Table 1 lists the number of courses providing complete artifacts for analysis in each of the five occupations.

Table 1. Number of Courses for Each Occupational Area

Occupation	Number of Complete Courses		
	Total	Mathematics	Reading
Automotive Master Technician (pilot study)	42	21	21
Computer Support Specialist	20	9	11
Heating, Ventilation and Air Conditioning	29	16	13
Licensed Practical Nurse	22	12	10
Pharmacy Technician (Entry-Level)	25	12	13
Pharmacy Technician (Concluding-Level)	27	15	12
Total	**160**	**85**	**80**

Some instructors submitted course documents for more than one mathematics or reading course when they felt that doing so would better illustrate the KSAs relevant to their specific programs.[2]

A total of 85 mathematics course packets and 80 reading course packets, from 122 institutions, provided evidence of the KSAs expected for entering and concluding job training program in the five occupations. Approximately 2,000 artifacts were collected for the study, across all five occupational areas; not all artifacts that were collected were analyzed. Artifacts from concluding-level courses in all occupations were collected, but only the Pharmacy Technician concluding-level course artifacts were analyzed, due to difficulty in obtaining artifacts from sufficient numbers of courses in the other occupations.

Artifact Reviewers

Three types of experts reviewed and identified the prerequisite KSAs in the course artifacts for this study: occupational-area experts, content-area experts who were trained in the rating of course artifacts, and NAEP framework and item experts in each content area.

Occupational-Area Experts

The first reviewers, *occupational-area experts,* were job training program instructors who had participated in the earlier JSS study panels. These instructors taught one or more entry-level job training courses within one of the five

[2] There are more programs than institutions because some programs offered the same training program with slight differences in program outcomes (e.g., a certificate or an associate degree). Post hoc analysis of the content of these courses identified that the only substantive difference between associate-degree-granting and certificate-granting programs provided by the same institution was that those resulting in an associate degree tended to require elective and general-education courses that were not required in the certification program. The core job training prerequisites, however, were consistent across both program types.

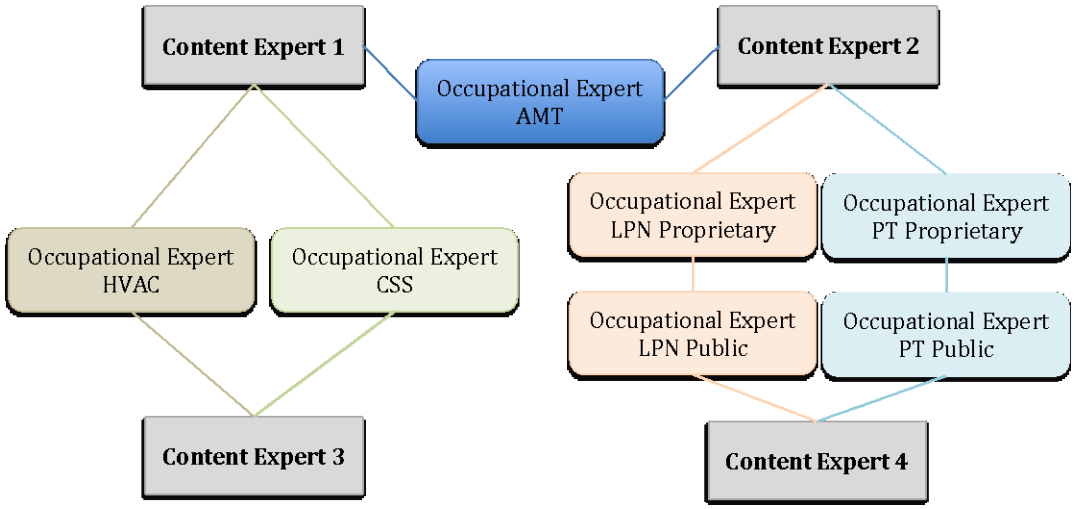
occupational areas and had some familiarity with NAEP from their participation in the earlier JSS studies. One such expert from each occupation and in each content area participated in this study, for a total of ten: five in mathematics and five in reading. Because there are a significant number of proprietary schools in the LPN and Pharmacy Technician occupations, an additional occupational expert was added to the review teams for these occupations, in order to represent these schools.

Content-Area Experts

The occupational-area experts worked in teams with the second type of expert reviewer, the *content-area experts.* The content-area experts were college faculty with in-depth knowledge of their content area (mathematics or reading), who had taught entry-level college courses within their content area, and who had previously participated in similar projects at EPIC, including group reviews, rating course artifacts, and reaching agreement through a convergent consensus process. Two teams of two reading experts and two teams of two mathematics experts reviewed two occupational areas each in the operational study, for a total of eight content-area experts.

Review teams for the Computer Support Specialist, HVAC, and Automotive Master Technician occupations consisted of two content experts and one occupational expert. Each team analyzed the artifacts from one occupation for either mathematics or reading, for a total of five reading teams and five mathematics teams. To ensure that the prerequisites for both proprietary and public institutions were identified, two occupational-area experts—one from each type of institution—served on review teams for the LPN and Pharmacy Technician programs, along with one content-area expert for each content area, for a total of four reviewers per team. Each team included an EPIC facilitator who was trained in facilitation and the convergent consensus process. This facilitator was to guide the discussions and ensure process integrity. The Pharmacy Technician review teams analyzed artifacts from both entry-level and concluding-level courses. Figure 3 shows the structure of the review teams for each content area.

Figure 3. Review Team Structure for Each Content Area



Key: AMT = Automotive Master Technician; CSS = Computer Support Specialist; PT = Pharmacy Technician. Notes: Rectangles represent content-area experts; circles represent occupational-area experts. The darker shading denotes those consultants who participated in the operational study only (those representing proprietary programs). Color-coded lines connect the content-area experts and the occupational-area expert(s) to denote the review teams.

NAEP Experts

The third set of reviewers, *NAEP experts,* consists of individuals who have an extensive and foundational understanding of NAEP content through participation in the development of the frameworks, item development, and review, and having served as content facilitators in the JSS studies. Each of these individuals is an expert in either mathematics or reading; has participated in and contributed to the NAEP program in substantive ways; and is highly familiar with the JSS study. The NAEP experts were organized into subject-specific teams, one for mathematics and one for reading. Each team had three members.

Definition of Prerequisite Knowledge, Skills, and Abilities

A primary goal of the project was to identify the KSAs required of students entering job training programs. Meeting this goal required that evidence of all KSAs required of students in entry-level job training program courses be analyzed. The analysis was not limited to the NAEP objectives. In the pilot study, the study designers considered and tested multiple options for collecting evidence of KSAs that were not measured by NAEP. These ranged from reviewers generating or rewriting standards statements to describe the evidence identified within course artifacts, to using occupation-specific standards or general career/technical education standards, to using academic standards. A systematic way of recording the evidence was needed.

To this end, *prerequisite KSA exclusions*, noted when most, but not all, of the KSAs described by an objective were observed, and *non-NAEP KSAs,* noted when KSAs

were observed that were not described by the NAEP frameworks, were introduced. Because the majority of the KSA evidence that reviewers identified was captured in the NAEP objectives, the NAEP objectives, combined with *prerequisite KSA exclusions*, and *non-NAEP KSAs,* were used in the operational study.

The comprehensiveness of the NAEP frameworks that was found in the pilot study is supported by findings from other studies (Rabinowitz, et al., 2010a, 2010b) that have found the frameworks to be very broad in domain coverage. This makes using the NAEP framework objectives to define prerequisite KSAs for this study less of a limitation than would otherwise be the case.

The prerequisites as defined by NAEP, the non-NAEP KSAs, and the prerequisite KSA exclusions for partial matches were captured by a comprehensive rating scheme, and all are discussed in the following study findings. The rating scheme is provided in Appendix B.

NAEP Objectives

The NAEP framework objectives defining the KSAs that artifacts were rated to in this study are the lowest level in the organizational structure of the frameworks. For reading, the framework (National Assessment Governing Board, 2008b) is structured as follows:

1. **Cognitive domain**
   1.1. Standard
   1.1.a Objective

For example, as shown below, the first reading cognitive domain is Locate/Recall: Locate or recall textually explicit information within and across texts, which may involve making simple inferences as needed for literal comprehension. A standard within this domain is "Locate or recall textually explicit information and make simple inferences within and across *both literary and informational texts,*" and an objective within that standard is "Locate or recall specific information such as definitions, facts, and supporting details in text or graphics."

1. **Locate/Recall: Locate or recall textually explicit information within and across texts, which may involve making simple inferences as needed for literal comprehension**
   1.1. Locate or recall textually explicit information and make simple inferences within and across *both literary and informational texts*
   1.1.a Locate or recall specific information such as definitions, facts, and supporting details in text or graphics

The reading framework contains a total of three cognitive domains, 11 standards, and 37 objectives. When reviewers found evidence of a KSA in a course artifact, they recorded it at the standard and objective level. As a time-saving measure, if all objectives within a standard were either prerequisite or new, those objectives were

automatically assigned the same rating as the standard. Otherwise, reviewers rated the individual prerequisite objectives within each standard. Results are presented at the objective level.

For mathematics, the framework (National Assessment Governing Board, 2008a) is structured as:

1. **Domain**
   1.1. Standard
   1.1.a. Objective

For example, as shown below, one of the mathematics domains is Data Analysis, Statistics, and Probability; a standard within that domain is "Data representation," and an objective within that standard is "Read or interpret graphical or tabular representations of data."

4. **Data Analysis, Statistics, and Probability**
   4.1. Data representation
   4.1.a. Read or interpret graphical or tabular representations of data

The mathematics framework contains a total of 5 domains, 24 standards, and 130 objectives. When reviewers found evidence of a KSA in a course artifact, they recorded it at the objective level. Results are reported at the objective level.

Rating Scheme

The NAEP frameworks served as the basis of the rating scheme to record evidence of the KSAs required of students. Artifact reviewers used the following directions, for rating both the applicability of each framework objective and (for those KSAs that were found to be prerequisite to the course) the importance of each objective, to map the KSAs that were evident in course artifacts to the NAEP objectives:

For each NAEP FRAMEWORK ELEMENT identified in the course artifacts, please indicate whether the evidence you reviewed indicates that it is a prerequisite for this course, is taught in this course, or is neither a prerequisite nor taught.

0—KSA is NOT APPLICABLE to this course
1—KSA is PREREQUISITE for this course
2—KSA is NEW content taught in this course

For each PREREQUISITE KSA, please select the option that best describes the KSA.

0—Minimally important; although a prerequisite, possessing this KSA will make minimal difference to student performance in this course.
1—A little important; if this prerequisite is possessed, the student is likely to learn more and have higher performance in the course.
2—Important; without this KSA, students will struggle with the course

material.
3—Very important; without this KSA, students are not prepared for, and will be unlikely to complete, this course.

Instructions provided for rating the sources of evidence for each prerequisite objective (i.e., in which artifact[s] the evidence was found) and, when a prerequisite objective contained multiple parts, which KSAs described in the objective statement (if any) were not evident in course materials (i.e., prerequisite KSA exclusions), were:

For each PREREQUISITE KSA, please identify the sources of evidence used for answering the questions above (i.e., for "rating" the KSAs in the course packets relative to the NAEP objectives). Please select all that apply:

1—Syllabus
2—Table of Contents
3—Assignment
4—Course Text Sample
5—Exam

Many times, part(s) of a KSA apply to a course while other parts don't apply. For each PREREQUISITE KSA where only **part of the KSA statement applies**, please identify the element(s) of the KSA statement that are **not applicable.**

Instructions provided for rating the relative course difficulty, as compared to both the JSS BPDs and the other courses reviewed within each occupation, were:

For each COURSE PACKET, please select the level of alignment between the PREREQUISITE KSA for this course and the KSA described by the BPD, using the following ratings:

1—Course requires **fewer or less complex/difficult** KSA elements than the BPD
2—Course KSA elements are **well-described** by the BPD
3—Course requires **more complex/difficult** KSA elements than the BPD

For each COURSE PACKET, please indicate if, *relative to the other courses reviewed for this occupation in this study*, the overall challenge level/rigor of the KSAs found in the artifacts from this course packet is:

1—Less than other courses **(less difficult)**
2—Equal to other courses **(typical)**
3—More than other courses **(more difficult)**

Finally, instructions provided for rating the non-NAEP KSAs, or KSAs that are prerequisite but not identified in the NAEP frameworks, were:

To help us identify additional KSAs that may be important to this occupation, for each COURSE PACKET, please identify all mathematics or reading knowledge, skills, or abilities that **appear to be** prerequisite to this course that were **not listed** in the framework elements provided.

Appendix B contains complete rating instructions, details, and guidance provided to raters during rating.

Artifact Review

Artifact review followed a convergent consensus model, consisting of an independent review and a group review. Following artifact review, the NAEP expert teams met to synthesize and interpret results.

The Convergent Consensus Model

To determine the content of the mathematics and reading NAEP assessments that are prerequisite to entry-level college courses, the study relied on a convergent consensus model, developed by EPIC and loosely based on the Delphi method. Developed by the RAND Corporation and used extensively in the 1960s, '70s, and '80s (Cooke, 1991), these models systematically solicit informed opinions from experts with unique, specific, and relevant expertise.

The convergent consensus process begins with training of experts on the nature of the review process and the rating scheme. Next, experts make independent judgments and report them via a rating scheme. Finally, the experts come together and adjudicate discrepant ratings. During this final process, experts verbalize their reasons for making the decisions they made. The desired outcome of this process is a series of group decisions that the review team feels accurately captures the best responses available from among the options presented by the rating scheme and based on the collective expertise of the group.

Although high levels of expert agreement often occur, they are not expected initially. The level of agreement increases as raters engage in discussions of specific, contextualized differences. The goal of this process is to reach agreement on the ratings; consensus is the goal but not a requirement. In the final analysis, experts may not reach agreement on every item, and process facilitators do not force consensus when experts have substantial or deep-seated differences on a rating. Agreeing to disagree is a valid result of the convergent consensus process. However, group consensus is an intention of this process, and percentages of agreement are calculated as a finding of the study.

An important measure of procedural validity is the evaluation of the process by the experts themselves. High degrees of agreement with statements that ascertain whether they believed their opinions were heard, whether they felt pressured to

agree, and whether they thought the process overall was fair enhance the likelihood that, if the process were conducted again, similar results could be expected.

Training

The content-area experts had experience in convergent consensus and artifact review, and the occupational-area experts had participated as panelists in the JSS studies. All artifact reviewers were trained as a single group and provided with practice opportunities to familiarize themselves with the artifacts, the NAEP frameworks, the rating scheme, and the rating tasks. They were all required to attend a training webinar prior to the independent reviews. This training described study objectives, processes, materials, timelines, and desired outcomes. The experts could attend more than one training session. Once they were confident in their understanding of the study process, the experts began the individual rating task.

During the group review meetings, experts were provided with a brief instructional session on the artifacts, the NAEP frameworks, and the rating scheme, during which they were instructed on the group rating tasks, processes, and desired outcomes. An *a priori* list of decision rules (see Appendix J), developed with a NAEP expert to assist reviewers with rating, were provided and reviewed during training. All training sessions used documents that were representative of those that reviewers would encounter during the operational course packet reviews.

Independent Artifact Review

Once training was complete, the reviewers independently reviewed course packets and identified the mathematics and reading KSAs required for entry into each course, as defined by the NAEP framework objectives and evidenced by the course artifacts. Parts of objectives that did not apply were noted. Prerequisite KSAs that were independent of the NAEP objectives were also identified and recorded. Reviewer responses were collected and compiled through a web-based application customized for this study. Throughout the process, participants evaluated their understanding of the task and their confidence in the results.

Independent Rater Consistency

Because the convergent consensus model does not expect or require consistency among individuals during independent reviews, typical reliability analyses are not applicable. However, this does not mean that they are unimportant or ignored. Rater agreement is calculated to identify and prepare a list of courses requiring adjudication for the group review. Convergence to a group decision through dialogue is the key outcome of the convergent consensus process, and agreement among individual raters prior to the group process is helpful to the extent that it reveals rater misunderstandings that can be addressed at the start of the group process. Throughout the process, differences of opinions are OK; misunderstandings are not. To describe the extent to which individual raters agreed prior to the group process, the percentage of courses that required adjudication and the percentage of objectives within each course that required adjudication were calculated (See tables 16-17 in the *Rater Consistency* section below).

Group Artifact Review

EPIC staff analyzed the independent ratings of the KSAs to differentiate those that were independently rated the same by all review team members from those that were rated differently by one or more team members. Reviewers who participated in the independent reviews were convened to complete, for all programs, onsite adjudication reviews of the objectives that were not independently unanimously rated, over the weekends of October 5–7, 2012, and October 11–14, 2012. Attendees at this meeting included EPIC staff serving as facilitators and scribes, occupational-area experts, and content-area experts. Observers from the Governing Board and from WestEd were in the rooms throughout the meeting, and rotated among rooms.

For each adjudication review, facilitators directed the work, led discussions, presented the independent ratings for each packet via PowerPoint, and documented decision rules (see Appendix J) and general comments. Prior to the convening, the facilitators had participated in a two-week training process. All were experienced in process facilitation and the convergent consensus process. The scribes documented final group ratings. The review team members participated in discussions of their rating rationales and provided feedback through evaluations completed upon the conclusion of the first and last sessions of each adjudication meeting.

The purpose of the workshops was to discuss all course-packet review ratings that were not unanimous during independent review, with the goal of reaching agreement on the prerequisite KSAs evident in the course artifacts. The focus of the workshops was on the applicability ratings that determine if evidence found in artifacts is prerequisite, new, or not applicable, and also on the importance ratings for each prerequisite. Lack of agreement on the applicability rating differentiated course packets that required adjudication from those that did not.

Teams were provided with initial project decision rules and rating instructions, and they discussed applicability ratings for the courses identified for adjudication. One of the instructions provided was to base team decisions only on the complete objective, and to not consider additions or exclusions for partial matches. For the objectives that the team agreed were prerequisite, importance ratings were also discussed. Review teams' agreement on the prerequisite KSAs necessary for preparedness to enter each job training program partially addresses the first two research questions and provides the data needed to answer the third and fourth research questions. Common decision rules and points of evidence from course packets guided these discussions, as did content-area decision rules for reading. The discussions often resulted in additional decision rules (see Appendix J) specific to each occupation.

To prepare for the group reviews, participants reviewed the following documents, provided by email and available on the project collaboration website:

1. Content review team agenda
2. Orientation PowerPoint

3. Overview of study process
4. Overview of adjudication outcomes, including agreeing to disagree
5. Description of team and staff roles
6. List of additional materials to be provided onsite

Project staff provided participants with the following hard-copy documents onsite:

1. List of all packets
2. One completed packet for each course
3. Three representative course textbooks for each occupational area
4. NAEP frameworks
5. Three representative textbooks for each occupational area
6. Decision rules for reading, developed in consultation with a NAEP reading expert

For each occupation, there were two review teams—one for mathematics and one for reading—including one occupational expert and two content experts. Review teams discussed the evidence that was contained in the course packets and for which there were differences in the independent judgments regarding the relevance (i.e., applicability) of the evidence. Agreement was not always reached during these discussions; in such cases, the scribe noted that the team agreed to disagree and retained the independent ratings for final analysis.

Reviewer Evaluations

Review participants provided feedback at multiple points during the onsite meetings, including immediately following task orientation (the first session) and upon conclusion of the final session. Feedback was anonymously collected through an online survey platform.

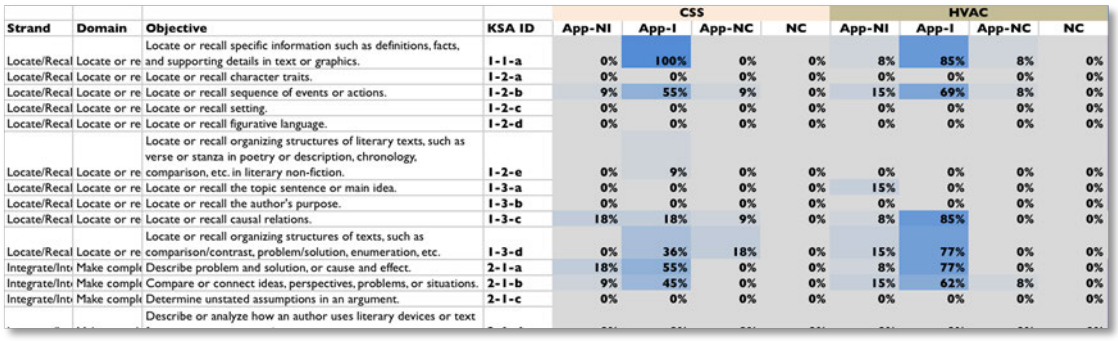
Content Review Summaries

Artifact review content maps summarize the results of the artifact review at the NAEP objective level, describing the applicability and importance of the adjudicated prerequisite KSAs, aggregated across courses, for the job training programs in each occupation. Color coding is used in the maps to make extreme values and patterns easy to identify. Group decisions across courses, as well as frequency of "agree to disagree" decisions, are given as percentages.

The primary variable of interest in these summaries is applicability. Separate content maps describe the adjudicated ratings for each of the three values of the applicability variable (prerequisite, not applicable, or new content). Group decisions of "agree to disagree" are noted as such in the content maps. Reviewers ran out of time to complete packet review for the two Pharmacy Technician teams at the group review meeting; for these teams, the modal responses were used as the consensus decision (10 reading courses/11 mathematics courses).

Figure 4 provides a partial visual representation of a content map summarizing artifact review findings. The full-size content maps summarizing findings for each occupation are provided in Appendices E–H.

Figure 4. Partial Visual Representation of Content Map



				CSS				HVAC			
Strand	Domain	Objective	KSA ID	App-NI	App-I	App-NC	NC	App-NI	App-I	App-NC	NC
Locate/Recal	Locate or re	Locate or recall specific information such as definitions, facts, and supporting details in text or graphics.	1-1-a	0%	100%	0%	0%	8%	85%	8%	0%
Locate/Recal	Locate or re	Locate or recall character traits.	1-2-a	0%	0%	0%	0%	0%	0%	0%	0%
Locate/Recal	Locate or re	Locate or recall sequence of events or actions.	1-2-b	9%	55%	9%	0%	15%	69%	8%	0%
Locate/Recal	Locate or re	Locate or recall setting.	1-2-c	0%	0%	0%	0%	0%	0%	0%	0%
Locate/Recal	Locate or re	Locate or recall figurative language.	1-2-d	0%	0%	0%	0%	0%	0%	0%	0%
Locate/Recal	Locate or re	Locate or recall organizing structures of literary texts, such as verse or stanza in poetry or description, chronology, comparison, etc. in literary non-fiction.	1-2-e	0%	9%	0%	0%	0%	0%	0%	0%
Locate/Recal	Locate or re	Locate or recall the topic sentence or main idea.	1-3-a	0%	0%	0%	0%	15%	0%	0%	0%
Locate/Recal	Locate or re	Locate or recall the author's purpose.	1-3-b	0%	0%	0%	0%	0%	0%	0%	0%
Locate/Recal	Locate or re	Locate or recall causal relations.	1-3-c	18%	18%	9%	0%	8%	85%	0%	0%
Locate/Recal	Locate or re	Locate or recall organizing structures of texts, such as comparison/contrast, problem/solution, enumeration, etc.	1-3-d	0%	36%	18%	0%	15%	77%	0%	0%
Integrate/Int	Make compl	Describe problem and solution, or cause and effect.	2-1-a	18%	55%	0%	0%	8%	77%	0%	0%
Integrate/Int	Make compl	Compare or connect ideas, perspectives, problems, or situations.	2-1-b	9%	45%	0%	0%	15%	62%	8%	0%
Integrate/Int	Make compl	Determine unstated assumptions in an argument.	2-1-c	0%	0%	0%	0%	0%	0%	0%	0%
		Describe or analyze how an author uses literary devices or text									

Figure 4 can be read as follows: For example, evidence that objective 1.1.a was prerequisite (i.e., applicable) to and important for preparedness in Computer Support Specialist courses was found in 100% of those courses, while evidence that the same objective was prerequisite to and important for preparedness in HVAC courses was found in 85% of those courses, but evidence that the same object was prerequisite to, but not very important for, preparedness in HVAC courses was found in 8% of those courses.

NAEP Review

Following completion of the content review team ratings, the NAEP experts convened for a two-day in-person meeting to complete the following tasks necessary to address the third and fourth research questions:

- Describe the mathematics and reading KSAs that are prerequisite for each job training program, based on the evidence from the course content analysis.
- Compare the evidence-based descriptions to the BPDs developed for the JSS studies for each occupational area.
- Compare the prerequisite KSAs to the KSAs measured by the NAEP items.

Each content-area team was originally composed of three NAEP experts who had participated in the JSS studies; however, due to scheduling conflicts, only one expert with JSS study experience participated in the reading review. Two other experts participated, one a member of the NAEP Framework team and the other experienced in NAEP alignment and previous preparedness research. Other participants in this meeting included two project staff to support the experts, as well as an observer from the Governing Board.

The following materials were provided for review prior to the meeting:

- Three artifact review content maps at the NAEP objective level

    - These content maps combined the previous reviews' applicability ratings and importance ratings into the following summary categories:
        - *prerequisite and important* (combining the "very important" and "important" importance ratings);
        - *prerequisite and not important* (combining the "minimally important" and "a little important" importance ratings);
        - *no group decision* could be reached;
        - *new content*; not prerequisite to, but taught in the course; and,
        - objectives that are *not applicable*.
- Summary of prerequisite KSA exclusions
- Summary of non-NAEP KSAs (prerequisites that are not currently measured by NAEP)
- Rich text descriptions for the Automotive Master Technician occupation (developed in the pilot study) and comparison ratings for the occupations included in the operational study
- JSS BPDs
- Comparison of prerequisite KSAs for each course to the KSAs described by the JSS BPDs
- Rating scheme used for artifact reviews
- Task objectives and desired outcomes PowerPoint

The following materials were made available at the meeting:

- Ordered item booklets (OIBs) A & B
- Item maps
- Sample course packets
- Rating scheme used for artifact reviews
- Decision rules
- Grade 12 NAEP anchor descriptions
- Task objectives and desired outcome descriptions
- Sample artifacts and sources of evidence
- Additional course and rater data[3]

To meet the first objective of the study—to describe the prerequisite mathematics and reading KSAs for each job training program—the NAEP review teams took the following steps:

1. Independently review the prerequisite KSAs from the content maps and the prerequisite KSA exclusions for each occupation
2. Collaboratively review the prerequisite KSAs from the content maps and the prerequisite KSA exclusions for each occupation

[3] Additional information about these materials can be found in the JSS study reports (WestEd & Measured Progress, 2011; Measured Progress & WestEd, 2012).

3. Draft descriptions of the prerequisite KSAs for each occupation, including exclusions identified by partial matches

At the beginning of each meeting, the NAEP experts were provided with the following instructions concerning process flexibility:

> The exact process to use will be determined by what works best for your team. For example, you may complete all tasks for one occupation and then move through each occupation individually, or you may complete the first task for all occupations and then complete the second task for all occupations.

Both teams proceeded using the following steps:

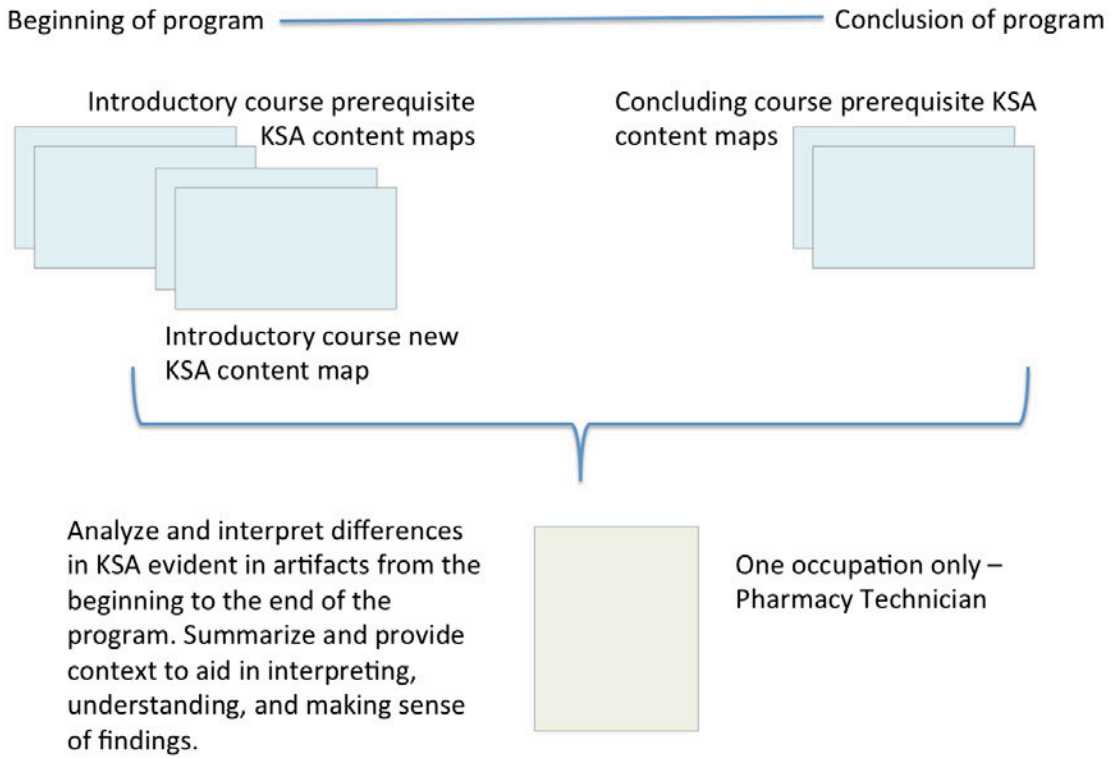
Their task began with a review of the prerequisite KSAs and those KSAs that were identified by the review teams as new content to be taught in a course. Each KSA was identified as a specific NAEP objective. The reviewers independently reviewed the results and then, as a group, synthesized and interpreted them based on their expertise with the NAEP frameworks and their in-depth understanding of the content domain. Using the prerequisites extracted from the course artifacts—including the partial alignments (prerequisite KSA exclusions)—they drafted a detailed listing of the mathematics and reading content that students must possess in order to be prepared to enter each program. Because additional KSAs were relatively infrequent, they were added to the descriptions after the meeting. The initial design for this step of the process was to develop *rich* text descriptions of the prerequisite KSAs; however, the small number of objectives evidenced in the course materials did not allow for development of rich text descriptions. The text summaries produced instead of rich text descriptions are referred to as *prerequisite KSA descriptions*. These are the final descriptions of the KSAs that were evident as prerequisites for students entering the job training programs. They have not been subjected to further review.

Next, the teams compared the prerequisite KSAs evident in the entry-level Pharmacy Technician course artifacts to those that were evident in artifacts from the completion of the program. To address the second research question of the study, the NAEP experts completed the following tasks:

1. Review content maps summarizing *concluding-level* Pharmacy Technician KSAs
2. Review content maps summarizing *entry-level* Pharmacy Technician KSAs
3. Review new content (KSAs) taught in entry-level Pharmacy Technician programs
4. Identify the KSAs that Pharmacy Technician students are expected to have at program completion by comparing the content maps
5. Discuss concluding-level Pharmacy Technician KSAs in terms of the NAEP frameworks and the content areas in general, noting any patterns and unexpected or surprising findings

Figure 5 summarizes this process.

Figure 5. Entry-Level and Concluding-Level Prerequisite Comparison Process Summary



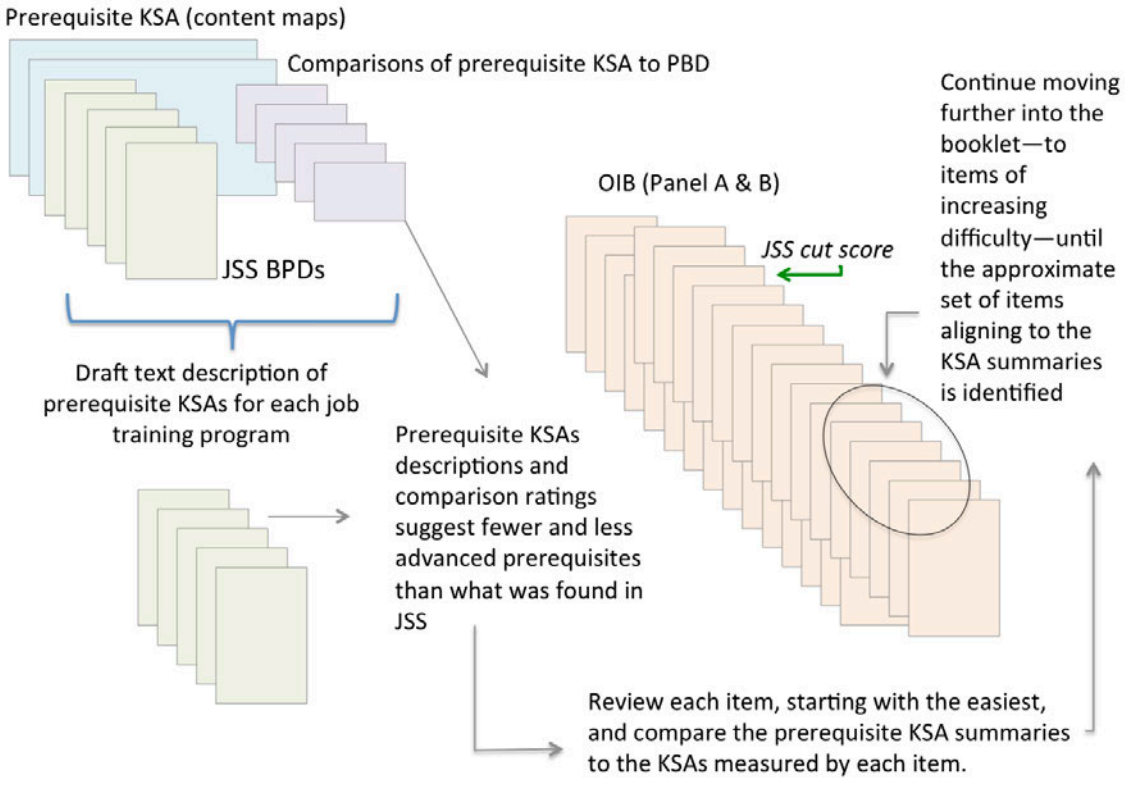
The final task of the NAEP review team was to determine the extent to which the prerequisite KSAs were measured by the NAEP, in order to address the third research question. This task was an alternative to the original plan to compare the BPDs and cut-score ranges from the JSS studies to the evidence-based descriptions. Given that the KSAs described by the evidence were not near the range of cut scores set by the JSS study panels, the planned comparisons did not seem worthwhile, and the need for an alternative approach became clear. As a result, the experts reviewed the NAEP items, ordered from least to most difficult, and determined how the evidence-based descriptions aligned to all available items, not just those in the range between cut scores set by replicate panels in the JSS studies.

In order to accomplish this alignment, the prerequisite KSAs were compared to the KSAs that are measured by the NAEP items. Two ordered item booklets (OIBs), booklets A and B, contained different sets of items that were matched in content coverage, difficulty, and item type. The NAEP experts reviewed each item, starting with the easiest, and compared the prerequisite KSA summaries to the KSAs measured by each item. They continued moving further into the booklet, evaluating items of increasing difficulty, until they determined the approximate set of items that align to the KSA summaries and thus correspond to the prerequisite KSAs for a job training program. Because the items had been mapped using a .67 probability

for the JSS studies, this was the criterion used to make the same determination in this study.

Figure 6 summarizes this alignment process.

Figure 6. Alignment Process of Prerequisite KSA Summaries to NAEP Items



Results

While the NAEP frameworks provided the structure for identifying prerequisite KSAs, prerequisite KSAs identified were not limited to those measured by NAEP. Although findings are summarized separately for entry-level and concluding-level courses, analyses for both are presented together throughout this section. To aid in interpreting findings, Appendix C provides sample learning objectives taken from syllabi that are typical for each of the five occupational areas.

Results from all five occupational areas are presented together when they are comparable. Not all data collected during the pilot study (of the Automotive Master Technician occupation) were comparable to the data collected in the operational study; thus, to emphasize this difference, throughout this section, pilot-study findings are visually differentiated from operational-study findings. Similarities and differences between Automotive Master Technician programs and job training programs in the other four occupations should be interpreted cautiously, given the differences in methods between the pilot study and the operational study.

Before the full results of this study are presented, examination of the exclusions noted by the partial matches is helpful for interpreting study findings, as is review of the additional prerequisites identified that are not currently measured by NAEP.

Prerequisite KSA Exclusions

During independent artifact review, exclusions of parts of prerequisite objectives were identified. Further exclusions were not identified during adjudication; review-team consensus was not sought for exclusions recorded during independent review.

As noted earlier in this report, independent reviewers noted the excluded part of the prerequisite in response to the following instruction:

> Many times, part(s) of a KSA apply to a course while other parts don't apply. For each PREREQUISITE KSA where only **part of the KSA statement applies**, please identify the element(s) of the KSA statement that are **not applicable.**

Exclusions were common with literary texts and multi-part NAEP objectives that contained prerequisites but also contained skills that were not evident in the artifacts. Often, the more challenging and complex elements of an objective were excluded. In some cases, the NAEP experts noticed that excluding these elements made the remaining prerequisite KSAs identical to the corresponding grade 8 NAEP framework objectives.

The most commonly identified exclusions are listed in the following sections, and all are provided in full in Appendix D. Throughout this report, exclusions are

incorporated into the prerequisite KSA descriptions for each occupation, indicated by strikethrough text.

Mathematics

Table 2 describes the mathematics exclusions by occupation, listing the more frequent exclusions (those that were identified by multiple reviewers across multiple courses) first and the less frequent exclusions (those that were identified by fewer reviewers across fewer courses) last.

In some cases, exclusions were noted for more than one objective, so corresponding NAEP objectives are not identified here but are available in Appendix D.

Table 2. Excluded Mathematics Elements from Partial Prerequisites

Occupation	Exclusion
Computer Support Specialist	• Irrational numbers • Exponents and logarithms • Inequalities (quadratic, exponential, or trigonometric) • Small numbers • 3D figures • Exponential functions • Polynomials
HVAC	• Exponents and logarithms • Very large or very small numbers • Fractional powers • Irrational numbers • Multi-step problems • Measurements not typically geometric in nature • Bivariate • Reasoning limited to mathematics • Inequalities • Polynomials • Quadratics • Absolute value

Occupation	• Exclusion
Pharmacy Technician (Entry-Level)	• Exponents and logarithms • Very large and very small real numbers • Expressions involving absolute value • Problem situations involving absolute value • Common irrational numbers • Percentages; Multiples or prime factorization
Pharmacy Technician (Concluding-Level)	• Common irrational numbers • Exponents and logarithms • Expressions involving absolute value • Compound percentages • Order of operations • Speed, density, population density • Approximate or subject to variation • Discussion of advantages or disadvantages • Absolute values
Automotive Master Technician	• Venn diagrams • Evaluate relative advantages or disadvantages of different representations to answer specific questions • Polynomials and rational expressions • Quadratic equations • Inequalities, including those involving absolute value • Linear, quadratic, exponential, or logarithmic equations or inequalities • Recognize the relationship between analytic and graphic solutions

Reading

Table 3 describes the reading exclusions by occupation, listing the more frequent exclusions first and the less frequent exclusions last. The majority of reading exclusions centered around literary text, which is less applicable to student preparedness for job training programs than it is to preparedness for academic programs.

In some cases, exclusions were noted for more than one objective, so corresponding NAEP objectives are not identified here but are available in Appendix D.

Table 3. Excluded Reading Elements from Partial Prerequisites

Occupation	Exclusion
Computer Support Specialist	• Literary texts • Literary devices • Point of view
HVAC	• Literary texts • Literary devices • Topic sentences • Point of view
LPN	• Literary texts • Literary devices • Provide supporting information • Analyze
Pharmacy Technician (Entry-Level)	• Literary texts • Literary devices
Pharmacy Technician (Concluding-Level)	• Literary texts • Literary devices
Automotive Master Technician	• Literary texts such as verse or stanza in poetry or description, chronology, comparison, etc., in literary nonfiction • Evaluate the strength and quality of evidence used by the *author* (as opposed to a person) to support his or her position

Appendix E provides an objective-level summary (content map) of KSAs that were not applicable to job training programs within each occupation. These are the objectives for which no evidence of the need for the KSAs described was found in any of the courses of the training programs in each occupational area. The percent of Reading objectives for which no evidence was found in any course artifacts are: 18% (Computer Support Specialist), 67% (HVAC), 8% (Licensed Practical Nursing), 16% (Pharmacy Technician (Entry-Level)), 78% (Pharmacy Technician (Concluding-Level)), and 49% (Automotive Master Technician). For Mathematics, the percent of objectives for which no evidence was found in any course artifacts are: 52% (Computer Support Specialist), 0% (HVAC), 46% (Licensed Practical Nursing), 48% (Pharmacy Technician (Entry-Level)), 58% (Pharmacy Technician (Concluding-Level)), and 56% (Automotive Master Technician).

Prerequisite KSAs Not Currently Measured by NAEP

Although the NAEP frameworks provided the structure for identification of prerequisite KSAs, prerequisite KSAs were not limited to those measured by NAEP. Non-NAEP KSAs that were evident in the course artifacts were also identified and recorded during independent artifact review, but review team consensus was not sought.

Mathematics

In mathematics, no additional KSAs were identified in HVAC and concluding-level Pharmacy Technician artifacts; the NAEP objectives sufficiently described the prerequisites identified in the artifacts for these programs. Additional KSAs identified in Computer Support Specialist and entry-level Pharmacy Technician artifacts tended to relate to subject-specific KSAs, while those identified in LPN artifacts included elements of application, synthesis, and demonstration of knowledge—elements of higher-order thinking, generally referred to as 21st-Century Skills, Deeper Learning, and Key Cognitive Strategies. Table 4 describes suggestions for additional prerequisite KSAs that were identified in course artifacts for mathematics courses in four of the five occupations (non-NAEP KSAs for the Automotive Master Technician occupation are not available); each of the suggestions was provided more than once.

Table 4. Non-NAEP Mathematics KSAs

Occupation	Non-NAEP KSA	Notes
Computer Support Specialist	• Boolean algebra • Other number bases • Designing an efficient algorithm in the form of a computer program that solves a problem	All suggestions were provided for multiple courses by a single content-area expert.
HVAC	None	
LPN	• Interpreting mathematics symbols	E.g., on a label. Reviewers indicated that the NAEP frameworks did not include all prerequisites for entry-level LPN courses, but specific KSAs needed were not identified.
Pharmacy Technician (Entry-Level)	• Converting temperature • Business mathematics (profits)	One reviewer suggested that a copy of the certification examination would be helpful in determining additional prerequisite KSAs.
Pharmacy Technician (Concluding-Level)	None	

Reading

In reading, additional KSAs were identified in courses from all occupational areas. Table 5 describes the additional prerequisite KSAs identified in course artifacts for reading courses in four of the five occupations (again, non-NAEP KSAs for the Automotive Master Technician occupation are not available); each of the suggestions was provided more than once.

Table 5. Non-NAEP Reading KSAs

Occupation	Non-NAEP KSA	Notes
Computer Support Specialist	• Comprehend and follow written instructions • Writing, e.g., research, program documentation	All suggestions were provided for multiple courses by a single content-area expert.
HVAC	• Comprehend and follow written instructions • Reading charts, graphs and diagrams • A conceptual understanding sufficient to apply scientific concepts*	*Suggested by a single reviewer.
LPN	• Identify, recall, and discuss information • Apply knowledge • Demonstrate evidence of knowledge; reflect on one's knowledge • Conceptualize and integrate knowledge	All suggestions were provided by one reviewer (an occupational-area expert).
Pharmacy Technician (Entry-Level)	• Reading materials on a computer screen rather than on paper • Able to decipher text that includes spelling/grammatical errors in a context-appropriate way and without difficulty*	*One reviewer noted several typos and grammatical errors in course materials and suggested this additional KSA based on observing students struggling with this content. The following example was provided: "such as inferring that the misspelled word 'Drung' is likely meant to be 'Drug'"—a helpful skill to have in a health-care profession.
Pharmacy Technician (Concluding-Level)	None	

Additional KSAs are noted in the prerequisite KSA summaries for each occupational area described below.

Overview of Prerequisites by Content Area and Domain/Cognitive Domain

Table 6 describes overall findings in terms of the percentage of objectives within each mathematics domain that were prerequisite to a majority (>50%) of job training programs in each of the occupational areas. In mathematics, the Number Properties and Operations domain includes the most prerequisites. No programs had prerequisites in the Data Analysis, Statistics, and Probability domain, and few had prerequisites in the Geometry and

Research Question #1: *What mathematics and reading KSAs are prerequisite to the entry-level courses for the job training programs in each occupation?*

Algebra standards. The NAEP objectives were less evident in concluding-level Pharmacy Technician courses than they were in entry-level courses. Mathematics prerequisites are identified in detail in the following sections and in Appendix F. Table 6 provides a high-level overview of the prerequisites that were observed in 50% or more of the courses within each occupation.

Table 6. Percentages of NAEP Mathematics Objectives Prerequisite to a Majority of Courses, by Domain and Occupational Area

	Percent of Prerequisite Objectives					
Domain	**CSS**	**HVAC**	**LPN**	**PT Intro**	**PT Conc**	**AMT**
Number Properties and Operations	28%	22%	22%	17%	6%	11%
Measurement	0%	11%	0%	0%	0%	11%
Geometry	0%	0%	0%	0%	0%	3%
Data Analysis, Statistics, and Probability	0%	0%	0%	0%	0%	0%
Algebra	0%	7%	10%	0%	0%	3%

Key: CSS = Computer Support Specialist; PT Intro = Pharmacy Technician (entry-level); PT Conc = Pharmacy Technician (concluding-level); AMT = Automotive Master Technician.

Table 6 can be read as follows: For example, 28% of the mathematics objectives within the Number Properties and Operations domain were prerequisite to a majority (>50%) of Computer Support Specialist courses, while none of the objectives within other domains were prerequisite to a majority of Computer Support Specialist courses, and 22% of the mathematics objectives within the Number Properties and Operations domain were prerequisite to a majority of HVAC courses.

Between 83 (LPN) and 101 (Automotive Master Technician) of the 130 mathematics objectives were not evident as prerequisite in any course in a given occupation.

There is more overlap between the prerequisite KSAs evident in course materials for reading and the NAEP reading frameworks. Many courses in each occupation required KSAs that are described in the Locate/Recall cognitive domain; slightly fewer required KSAs were found in the Integrate/Interpret cognitive domain, and only in one occupation (Automotive Master Technician) were objectives within the Critique/Evaluate cognitive domain prerequisites to many courses.

Reading prerequisites are identified in detail in the following sections and in Appendix G. Table 7 is a high-level overview of the reading prerequisites observed in 50% or more of the courses within each occupation.

Table 7. Percentages of NAEP Reading Objectives Prerequisite to a Majority of Courses, by Domain and Occupational Area

	Percent of Prerequisite Objectives					
Cognitive Domain	**CSS**	**HVAC**	**LPN**	**PT Intro**	**PT Conc**	**AMT**
Locate/Recall	30%	40%	20%	30%	20%	50%
Integrate/Interpret	18%	35%	24%	12%	6%	53%
Critique/Evaluate	0%	0%	0%	0%	0%	30%

Key: CSS = Computer Support Specialist; PT Intro = Pharmacy Technician (entry-level); PT Conc = Pharmacy Technician (concluding-level); AMT = Automotive Master Technician.

Table 7 can be read as follows: For example, 30% of the reading objectives within the Locate/Recall cognitive domain, 18% of the objectives within the Integrate/Interpret cognitive domain, and none of the objectives within the Critique/Evaluate cognitive domain were prerequisite to a majority (>50%) of Computer Support Specialist courses.

Between six (PT) and 25 (HVAC) of the 37 reading objectives were not evident as prerequisite in any course in a given occupation.

Overview of Prerequisites by Content Area and Standard

Table 8 summarizes the percentages of mathematics objectives, within each domain and standard, that were observed in 50% or more of the courses within each occupation and that describe prerequisite KSAs for job training programs in each occupation.

Table 8. Percentages of NAEP Mathematics Objectives Prerequisite to a Majority of Courses, by Domain, Standard, and Occupational Area

Domain	**Standard (Number of Objectives)**	**CSS**	**HVAC**	**LPN**	**PT Intro**	**PT Conc**	**AMT**
Number Properties and Operations	Number sense (4)	50%	25%	25%	25%	0%	25%
	Estimation (3)	0%	0%	0%	0%	0%	0%
	Number operations (5)	40%	40%	40%	40%	0%	0%
	Ratios and proportional reasoning (2)	0%	0%	0%	0%	0%	0%
	Properties of number and operations (4)	25%	25%	25%	0%	25%	25%
	Mathematical reasoning using number (2)	0%	0%	0%	0%	0%	0%
Measurement	Measuring physical attributes (6)	0%	0%	0%	0%	0%	0%
	Systems of measurement (5)	0%	40%	0%	0%	0%	40%
	Measurement in triangles (7)	0%	0%	0%	0%	0%	0%
Geometry	Dimension and shape (4)	0%	0%	0%	0%	0%	25%
	Transformation of shapes and preservation of properties (6)	0%	0%	0%	0%	0%	0%
	Relationships between geometric figures (6)	0%	0%	0%	0%	0%	0%
	Position, direction, and coordinate geometry (8)	0%	0%	0%	0%	0%	0%
	Mathematical reasoning in geometry (5)	0%	0%	0%	0%	0%	0%
Data Analysis,	Data representation (6)	0%	0%	0%	0%	0%	0%

Domain	Standard (Number of Objectives)	CSS	HVAC	LPN	PT Intro	PT Conc	AMT
Statistics, and Probability	Characteristics of data sets (7)	0%	0%	0%	0%	0%	0%
	Experiments and samples (5)	0%	0%	0%	0%	0%	0%
	Probability (9)	0%	0%	0%	0%	0%	0%
	Mathematical reasoning with data (5)	0%	0%	0%	0%	0%	0%
Algebra	Patterns, relations, and functions (6)	0%	0%	0%	0%	0%	0%
	Algebraic representations (7)	0%	0%	29%	0%	0%	0%
	Variables, expressions, and operations (7)	0%	17%	0%	0%	0%	14%
	Equations and inequalities (6)	0%	17%	17%	0%	0%	0%
	Mathematical reasoning in algebra (3)	0%	0%	0%	0%	0%	0%

Key: CSS = Computer Support Specialist; PT Intro = Pharmacy Technician (entry-level); PT Conc = Pharmacy Technician (concluding-level); AMT = Automotive Master Technician.
Note. Exclusions describe the objective level of the NAEP frameworks and are not reported at the standards level.

Table 8 can be read as follows: Fifty-percent of the mathematics objectives within the "Number sense" standard were prerequisite to a majority of Computer Support Specialist courses, and 25% of the mathematics objectives within the "Number sense" standard were prerequisite to a majority of HVAC, LPN, entry-level Pharmacy Technician, and Automotive Master Technician courses.

As shown in Table 8, programs in nearly all occupations contained prerequisite KSAs described by the "Number sense," "Number operations," and "Properties of number and operations" standards. A majority of the courses within the mechanical occupations—HVAC and Automotive Master Technician—contained prerequisites in the "Systems of measurement" standard. Objectives in the Measurement domain were not found to be prerequisite to the majority of courses in the health occupation job training programs (LPN or Pharmacy Technician). Of the mechanical occupations, only in the Automotive Master Technician programs were any of the Geometry standards identified as prerequisite in a majority of courses ("Dimension and shape, with 25% of objectives identified as prerequisite). 29% of the objectives within the "Algebraic representations" standard were prerequisite to a majority of LPN courses. A majority of the objectives in "Variables, expressions, and operations" and "Equations and inequalities" were prerequisite to fewer than 20% of courses in HVAC, Automotive Master Technician, and Licensed Practical Nursing programs. None of the Data Analysis, Statistics, and Probability objectives were prerequisite to a majority of courses within any occupational area.

Table 9 summarizes the percentages of reading objectives, within each cognitive domain and standard, that were observed in 50% or more of the courses within each occupation and that describe prerequisite KSAs for job training programs in each occupation.

Table 9. Percentages of NAEP Reading Objectives Prerequisite to a Majority of Courses, by Cognitive Domain, Standard, and Occupational Area

Cognitive Domain	Standard (Number of Objectives)	CSS	HVAC	LPN	PT Intro	PT Conc	AMT
Locate/ Recall	Locate or recall textually explicit information and make simple inferences ~~within and across both literary and informational texts~~. (1)	100%	100%	0%	0%	0%	100%
	Locate or recall textually explicit information and make simple inferences ~~within and across literary texts~~. (5)	20%	20%	0%	0%	0%	20%
	Locate or recall textually explicit information and make simple inferences within and across informational texts. (4)	50%	100%	100%	100%	100%	100%
Integrate/ Interpret	Make complex inferences ~~within and across both literary and informational texts~~. (6)	33%	33%	0%	0%	0%	50%
	Make complex inferences within and across literary texts. (5)	0%	0%	0%	0%	0%	0%
	Make complex inferences within and across informational texts. (5)	0%	60%	80%	40%	20%	100%
	Apply understanding of vocabulary to comprehension of ~~both literary and~~ informational texts. (1)	100%	100%	0%	0%	0%	100%
Critique/ Evaluate	Consider ~~both literary and~~ informational texts critically. (3)	0%	0%	0%	0%	0%	33%
	Consider ~~literary~~ texts critically. (3)	0%	0%	0%	0%	0%	0%
	Consider informational text critically. (4)	0%	0%	0%	0%	0%	50%

Key: CSS = Computer Support Specialist; PT Intro = Pharmacy Technician (entry-level); PT Conc = Pharmacy Technician (concluding-level); AMT = Automotive Master Technician.
Note. Exclusions identified for reading describe the standard and objective level of the NAEP frameworks; they are identified using strikethrough text.

Table 9 can be read as follows: For example, all (100%) of the objectives within the standard "Locate or recall textually explicit information and make simple inferences within and across both literary and informational texts" were prerequisite to a majority (>50%) of Computer Support Specialist courses. Reviewers indicated that the "within and across both literary and informational texts" part of the standard was not prerequisite. Strikethrough text is used to identify the exclusion in an objective when that objective is described in text below.

A majority of objectives described by the "Locate or recall textually explicit information and make simple inferences ~~within and across both literary and informational texts~~" and (with the exception of Computer Support Specialist programs) "Make complex inferences ~~within and across both literary and informational texts~~" standards were prerequisite to a majority of courses in job

training programs in all occupations. In all but the health-related occupations (Pharmacy Technician and LPN), objectives within the "Apply understanding of vocabulary to comprehension of ~~both literary and~~ informational texts" and "Locate or recall textually explicit information and make simple inferences ~~within and across both literary and informational texts~~" standards were prerequisite to a majority of courses. Between 33% and 50% of the objectives within the "Make complex inferences ~~within and across both literary and informational texts~~" standard were prerequisite to a majority of these courses.

Only the Automotive Master Technician program reviewers identified any of the Critique/Evaluate standards as prerequisite to a majority of courses ("Consider informational text critically," with 50% of objectives prerequisite to a majority of courses, and "Consider ~~both literary and~~ informational texts critically," with a third of the objectives prerequisite).

Prerequisite Mathematics KSAs

The initial task for the NAEP experts was to describe the mathematics and reading KSAs that are prerequisite for job training programs in each occupation. Each NAEP review team applied different criteria when describing prerequisite KSAs, documenting key findings using general language such as "half," "two thirds," "most," and "all." The exact percentages of reviewed courses that provided evidence for each of the NAEP objectives that are summarized in these descriptions are provided in Appendices E, F, and H.

In mathematics, the NAEP review resulted in the following descriptions of the prerequisite KSAs for each occupation. The reviewers generally used four criteria in the description—less than 33%, close to half, 66% or more, and 100%. They did not include any KSAs that were identified in only one or two courses in the prerequisite KSA descriptions.

The prerequisite KSA descriptions developed by the NAEP experts are provided in the following sections. While developing the prerequisite KSA descriptions, the teams reviewed and considered the exclusions noted in the partial matches, and included them in the prerequisite KSA descriptions, indicated by strikethrough text. They also considered the non-NAEP KSAs, but did not include them in the prerequisite KSA descriptions, focusing instead on the relevant NAEP objectives. The most common exclusions noted in the partial matches are listed at the top of each description, and the additional KSAs identified that are not currently measured by NAEP are listed at the bottom of each description.

Prerequisite KSA Description: Computer Support Specialist

Common Objective Components Identified as Exclusions in Partial Matches

Irrational numbers; Exponents and logarithms; Inequalities (quadratic, exponential, or trigonometric); Small numbers; 3D figures; Exponential functions; Polynomials

Review of the artifacts revealed only five framework objectives that were prerequisite to entry-level job training programs in two thirds or more of the courses. All five objectives focused on number properties and operations. In particular, they dealt with representing, ordering, comparing, and operating with numbers—mainly whole numbers and rationals. They also included order of operations and solving application problems. The following prerequisites were judged necessary for students to be successful in the course:

- 1.1.d ~~Represent~~, interpret, or compare expressions for real numbers, including expressions ~~using exponents and logarithms~~
- 1.1.i Order or compare real numbers~~, including very large and very small~~ real numbers
- 1.3.b Perform arithmetic operations with real numbers~~, including irrational numbers~~
- 1.3.f Solve application problems involving numbers~~, including rational and common irrationals~~
- 1.5.e Apply basic properties of operations, including conventions about the order of operations

For program preparedness, students also need familiarity with variables, expressions, and operations sufficient to use algebraic expressions, equations, or ~~inequalities~~ to represent situations (5.3.b). This was evident in artifacts for just under half of the courses reviewed. Limited evidence suggested that applying divisibility or remainders (1.5.d) and conversions across different measurement systems (2.2.b) to problem solving involving conversions, and creation and translation between different representations of algebraic expressions, equations, and inequalities (5.2.a) might be an additional prerequisite KSAs for a few programs (with fewer than 25% of courses).

Additional Prerequisites Independent of NAEP

Boolean algebra; Other number bases; Designing an efficient algorithm in the format of a computer program that solves a problem

Prerequisite KSA Description: HVAC

Common Objective Components Identified as Exclusions in Partial Matches

Exponents and logarithms; Very large or very small numbers; Fractional powers; Irrational numbers; Multi-step problems; Measurements not typically geometric in nature; Bivariate; Reasoning not related to mathematics; Inequalities; Polynomials; Quadratics; Absolute value

Evidence was found in artifacts from two thirds or more of the HVAC courses that only four Number Properties and Operations objectives were prerequisite to entry-level courses. These objectives dealt with representing, interpreting, or comparing numerical expressions. They also included operating with rational numbers and applying conventions about the order of operations. The four prerequisite objectives are:

1.1.d Represent, interpret, or compare expressions for real numbers~~, including exponents and logarithms~~

1.3.b Perform arithmetic operations with real numbers~~, including common irrational numbers~~

1.3.f Solve application problems involving numbers~~, including rational and common irrationals~~

1.5.e Apply basic properties of operations~~, including conventions about the order of operations~~

For the majority of the courses, solving application problems was the only prerequisite objective judged to be important for students to succeed in the courses.

In the Measurement domain, only one objective was judged to be prerequisite to entry-level courses:

2.2.b Solve problems involving conversions within or between measurement systems, given the relationship between the units

In the Algebra domain, only one objective was judged to be prerequisite to entry-level courses:

5.4.e Solve problems involving special formulas such as: $A = P(I + r)^t$, $A = Pe^{rt}$

In the Data Analysis, Statistics, and Probability and Geometry domains, no objectives were identified as prerequisite.

Additional Prerequisites Independent of NAEP

None

Prerequisite KSA Description: LPN

Common Objective Components Identified as Exclusions in Partial Matches

Irrational numbers; Exponents and logarithms; Expressions involving absolute value; Rates of change; Compound percentages; Prime factorization

In the Number Properties and Operations domain, evidence was found in artifacts from all of the LPN courses that five objectives were prerequisites to entry-level courses. These objectives dealt with representing, comparing, and operating with whole numbers and rationals. They also included order of operations, proportions, and solving application problems. With the exception of proportions (1.4.c), these objectives were judged to be important prerequisites for students to succeed in the course:

- 1.1.d Represent, interpret, or compare expressions for real numbers~~, including expressions using exponents and logarithms~~
- 1.3.b Perform arithmetic operations with real numbers~~, including common irrationals~~
- 1.3.f Solve application problems involving numbers~~, including rationals and common irrationals~~
- 1.4.c Use proportions to solve problems~~, including rates of change~~
- 1.5.e Apply basic properties of operations~~, including conventions about the order of operations~~

No objectives in the Measurement domain were judged to be prerequisites for students to succeed in most of the courses. Two objectives were evident in 50–70% of courses as new course content:

- 2.2.a 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
- 2.2.b Solve problems involving conversions within or between measurement systems, given the relationship between the units

The following objective was evident in half of the courses as new content:

- 2.1.i Solve problems involving rates ~~such as speed, density, population density, or~~ flow rates

In the Algebra domain, the three most important objectives in the LPN courses—evident in 50%, 40%, and 70% of the courses, respectively—were:

- 5.2.a 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

5.2.b 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

5.4.a Solve linear, rational, ~~or quadratic~~ equations ~~or inequalities, including those involving absolute value~~

The following objective was also related to algebraic procedures. It was present as new content in 40% of the courses:

5.3.c Perform basic operations, using appropriate tools, on algebraic expressions including polynomials and rational expressions

Three Algebra objectives concerning applications described new course content in most (80–90%) of the courses:

5.3.b Write algebraic expressions or equations to represent a situation

5.4.c Analyze situations, develop mathematical models, or solve problems using linear equations

5.4.e Solve problems involving special formulas such as: $A = P(I + r)^t$, $A = Pe^{rt}$

Additional Prerequisites Independent of NAEP

Interpreting mathematics symbols

Prerequisite KSA Description: Pharmacy Technician (Entry-Level)

Common Objective Components Identified as Exclusions in Partial Matches

Exponents and logarithms; Very large and very small real numbers; Expressions involving absolute value; Problem situations involving absolute value; Common irrational numbers; Percentages; Multiples or prime factorization

In the Number Properties and Operations domain, evidence that three objectives were important prerequisites for students to succeed in entry-level Pharmacy Technician courses was found in course artifacts. These objectives dealt with representing, interpreting, and comparing numerical expressions; operating with rational numbers; and solving application problems:

1.1.d Represent, interpret, or compare expressions for real numbers~~, including expressions using exponents and logarithms~~

1.3.b Perform arithmetic operations with real numbers~~, including common irrational numbers~~

1.3.f Solve application problems involving numbers~~, including rational and common irrationals~~

The following objective was seen as necessary for entry-level Pharmacy Technician courses, but in some courses it was treated as a prerequisite, and in other courses it was treated as new material:

1.4.c Use proportions to solve problems~~, including rates of change~~

In nearly half of the courses, the following objective was a necessary prerequisite; in about a third of the courses, however, there was no evidence that it was either a prerequisite or treated as new content:

1.4.d Solve multistep problems involving percentages~~, including component percentages~~

There was evidence that 60% of the courses treated the following objective as either a prerequisite or new content:

1.5.e Apply basic properties of operations~~, including conventions about the order of operations~~

In the Measurement domain, the following objective was treated as new content in 40% of the courses:

2.2.b Solve problems involving conversions within or between measurement systems, given the relationship between the units

In about a third of the courses, the following objective was treated as new content, but another third showed no evidence of this objective:

2.2.d Understand that numerical values associated with measurements of physical quantities ~~are approximate, are subject to variation, and~~ must be assigned units of measurement

The following two objectives were identified as new content in just under half of the courses:

2.1.i Solve problems involving rates ~~such as speed, density, population density, or~~ flow rates

2.2.a 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

In the Algebra domain, the following two objectives were new content in 40% of the courses:

5.4.c Analyze situations, develop mathematical models, or solve problems using linear~~, quadratic, exponential, or logarithmic~~ equations or inequalities symbolically or graphically

5.4.e Solve problems involving special formulas such as: $A = P(I + r)^t$, $A = Pe^{rt}$

Additional Prerequisites Independent of NAEP

Converting temperature; Business mathematics (profits)

Prerequisite KSA Description: Automotive Master Technician

Common Objective Components Identified as Exclusions in Partial Matches

Venn diagrams; Evaluate relative advantages or disadvantages of different representations to answer specific questions; Polynomials and rational expressions; Quadratic equations; Inequalities, including those involving absolute value; Linear, quadratic, exponential, or logarithmic equations or inequalities; Recognize the relationship between analytical solutions and graphic solutions

All of the Automotive Master Technician courses considered the following objective in the Number Properties and Operations domain to be a prerequisite necessary for students to be successful in the course:

1.1.i Order or compare real numbers, including very large and very small real numbers

More than half of the courses considered the following objective to be a prerequisite necessary for students to be successful in the course:

1.5.e Apply basic properties of operations, including conventions about the order of operations

In the Measurement domain, at least three quarters of the courses considered the following two objectives to be necessary prerequisites:

2.2.b Solve problems involving conversions within or between measurement systems, given the relationship between the units

2.2.d Understand that numerical values associated with measurements of physical quantities are approximate, are subject to variation, and must be assigned units of measurement

In the Geometry domain, more than 80% of the courses provided evidence that they considered the following objective a necessary prerequisite:

3.1.e Use two-dimensional representations of three-dimensional objects to visualize and solve problems

In the Algebra domain, more than one third of the courses considered the following objective a necessary prerequisite:

5.2.b 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~~

A little over half of the courses considered the following objective a necessary prerequisite:

5.3.b Write algebraic expressions, equations, or inequalities to represent a situation

More than one third of the courses considered the following objectives necessary prerequisites:

5.3.e Evaluate algebraic expressions ~~including polynomials and rational expressions~~

5.4.a Solve linear, rational~~, or quadratic~~ equations ~~or inequalities, including those involving absolute value~~

5.4.d Solve (symbolically or graphically) a system of equations or inequalities ~~and recognize the relationship between the analytical solution and graphical solution~~

Additional Prerequisites Independent of NAEP

None

Prerequisite Reading KSAs

In reading, the NAEP review resulted in the following descriptions of the prerequisite KSAs for each occupation. The descriptions do not include any KSAs that were identified in fewer than 25% of the courses.

Prerequisite KSA Description: Computer Support Specialist

Common Objective Components Identified as Exclusions in Partial Matches

Literary texts; Literary devices; Point of view

For students entering courses in Computer Support Specialist programs, the prerequisite reading skills focus on informational text, with skills applied both within and across texts. After considering exclusions, no prerequisite reading skills for these courses included NAEP objectives for literary text. The required reading skills cover a total of seven NAEP objectives in the Locate/Recall and Integrate/Interpret cognitive domains. No prerequisite reading skills for these courses address NAEP objectives in the Critique/Evaluate cognitive domain.

All of the skills described in the following objectives were identified as prerequisites for some or all courses in Computer Support Specialist programs. The objectives in

bold describe skills that were identified as both prerequisite and important or very important for success in more than half of the courses.

Across all entry-level courses in Computer Support Specialist programs, students need to be able to:

- **Locate or recall specific information such as definitions, facts, and supporting details in text and graphics**
- **Determine word meanings as used in context**

In more than half of the courses, students also need to be able to:

- **Locate or recall a sequence of events or actions in text**
- **Describe ~~problems and solutions or~~ cause and effect in texts**
- Compare or connect ideas, perspectives, problems, or situations within and across texts

Other reading skills were found to be prerequisite in just under half of the courses. For these courses, students also need to be able to:

- Locate or recall causal relations
- Locate or recall organizing structures of texts, such as comparison/contrast, problem/solution, enumeration, etc.

No NAEP objectives were identified as new reading skills and abilities for more than one Computer Support Specialist course.

Additional Prerequisites Independent of NAEP

Comprehend and follow written instructions; Writing, e.g., research, program documentation

Prerequisite KSA Description: HVAC

Common Objective Components Identified as Exclusions in Partial Matches

Literary texts; Literary devices; Topic sentences; Point of view

The prerequisite reading skills for students entering courses in HVAC programs focus on informational text, with skills applied both within and across texts. No prerequisite reading skills for these courses address NAEP objectives for literary text. The required reading skills cover a total of eight NAEP objectives in the Locate/Recall and Integrate/Interpret cognitive domains. No prerequisite reading skills for these courses address NAEP objectives in the Critique/Evaluate cognitive domain.

All of the skills described in the following objectives were identified as prerequisites for some or all courses in HVAC programs. The objectives in **bold** describe skills that were identified as both prerequisite and important or very important for success in more than half of the courses.

Across all entry-level courses in HVAC programs, students need to be able to:

- **Locate or recall specific information such as definitions, facts, and supporting details in text and graphics**
- **Determine word meanings as used in context**

In over two thirds of the courses, students also need to be able to:

- **Locate or recall a sequence of events or actions in text**
- **Locate or recall causal relations**
- **Locate or recall organizing structures of texts, including comparison/contrast, problem/solution, enumeration, etc.**
- **Describe ~~problems and solutions and~~ cause and effect**
- **Compare or connect ideas, perspectives, problems, or situations**
- **Summarize major ideas**
- **Draw conclusions, and provide supporting information**

In over half of the courses, students need to be able to:

- **Find evidence in support of an argument**

In approximately one third to just under half of the courses, students need to be able to:

- Determine the importance of information within and across texts

No NAEP objectives were identified as new reading skills and abilities for any HVAC courses.

Additional Prerequisites Independent of NAEP

Comprehend and follow written instructions; Reading charts, graphs and diagrams; A conceptual understanding sufficient to apply scientific concepts

Prerequisite KSA Description: LPN

Common Objective Components Identified as Exclusions in Partial Matches

Literary texts; Literary devices; Provide supporting information; Analyze

The prerequisite reading skills for students entering courses in LPN programs focus on informational text, with skills applied both within and across texts. No prerequisite reading skills for these courses address NAEP objectives for literary text. The required reading skills cover a total of six NAEP objectives in the Locate/Recall and Integrate/Interpret cognitive domains. No prerequisite reading skills for these courses address NAEP objectives in the Critique/Evaluate cognitive domain.

All of the skills described in the following objectives were identified as prerequisites for some or all courses in LPN programs. The objectives in **bold** describe skills that were identified as both prerequisite and important or very important for success in more than half of the courses.

Across all entry-level courses in LPN programs, students need to be able to:

- **Summarize major ideas**

In over two thirds of the courses, students need to be able to:

- **Locate or recall causal relations**
- **Locate ~~or recall~~ organizing structures in texts, such as comparison/contrast, problem/solution, enumeration, etc.**
- **Distinguish facts and opinions**
- **Draw conclusions ~~and provide supporting information~~**
- **Determine the importance of information within ~~and across~~ texts**

No NAEP objectives were identified as new reading skills and abilities for any LPN courses.

Additional Prerequisites Independent of NAEP

Identify, recall, and discuss information; Apply knowledge; Demonstrate evidence of knowledge; reflect on one's knowledge; Conceptualize and integrate

Prerequisite KSA Description: Pharmacy Technician (Entry-Level)

Common Objective Components Identified as Exclusions in Partial Matches

Literary texts; Literary devices

The prerequisite reading skills for students entering entry-level courses in Pharmacy Technician programs focus on informational text, with skills applied both within and across texts. No prerequisite reading skills for these courses address NAEP objectives for literary text. The required reading skills cover a total of seven NAEP objectives in the Locate/Recall and Integrate/Interpret cognitive domains. No prerequisite reading skills for these courses address NAEP objectives in the Critique/Evaluate cognitive domain.

All of the skills described in the following objectives were identified as prerequisites for some or all entry-level courses in Pharmacy Technician programs. The objectives in **bold** describe skills that were identified as both prerequisite and important or very important for success in more than half of the courses.

In more than two thirds of the courses, students need to be able to:

- **Locate or recall causal relations**
- **Locate or recall organizing structures of texts, such as comparison/contrast, problem/solution, enumeration, etc.**
- **Determine the importance of information within and across texts**

In more than half of the courses, students need to be able to:

- **Locate or recall a topic sentence or main idea**
- Summarize major ideas.

Other reading skills were found to be prerequisite in approximately one third to just under half of the courses. For these courses, students need to be able to:

- Draw conclusions and provide supporting information
- Distinguish facts and opinions.

No NAEP objectives were identified as new reading skills and abilities for more than one entry-level Pharmacy Technician course.

Additional Prerequisites Independent of NAEP

Reading materials on a computer screen rather than on paper; Able to decipher text that includes spelling/grammatical errors in a context-appropriate way and without difficulty

Prerequisite KSA Description: Automotive Master Technician

Common Objective Components Identified as Exclusions in Partial Matches

Literary texts such as verse or stanza in poetry or description, chronology, comparison, etc.., in literary nonfiction; Evaluate the strength and quality of evidence used by the author (as opposed to a person) to support his or her position

The prerequisite reading skills for students entering courses in Automotive Master Technician programs focus on informational text, with skills applied both within and across texts. The required reading skills cover a total of 20 NAEP objectives in the Locate/Recall, Integrate/Interpret, and Critique/Evaluate domains.

All of the skills described in the following objectives were identified as prerequisites for some or all courses in Automotive Master Technician programs. The objectives in **bold** describe skills that were identified as both prerequisite and important or very important for success in more than half of the courses.

Across all entry-level Automotive Master Technician courses, students need to be able to:

- **Locate or recall specific information such as definitions, facts, and supporting details in text and graphics**
- **Compare or connect ideas, perspectives, problems, or situations**
- **Draw conclusions and provide supporting information**
- **Distinguish facts from opinions**
- **Determine word meaning as used in context**

In more than two thirds of the courses, students also need to be able to:

- **Locate or recall sequence of events or actions**
- **Locate or recall the topic sentence or main idea**
- Locate or recall causal relations
- **Describe problem and solution, or cause and effect**
- **Summarize major ideas**
- **Find evidence in support of an argument**
- **Determine the importance of information within and across texts**

- **Determine the quality of counterarguments within and across texts**
- **Judge the coherence or logic of an argument**

In more than half the courses, students need to be able to:

- Locate or recall organizing structures of ~~literary~~ texts, such as ~~verse or stanza in poetry or description, chronology,~~ comparison ~~in literary non-fiction.~~
- Determine unstated assumptions in an argument
- Analyze, critique, or evaluate the author's perspective or point of view

Other reading skills were found to be prerequisite in approximately one third to just under half the courses. For these courses, students need to be able to:

- Describe or analyze how an author uses organizing structures to convey meaning
- Evaluate the strength and quality of evidence used by the author to support his or her position

No NAEP objectives were identified as new reading skills and abilities for more than one Automotive Master Technician course.

Additional Prerequisites Independent of NAEP

None

Concluding-Level Course Expectations

Prerequisite and new KSAs evidenced in the concluding-level course materials describe the mathematics and reading KSAs that are expected of students at the conclusion of job training programs. Artifacts from concluding-level courses in Pharmacy Technician job training programs were analyzed.

Research Question #2: *What mathematics and reading KSAs are students expected to have attained at the conclusion of the job training programs in each occupation?*

For mathematics, the evidence was judged to indicate that similar KSAs were prerequisite to both entry-level and concluding-level Pharmacy Technician courses. Concluding-level course prerequisites are described by objectives in the Number Properties and Operations (10 objectives), Measurement (5 objectives), Data Analysis, Statistics, and Probability (2 objectives), and Algebra (5 objectives) domains. Table 10 shows the objectives that were evident as prerequisite KSAs in 40% or more of the concluding-level courses, and the percentages of concluding-level courses for which each objective was judged to be prerequisite. For comparison, Table 10 also includes the percentages of entry-level courses for which the same objective was judged to be prerequisite.

Table 10. Concluding-Level Pharmacy Technician Course Prerequisites

Objective	Percent of Courses	
	Concluding	Introductory
Apply basic properties of operations, including conventions about the order of operations	87	35
Understand that numerical values associated with measurements of physical quantities are approximate, are subject to variation, and must be assigned units of measurement	47	20
Solve application problems involving numbers, including rational and common irrationals.	47	85
Represent, interpret, or compare expressions for real numbers, including expressions using exponents and logarithms	40	65
Perform arithmetic operations with real numbers, including common irrational numbers	40	80
Use proportions to solve problems (including rates of change)	40	30
Solve multistep problems involving percentages, including compound percentages	40	50
Solve problems involving conversions within or between measurement systems, given the relationship between the units	40	10

It is likely that many of the entry-level course prerequisites are not evident in courses at the end of the training program because the KSAs evident in concluding-level courses are not necessarily *all* of the KSAs that students need to have acquired by the time they take a concluding-level course.

For mathematics, the grade 12 NAEP objectives that the evidence indicated as new content that was taught to students in the concluding-level Pharmacy Technician courses are similar to those taught to students in the entry-level courses. Table 11 lists the objectives identified as new content and the percentages of entry-level and concluding-level courses requiring each objective.

Table 11. Mathematics Objectives Taught in Both Entry-Level and Concluding-Level Pharmacy Technician Courses.

Objective	Percent of Courses	
	Concluding	Introductory
Solve problems involving rates such as speed, density, population density, or flow rates	73	45
Solve problems involving conversions within or between measurement systems, given the relationship between the units	60	40
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	53	40
Write algebraic expressions, equations, or inequalities to represent a situation	47	30
Solve problems involving special formulas such as: $A = P(I + r)^t$, $A = Pe^{rt}$	47	40
Use proportions to solve problems (including rates of change)	47	40
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	33	25
Analyze situations, develop mathematical models, or solve problems using linear, quadratic, exponential, or logarithmic equations or inequalities symbolically or graphically	33	40
Understand that numerical values associated with measurements of physical quantities are approximate, are subject to variation, and must be assigned units of measurement	20	35
Represent or interpret expressions involving very large or very small numbers in scientific notation.	13	15

In reading, there was no evidence of 12th grade NAEP objectives being taught in the concluding courses in pharmacy technician job training programs. Evidence of ten NAEP reading objectives was found as new material in an introductory course for ten different programs; each objective was evident in only one course. There were no new (taught) objectives found in the concluding courses, and all of the objectives identified as prerequisite to the concluding courses, were also identified as prerequisite to the introductory courses.

A KSA summary describing the knowledge, skills, and abilities that are prerequisite to courses offered at the conclusion of pharmacy technician job training programs follows.

Mathematics Prerequisite KSA Description: Pharmacy Technician (Concluding)

Common Objective Components Identified as Exclusions in Partial Matches

Common irrational numbers; Exponents and logarithms; Expressions involving absolute value; Compound percentages; Order of operations; Speed, density, population density; Approximate or subject to variation; Discussion of advantages or disadvantages; Absolute values

In the Number Properties and Operations domain, for almost half the courses, the use of proportions to solve problems was considered new content. The ability to apply basic properties of operations was seen as a prerequisite necessary for about three quarters of the courses:

1-4-c	Use proportions to solve problems
1-5-e	Apply basic properties of operations~~, including conventions about the order of operations~~

In the Measurement domain, for almost three quarters of the courses, solving problems involving rates was viewed as new content. For more than half of the courses, both the role and use of units and measurement conversion were also viewed as new content. Measurement conversion was evident in all of the concluding courses, whereas the role and use of units was evident in only three quarters of the courses.

2-1-i	Solve problems involving rates such as flow rates
2-2-a	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
2-2-b	Solve problems involving conversions within or between measurement systems, given the relationship between the units

The following objective was a prerequisite necessary to 40 percent of the courses, was new content in 20 percent, and was not evident in 27 percent:

2-2-d	Understand that numerical values associated with measurements of physical quantities ~~are approximate, are subject to variation, and~~ must be assigned units of measurement

In the algebra domain, almost half the courses treated the following objective as new content, but in 20 percent it did not appear:

5-3-b	Write algebraic expressions, equations, or inequalities to represent a situation

The following objective was considered new content in 40 percent of the courses:

5-4-e Solve problems involving special formulas such as: $A = P(I + r)^t$, $A = Pe^{rt}$

Additional Prerequisites Independent of NAEP
None

Reading Prerequisite KSA Description: Pharmacy Technician (Concluding)

Common Objective Components Identified as Exclusions in Partial Matches
Literary texts; Literary devices

The prerequisite reading skills for students in concluding courses in pharmacy technology focused on informational texts with skills applied both within and across texts. No prerequisite reading skills for these courses address NAEP objectives for literary text. The required reading skills cover a total of four NAEP objectives in the Locate/Recall and Integrate/Interpret domains. No prerequisite reading skills for these courses address NAEP objectives in the Critique/Evaluate cognitive domain.

Across all courses, students need to be able to:

- Locate or recall causal relations

This skill was considered important for success in all concluding pharmacy technician courses.

In over two thirds of the courses, students need to be able to:

- Locate or recall organizing structures of texts, such as comparison/contrast, problem/solution, enumeration, etc.
- Determine the importance of information within and across informational texts

In one third of the courses, students need to be able to:

- Draw conclusions and provide supporting information

No NAEP objectives were identified as new reading skills and abilities for any courses.

Additional Prerequisites Independent of NAEP
None.

The evidence was judged to indicate that 12th Grade NAEP objectives were taught as new content in courses in other occupational areas. A summary of the 12th Grade NAEP objectives judged to be new content in all occupational job training programs is provided in Appendix H.

Prerequisite KSAs Compared to JSS Borderline Performance Descriptions

Both the Job Training Program study and the Judgmental Standard Setting study sought to identify the expectations for entry into job training programs and to explore the overlap between these expectations and the KSAs measured by NAEP. The JSS borderline performance descriptors developed by the job trainers state the KSAs required for minimal academic preparedness for entry into job training programs and provide a point of comparison for the prerequisite KSA descriptions derived from analysis of course artifacts.

> **Research Question #3**: *How do the prerequisites for job training programs in each occupation relate to descriptions of minimal academic preparedness on NAEP (as described by the BPDs from the JSS studies)?*

The following comparisons were made across the two studies:

1) Artifact reviewers compared the prerequisite KSA identified in the artifacts analyzed for each course to those described by the JSS BPDs
2) NAEP content expert review teams drafted summaries of the prerequisite for each occupation as identified through the artifact analysis; these can be compared to the JSS BPDs to identify similarities and differences across both summaries.

The JSS BPDs describe the KSAs that the study panelists judged students to need in order to be minimally prepared for entry into job training programs. Content and occupational experts compared the KSAs for each course (not for each prerequisite) to the JSS BPDs, and determined if the course required fewer or less complex/difficult KSAs than the BPD, was well-described by the BPD, or required more complex/difficult KSAs than the BPD. The experts' response options for the comparisons follow.

> For each COURSE PACKET, please select the level of alignment between the PREREQUISITE KSA for this course and the KSA described by the BPD, using the following ratings:
>
> 1—Course requires **fewer or less complex/difficult** KSA elements than BPD
> 2—Course KSA elements are **well-described** by the BPD
> 3—Course requires **more complex/difficult** KSA elements than BPD

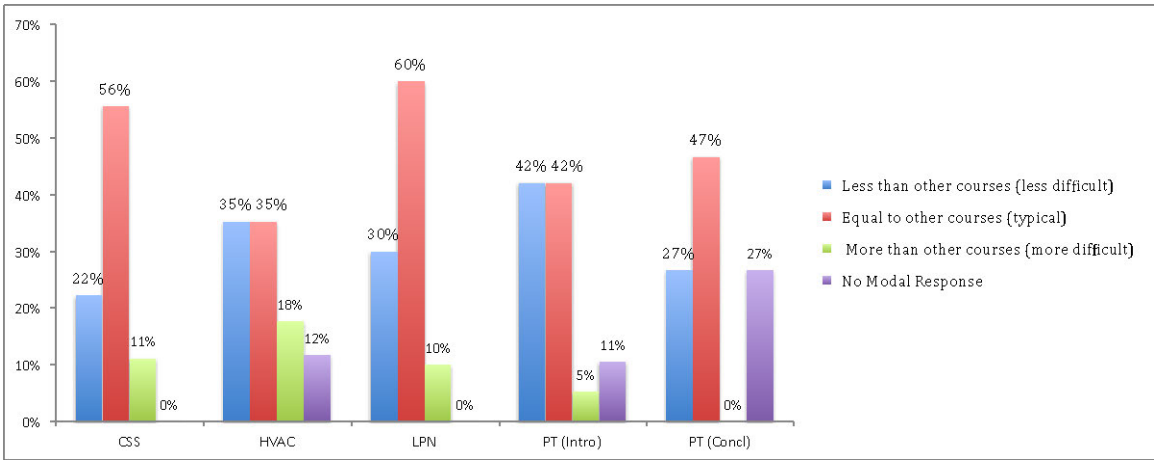
Modal responses for each course, across reviewers, represent the level of complexity or difficulty of each course compared to that of the BPDs. Overall, the prerequisite KSAs identified through analysis of course artifacts were found to be fewer or less complex/difficult than the JSS BPDs. Overall, 70% of courses required

fewer or less complex/difficult KSAs than the BPDs, 25% were well-described by the BPDs, and 5% were more complex/difficult than the BPDs.

The overall finding that the BPDs for each job training program describe higher expectations than were found in the job training course artifacts is more pronounced for mathematics courses, of which the majority require KSAs that are less complex than those described in the JSS BPDs. Consistency with the BPDs was highest for HVAC courses, where 30% of the courses were judged to be well-described by the BPDs. Nearly all of the Computer Support Specialist and concluding-level Pharmacy Technician courses contained fewer or less complex/difficult KSAs than described in the BPDs. None of the mathematics courses required KSAs that were more complex or difficult than those described by the BPDs.

Given that there are no BPDs for concluding-level Pharmacy Technician courses, reviewers of both the entry-level and concluding-level Pharmacy Technician courses compared the prerequisites evident in the course artifacts to the entry-level Pharmacy Technician BPDs. Compared to the entry-level course artifacts, 20% more of the KSAs identified in the concluding-level course artifacts were less complex/difficult than those described by the entry-level Pharmacy Technician BPDs. Figure 7 shows the percentages of mathematics courses with prerequisite KSAs that are less complex, equal to, or more complex than the BPD KSAs. (These data are not available for the Automotive Master Technician pilot study.)

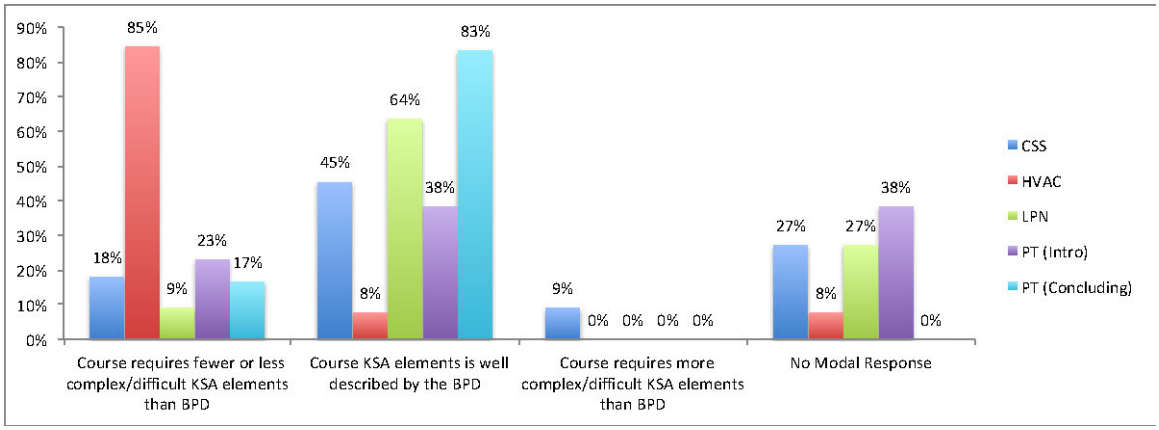
Figure 7. Prerequisite Mathematics KSAs Compared to BPD KSAs



Key: CSS = Computer Support Specialist; PT Intro = Pharmacy Technician (entry-level); PT Conc = Pharmacy Technician (concluding-level); AMT = Automotive Master Technician.
Note: "No Modal Response" indicates that four review teams' ratings were bimodal or that there was no majority rating.

Figure 8 shows the percentages of reading courses with prerequisite KSAs that are less complex, equal to, or more complex than the BPD KSAs. (Again, these data are not available for the Automotive Master Technician pilot study.)

Figure 8. Prerequisite Reading KSAs Compared to BPD KSAs



Key: CSS = Computer Support Specialist; PT Intro = Pharmacy Technician (entry-level); PT Conc = Pharmacy Technician (concluding-level); AMT = Automotive Master Technician.
Note: "No Modal Response" indicates that four review teams' ratings were bimodal or that there was no majority rating.

In reading, the prerequisite KSAs that were evident in course artifacts are similar to those described by the BPDs. In only one occupation—HVAC—were the KSAs found in a majority of courses (84%) judged to contain fewer or less complex/difficult KSAs than the BPDs. Consistency with the BPDs was highest for the concluding-level Pharmacy Technician KSAs, for which 82% of the course prerequisites were well-described by the BPDs. In only one occupation, Computer Support Specialist, were the prerequisite KSAs for any course judged to be more complex/difficult than those described in the BPDs.

Appendix I provides all JSS BPDs.

Prerequisite KSAs Mapped to NAEP Scale

To provide some context in understanding where the expectations for program entry (i.e., prerequisite KSAs) fall in relation to NAEP, the mathematics and reading NAEP content expert teams compared the prerequisites for each occupation to the KSAs measured by grade 12 NAEP items.

Research Question #4: *How do the prerequisites for job training programs for each occupation relate to the content assessed by NAEP?*

The original plan for this comparison was to evaluate the items between the cut scores set by the replicate panels in the JSS studies. However, given the sparse coverage of the framework objectives by the KSAs that were evident in the course artifacts, this plan was modified to more appropriately relate the KSAs evident in the course artifacts to locations on the NAEP scale.

NAEP experts identified regions of the NAEP scale that best represent the range of items reflecting the KSA content and level of difficulty evident in the job training course artifacts. They accomplished this by reviewing items that were ordered in terms of difficulty and evaluating how the prerequisite KSA descriptions they had created were related to the items at different points on the NAEP scale. Their review compared the KSAs for each occupation's job training program to two statistically equivalent[4] sets of items. Table 12 shows the prerequisite KSAs for job training programs mapped onto the NAEP mathematics and reading scales. Proficient indicates performance at or above the Proficient level.

Table 12. Prerequisite KSAs for Job Training Programs Mapped onto NAEP Mathematics and Reading Scales

	Mathematics		Reading	
Occupation **JSS Replicate Panel**	**JTPCS**	**JSS Studies**	**JTPCS**	**JSS Studies**
Computer Support Specialist				
A	Below Proficient	Below Proficient	Proficient	Below Proficient
B	Below Proficient	Proficient	Below Proficient	Proficient
HVAC				
A	Below Proficient	Proficient	Proficient	Below Proficient
B	Below Proficient	Proficient	Proficient	Below Proficient
LPN				
A	Below Proficient	Proficient	Proficient	Proficient
B	Below Proficient	Proficient	Below Proficient	Below Proficient
Pharmacy Technician (Entry-Level)				
A	Below Proficient	Below Proficient	Proficient	Proficient
B	Below Proficient	Proficient	Below Proficient	Below Proficient
Pharmacy Technician (Concluding-Level)				
A	Below Proficient	N/A	Proficient	N/A
B	Below Proficient	N/A	Below Proficient	N/A
Automotive Master Technician				

[4] Items in two ordered item booklets (the same booklets used in the JSS studies) were selected from within a range of reasonable scores. The items in each booklet are not a random sample, but they do include some scores above Proficient and some below Basic, with the majority falling within the Basic level.

Occupation JSS Replicate Panel	Mathematics		Reading	
	JTPCS	JSS Studies	JTPCS	JSS Studies
A	Below Proficient	Below Proficient	Proficient	Proficient
B	Below Proficient	Below Proficient	Proficient	Below Proficient

The KSAs identified by artifact analysis for mathematics corresponded to NAEP items below the Proficient level. The KSAs that the JSS study panels identified as being required for minimal academic preparedness require a higher level of student performance in mathematics than the level indicated by the evaluation of evidence collected for the courses in the job training programs.

The KSAs identified by artifact analysis for reading corresponded to NAEP items near the Proficient level (some above and some below). As with mathematics, the KSAs that the JSS study panels identified as being required for minimal academic preparedness require a higher level of student performance in reading than the level indicated by the evaluation of evidence collected for the courses in the training programs.

Representativeness

Although the study sample is not a random sample of institutions or of job training programs, representativeness of the population of similar programs is important to interpreting and generalizing findings. Although there is no central database of characteristics of all job training programs, the Integrated Postsecondary Education Data System (IPEDS) provides a readily available database for identifying the institutions represented in this study and comparing them to similar institutions. Table 13 shows the institutional characteristics of the study sample, compared to IPEDS data describing similar job training programs. (Table 13 does not include data from the pilot study.)

Table 13. Institutional Characteristics of Sample

	Percent of Institutions	
Institutional Characteristic	JTPCS N = 122	IPEDS N = 1749
Level of Institution		
At least 2-year but less than 4-year	92	77
Less than 2 years (below associate)	8	23
Public/Private		
Public	73	65
Private	27	35
Institution Size		
Under 1,000	23	46
1,000–4,999	29	28
5,000–9,999	21	14
10,000–19,999	17	8
20,000 and above	10	4
Geographic Region		
Far West (AK, CA, HI, NV)	15	13
Great Lakes (IL, IN, MI)	7	7
Mideast (DE, DC, MD)	9	7
New England (CT, ME)	5	6
Plains (IA, KS, MN, MO)	20	20
Rocky Mountains (CO)	4	6
Southeast (AL, AR, FL)	26	28
Southwest (AZ, NM, OK)	15	13
Open Admissions		
Yes	92	84
No	8	16

Note. IPEDS data includes data only from the same states as the participating institutions. Source: http://nces.ed.gov/ipeds/datacenter/

As Table 13 shows, the population of institutions that provided artifacts for this study is generally similar to the population of similar institutions. The sample underrepresents less-than-two-year institutions and very small institutions with enrollments fewer than 1,000 students, and over represents larger institutions (enrollments greater than 10,000 students).

Relative Course Difficulty

To indicate relative course difficulty, artifact reviewers were asked to compare the difficulty of each reviewed course to the difficulty of the other courses reviewed within each occupation.

For each COURSE PACKET please indicate if, *relative to the other courses reviewed for this occupation in this study*, the overall challenge level/rigor of the KSAs found in the artifacts from this course packet is:

1—Less than other courses **(less difficult)**
2—Equal to other courses **(typical)**
3—More than other courses **(more difficult)**

Reviewers were allowed to return to this question as they reviewed more course packets and became increasingly able to compare courses to each other, and were encouraged to return to the question again upon completing the reviews for all course packets. Tables 14 and 15 show the percentages of reviewer responses for mathematics and reading courses, respectively, in four of the five occupations; data for the Automotive Master Technician pilot study are not shown in the tables.

Table 14. Relative Difficulty of Mathematics Courses, by Occupation

	Less Than Other Courses (Less Difficult)	Equal to Other Courses (Typical)	More Than Other Courses (More Difficult)	No Modal Response
Computer Support Specialist	22%	56%	11%	0%
HVAC	35%	35%	18%	12%
LPN	30%	60%	10%	0%
Pharmacy Technician (Entry-Level)	42%	42%	5%	11%
Pharmacy Technician (Concluding-Level)	27%	47%	0%	27%

Note: "No Modal Response" indicates that four member review teams' ratings were bimodal, or that there was no majority.

In mathematics, reviewers found most courses to be comparable to each other in terms of course difficulty, with between 40% and 60% of the courses within each occupation of typical difficulty and equal in difficulty to the other courses reviewed. Between 20% and 40% of the courses within each occupational area were judged to be less difficult than the other courses, and only a handful of courses were judged to be more difficult than the other courses.

Table 15. Relative Difficulty of Reading Courses, by Occupation

	Less Than Other Courses (Less Difficult)	Equal to Other Courses (Typical)	More Than Other Courses (More Difficult)	No Modal Response
Computer Support Specialist	9%	82%	9%	0%
HVAC	38%	31%	23%	8%
LPN	18%	64%	0%	18%
Pharmacy Technician (Entry-Level)	15%	62%	0%	23%
Pharmacy Technician (Concluding-Level)	9%	82%	0%	9%

Note: "No Modal Response" indicates that four member review teams' ratings were bimodal or that there was no majority.

The reading courses studied were found to be similar to each other in terms of difficulty; most courses were of typical difficulty and of equal difficulty to the other reviewed courses. With the exception of HVAC, the majority of courses in each of the occupations were found to be of equal difficulty (just over 60% of LPN and entry-level Pharmacy Technician courses, and more than 80% of Computer Support Specialist and concluding-level Pharmacy Technician courses). Only 30% of the HVAC courses were rated as typical, while nearly 40% were rated as less difficult and 20% were rated as more difficult than the other HVAC courses.

Modal responses did not emerge for entry-level Pharmacy Technician (23%) and LPN (18%) courses, indicating less reviewer uniformity in rating the relative difficulty of these courses.

Rater Consistency

The tables and descriptive text in this section examine different aspects of rater consistency. Data from the Automotive Master Technician pilot study are not included in the analyses in this section.

Independent Ratings Requiring Adjudication

The content-area and occupational-area experts reviewed all course artifacts independently. Upon completion of the independent reviews, results were compiled and the teams met in person to adjudicate each objective in every course packet for which the independent ratings were not in 100% agreement. Table 16 shows the average numbers of objectives, across all course packets, for which at least one of

the three applicability ratings (not applicable, prerequisite, or new content) differed from the others.

Table 16. Numbers and Average Percentages of Objectives Requiring Adjudication

	Mathematics: Number of Objectives = 130					Reading: Number of Standards and Objectives = 47				
	CSS	HVAC	LPN	PT Intro	PT Conc	CSS	HVAC	LPN	PT Intro	PT Conc
Mean	30	25	39	37	31	23	22	21	32	30
SD	17.4	8.1	9.8	15.7	4.6	2.3	5.4	7.8	6.7	6.6
Avg %	23%	19%	30%	29%	24%	49%	47%	45%	69%	64%

Key: CSS = Computer Support Specialist; PT Intro = Pharmacy Technician (entry-level); PT Conc = Pharmacy Technician (concluding-level).
Note: Reading reviewers were allowed to rate standards to indicate that all objectives under that standard were prerequisite. The total number of reading objectives is 37.

On average, across all mathematics course packets, between 19% and 30% of the 130 NAEP objectives required adjudication in each occupational area. Across all reading course packets, approximately half of the 47 NAEP standards and objectives required adjudication in each occupational area.

Table 17 describes the percentages of objectives in each course that required adjudication. Each row in the table corresponds to a course; the numbers of courses differed for each occupational area.

Table 17. Percentages of Objectives Requiring Adjudication in Each Course

CSS Math	CSS Reading	HVAC Math	HVAC Reading	LPN Math	LPN Reading	PT Intro Math	PT Intro Reading	PT Conc Math	PT Conc Reading
16%	47%	15%	64%	44%	100%	45%	91%	33%	64%
5%	45%	22%	45%	50%	49%	70%	83%	23%	66%
12%	49%	26%	45%	31%	38%	27%	53%	25%	64%
17%	47%	17%	47%	29%	47%	33%	66%	22%	66%
27%	51%	23%	51%	26%	38%	37%	79%	28%	38%
35%	38%	25%	34%	22%	38%	34%	68%	27%	72%
26%	53%	25%	55%	25%	38%	30%	64%	25%	55%
53%	53%	22%	49%	25%	38%	28%	62%	24%	57%
19%	55%	23%	53%	28%	55%	31%	64%	24%	57%
21%	53%	20%	51%	28%	36%	26%	62%	25%	72%
		21%	51%	28%	43%	26%	68%	25%	62%
		18%	51%	29%	34%	18%	64%	22%	38%
		15%	51%	31%	36%	27%	62%	22%	43%
		21%	15%	27%	53%	24%	68%	18%	83%
		17%			34%	27%	47%	19%	72%

CSS Math	CSS Reading	HVAC Math	HVAC Reading	LPN Math	LPN Reading	PT Intro Math	PT Intro Reading	PT Conc Math	PT Conc Reading
		8%				22%	81%	25%	89%
		25%				8%	62%	25%	79%
		3%				28%	38%	18%	64%
						12%	83%		77%
						25%	68%		
						25%	98%		
						26%	85%		

Key: CSS = Computer Support Specialist; PT Intro = Pharmacy Technician (entry-level); PT Conc = Pharmacy Technician (concluding-level).

As shown in Table 17, across all courses, the percentages of objectives requiring adjudication ranged from as low as 7% to as many as 100%.

Review Team Agreement

EPIC's convergent consensus approach does not require consensus. Rather than forcing a decision, facilitators can accept "agree to disagree" as a valid outcome. However, where and to what extent the review teams agree is an important result of the study. Tables 18 and 19 show the percentages of all decisions that were reached for each occupation for mathematics and reading. The total number of decisions for each occupational area is calculated by multiplying the number of objectives by the number of courses. When the Pharmacy Technician review teams ran out of time during group reviews, the modal response was used as the consensus decision.

Table 18. Percentages of Mathematics Decisions, by Occupational Area

Occupational Area	Total # Decisions	Consensus Reached	Consensus is Modal Response	Agree to Disagree
CSS	1170	100%	0%	0%
HVAC	2210	94%	6%	0%
LPN	1300	100%	0%	0%
PT Intro	2600	64%	34%	2%
PT Conc	1170	66%	32%	1%

Key: CSS = Computer Support Specialist; PT Intro = Pharmacy Technician (entry-level); PT Conc = Pharmacy Technician (concluding-level).
Note: Percentages may not sum to 100% due to rounding.

Table 19. Percentages of Reading Decisions, by Occupational Area

Occupational Area	Total # Decisions	Consensus Reached	Consensus is Modal Response	Agree to Disagree
CSS	407	97%	0%	2%
HVAC	481	100%	0%	0%
LPN	407	100%	0%	0%
PT Intro	444	100%	0%	0%
PT Conc	444	100%	0%	0%

Key: CSS = Computer Support Specialist; PT Intro = Pharmacy Technician (entry-level); PT Conc = Pharmacy Technician (concluding-level).
Note: Percentages may not sum to 100% due to rounding.

Across the full study, the level of review team agreement was very high, with consensus reached on nearly every decision observed in reading. The study was not designed to statistically separate the sources of agreement; however, overall agreement among rater teams, across all courses and all KSAs, on the important decision about whether or not a KSA is prerequisite can be calculated. For reading and mathematics, review team agreement can be calculated as the number of times the team agreed that a KSA was or was not prerequisite, divided by the number of possible agreements (i.e., number of applicability ratings possible), which is calculated by multiplying the number of KSAs by the number of courses.

Table 20 displays the percentages of review team agreement for mathematics and reading. Two Pharmacy Technician review teams did not finish a few course packets due to insufficient time; these packets were assigned final decisions that were the modal responses from independent ratings. As a result, the percent agreements shown in Table 20 may be slightly inflated by a few percentage points.

Table 20. Percent Agreement on Prerequisite KSAs by Reading and Mathematics Review Teams

	Reading	Mathematics
Number of Agreements	3009	10070
Number of Courses	82	78
Number of KSAs	37	130
Percent Agreement	99%	99%

Sources of Evidence

To determine the efficacy of using the selected course artifacts to identify prerequisite KSAs, occupational-area and content-area experts identified, during independent review, the source of evidence for each prerequisite KSA evident in the artifacts for each course:

> For each PREREQUISITE KSA, please identify the sources of evidence used for answering the questions above for the course packet. (Please select all that apply.)

The experts were able to select multiple artifact types as necessary to capture which artifacts provided evidence that a NAEP objective was prerequisite. Figure 9 shows the percentages of different sources of evidence used to identify prerequisite objectives in mathematics and reading. Percentages are of the total number of artifacts identified in each content area as providing evidence of prerequisite KSAs; within each content area, the percentages sum to 100%. Data collected in the pilot

study from the Automotive Master Technician occupation are not available and are not included in Figure 9.

Figure 9. Sources of Evidence Used to Identify Prerequisite Objectives

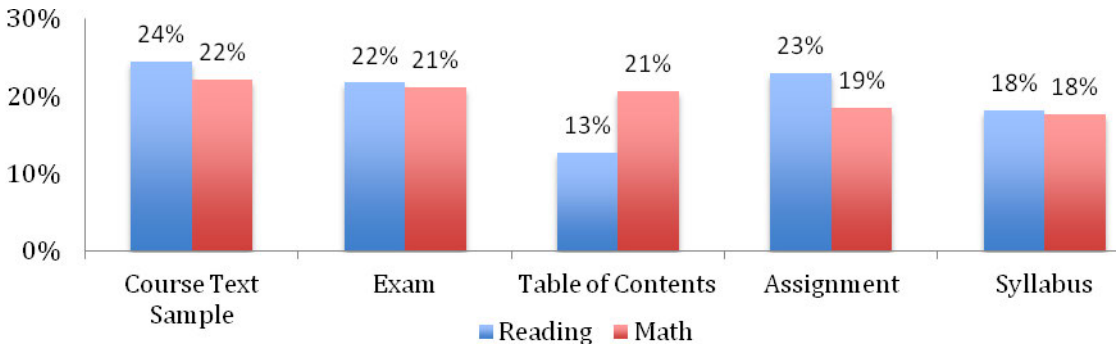


Figure 9 can be interpreted as follows: for example, course text samples made up 24% of all artifacts that provided evidence of reading prerequisite KSAs and 22% of all artifacts that provided evidence of mathematics prerequisite KSAs. As shown in Figure 9, similar patterns of evidence sources are evident across content areas. The only notable exception is that textbook tables of contents provided more evidence of prerequisite mathematics KSAs than they did for reading KSAs. The same pattern holds across the four occupational areas.

When reference textbooks were provided, reviewers found them to be extremely valuable supporting and clarifying sources of evidence.

Decision Rules

NAEP experts created some general rating decision rules prior to independent review training, and artifact reviewers were trained to implement them during independent review. Efforts were made to encourage uniform decision-making, but part of the convergent consensus process is to allow review teams to develop their own rules. Decision rules emerged at four levels: those that applied across both occupational areas and content areas and provided rating instruction or clarification; those that applied only to a specific content area; those that applied specifically to an occupational area or course packet; and those that applied only to a specific framework objective (or standard) within an occupation.

Appendix J provides the decision rules for each content area and occupational area for both mathematics and reading. The decision rules can be classified into five types: (1) clarifications of "evidence," (2) clarifications of "prerequisite," (3) clarifications of "importance," (4) clarifications of content or occupational specific terms, and (5) other. Figure 10 defines and provides examples of each type.

Figure 10. Types of Decision Rules Implemented During Onsite Group Review

Decision Rule Type/Category	Definition	Examples
Clarifications of "evidence"	Clarifications of reading or math content, provided to the occupational expert, or clarifications of occupational-specific content to the content experts, as these clarifications relate to identifying or locating evidence within artifacts.	"1.4.c: if no IV drip, look for other proportions", "5.3.b. Word problem is a trigger", "1.1.g: looking for absolute values, if none in packet, NA"
Clarifications of "applicability"	Used to apply occupational or content specific rules, often in the form "if we see x, y, or z, we know it is a prerequisite (or is not applicable). Most often applied to the determination of applicability.	"2.3.c - not applicable unless there's evidence of research assignment", "1.1.f If no scientific value = not applicable"
Clarifications of "importance"	Used to apply occupational or content specific rules, often in the form "if we see x, y, or z, we know it is important (or is not important).	"2.3.b - evidence based nursing; prerequisite and important"
Clarification of content or occupational specific terms	Content experts educating occupational expert on content-specific terms, or vice versa.	"1.3.d - nursing care plan is considered to be problem/solution", "5.3.e if we see Clark's rule or pediatric dosing, will be New"
Other	Anything not falling into the categories above.	"Agree to disagree" (almost always content vs. occupational, not content vs. content), "Summarize is differently understood by LPN than by content experts."

The majority of decision rules defined categories of applicability ("not applicable," "prerequisite," or "new") in ways that simplified and automated the process of identifying prerequisite KSAs for specific combinations of evidence and NAEP objectives within an occupational area. The next-most-common type of decision rule defined "evidence" for specific artifacts or in specific occupations.

The majority of decision rules standardized the decision-making process relating to determining if evidence found indicated that a KSA was prerequisite, new, or not applicable to the course.

Table 21. Application of Decision Rule Types by Content and Occupational Areas

	Applicability Ratings Defined	Evidence Defined	Importance Ratings Defined	Term Defined	Other
Mathematics	44	16	1	5	8
HVAC	0	2	0	0	0
LPN	21	9	1	3	2
PT	23	5	0	2	6
Reading	3	10	3	5	0
CSS	0	0	0	1	0
LPN	3	6	2	3	0

PT	0	4	1	1	0

Key: CSS = Computer Support Specialist; PT = Pharmacy Technician.

By occupation, decision rules were used most frequently in the health occupations (LPN and Pharmacy Technician).

Rater Confidence in Study Outcomes

Artifact reviewers completed evaluations after orientation and training and upon completion of the group reviews; results of these evaluations are shown in Table 22 and Table 23, respectively. Aggregate responses indicate acceptable levels of confidence in the process and outcomes.

Table 22. Training Evaluations

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The orientation webinar training that occurred in September—prior to conducting my independent ratings—prepared me for tasks I needed to complete.	26%	57%	9%	9%	0%
The orientation to the consensus process prepared me for the tasks I needed to complete.	35%	57%	4%	4%	0%
I'm comfortable with the process of this meeting.	61%	35%	4%	0%	0%
I feel my voice is being heard.	78%	22%	0%	0%	0%

As shown in Table 22, after training, all participants agreed or strongly agreed that their voice had been heard. All but two reviewers agreed or strongly agreed that they were comfortable with the process and that they felt prepared for project tasks.

Table 23. Process Evaluation Results

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I am confident in the outcomes of this meeting.	19	6	2	0	0
The meeting procedures were well-described.	19	8	0	0	0
I had enough time to provide my independent ratings.	13	12	1	1	0
My group had enough time to discuss discrepant ratings.	16	8	3	0	0
Overall, I think my team's	25	2	0	0	0

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
discussions were open and honest.					
Overall, I believe that my opinions were considered by others.	23	4	0	0	0
Overall, I am satisfied with my team's final rating.	20	7	0	0	0
I feel this procedure was fair.	23	4	0	0	0
The meeting was well-organized.	19	7	1	0	0

As shown in Table 23, overall analyses of the evaluations, provided at the conclusion of the group reviews, suggest a high level of rater confidence in study process and outcomes. All participants agreed or strongly agreed that processes were well-described, and that the team discussions were open and honest and considered team members' opinions. All participants also agreed or strongly agreed that they were satisfied with the prerequisite KSAs described and that they felt the process was fair. All but two reviewers were confident in the outcomes of the study (two were neutral).

Prerequisite KSAs Compared to BPDs from JSS Study

Prior to the onsite JSS study process, participating course instructors were asked to evaluate each NAEP objective in the mathematics or reading framework and to indicate if students must demonstrate the ability to perform each objective to be at least minimally prepared for entry into their program. The specific question to which the instructors were asked to respond was:

> Must students demonstrate the ability to perform each objective to be at least minimally prepared for entry into your program?

This information was collected from persons who had agreed to participate as JSS panelists, and the information was used by content facilitators (NAEP content experts) to draft preliminary BPDs for each occupational area, to serve as starting versions for panelists to develop and finalize as the BPDs to use in the JSS process.

The question asked of reviewers in this study was:

> For each NAEP FRAMEWORK ELEMENT identified in the course artifacts, please indicate whether the evidence you reviewed indicates that it is a prerequisite for this course, is taught in this course, or is neither a prerequisite nor taught.

Although the two questions are very different, comparing responses to related questions between the JSS studies and this study provides at least minimal validation of the artifact review process as compared to the JSS process.

Table 24 provides, for each of the occupational areas, the percentages of objectives identified as prerequisite in more than one course in this study, as well as the percentages of objectives identified by more than one JSS study panelist as necessary for preparedness for entry into their program.

Table 24. Percentages of Objectives Identified as Prerequisite

	Percent Prerequisite	
Reading	**JTPCS**	**JSS**
Computer Support Specialist	22%	81%
HVAC	30%	76%
LPN	24%	92%
Pharmacy Technician (Entry-Level)	22%	100%
Pharmacy Technician (Concluding-Level)	22%	N/A
Automotive Master Technician	49%	78%
Mathematics		
Computer Support Specialist	11%	83%
HVAC	21%	81%
LPN	12%	48%
Pharmacy Technician (Entry-Level)	14%	60%
Pharmacy Technician (Concluding-Level)	10%	N/A
Automotive Master Technician	18%	75%

Table 24 shows consistently higher percentages associated with asking instructors what KSAs students should have, as compared to asking artifact reviewers what evidence was found. Because the JSS panelists were asked about the KSAs that they think are necessary for students upon entry into *their* program (not every program or a typical program), the consistently higher prerequisite responses are likely due to differences between what KSAs instructors *think* students need in order to be at least minimally prepared for entry into their program and what can be evidenced from course artifacts as being prerequisite to entry-level college courses. If the two were very similar, it might indicate that the judgments of the job training program instructors in the JSS studies are similar to the reviewers' judgments based on evidence collected from the courses in the job training programs. Shared areas of importance may not be identified or be directly comparable.

Conclusion

Summary

Research Question #1: *What mathematics and reading KSAs are prerequisite to the entry-level courses for the job training programs in each occupation, and what mathematics and reading KSAs are taught in these entry-level courses?*

Mathematics. The job training programs studied have few prerequisite expectations in mathematics. The largest number of prerequisites across all occupational training programs were found in the Number Properties and Operations domain and the "Systems of measurement," "Variables, expressions, and operations," and "Equations and inequalities" standards. No programs had Data Analysis, Statistics, and Probability domain prerequisites, and few had Geometry domain prerequisites. There was no evidence of irrational numbers, exponents and logarithms, or absolute value as prerequisites in the artifacts.

A majority of the course artifacts within the HVAC and Automotive Master Technician programs contained evidence of prerequisites in the "Systems of measurement" standard. Little evidence was found that the health-care occupations (LPN and Pharmacy Technician) required Measurement domain objectives in many courses. The only occupation with evidence of prerequisite Geometry domain KSAs —specifically the "Draw or sketch from a written description plane figures and planar images of three-dimensional figures" and "Use two-dimensional representations of three-dimensional objects to visualize and solve problems" objectives—was Automotive Master Technician. Evidence was found that LPN programs teach measurement conversion as new content, when it would seem to be a prerequisite, and do not include the objective about precision and accuracy, or any objectives from the Data Analysis, Statistics, and Probability domain, as prerequisite.

There were more NAEP objectives identified as prerequisites for the Automotive Master Technician occupation than there were for programs in the other occupational areas. Keeping in mind the differences in methodology, the Automotive Master Technician program artifacts provided evidence of up to 20 prerequisites for most courses, while the other job training program artifacts provided evidence of between six and eight NAEP objectives each. HVAC programs, which would seem to have many of the same expectations as Automotive Master Technician programs, had no critical prerequisites about visualization from the Geometry domain, nor did they have any prerequisites from Data Analysis, Statistics, and Probability, which includes interpreting data and visual displays. Dissimilarities between Automotive Master Technician programs and the four other job training programs should be interpreted cautiously, given the differences in methods between the pilot study and the operational study.

The LPN and Pharmacy Technician programs described fewer objectives as prerequisites for their courses, compared to the other three occupational areas,

with the LPN programs identifying the smallest number (six) of objectives. Pharmacy Technician courses included no precision or accuracy objectives and no objectives from the Data Analysis, Statistics, and Probability domain. Rates, units of measure, and measurement conversions were new content, but would seem to be prerequisites. Courses in both health-related job training programs were expected to include substantial amounts of reading. Finally, none of the job training program artifacts showed evidence of estimating or of deciding reasonableness of answers, as either prerequisite or new content.

Raters identified relatively few prerequisites that were not measured by NAEP. This is both encouraging and potentially problematic in that, although occupational-area and content-area experts were unable to identify prerequisite KSAs that were not measured by NAEP, they identified relatively few prerequisite KSAs that are measured by NAEP—including some that might be expected. Mathematics prerequisites that are not currently measured by NAEP were evident in some occupational areas. These include Boolean algebra, other number bases, and solution-driven algorithm design (Computer Support Specialist); interpreting mathematics symbols (LPN); and converting temperature and business mathematics (entry-level Pharmacy Technician).

Reading. Across all programs, only NAEP objectives related to reading informational text, excluding literary text, were identified as prerequisites for entry-level courses. Exclusions were identified in all occupations for the objectives related to literary text and literary devices. Specific reading skills that are prerequisite to job training programs in all five occupational areas include *locating or recalling causal relations* and locating or recalling organizing structures of texts, such as comparison/contrast, problem/solution, enumeration, etc.

The objectives "Determine word meaning as used in context" and "Locate or recall specific information, such as facts, definitions, and supporting details" are the most applicable and most important for the Computer Support Specialist, HVAC, and Automotive Master Technician occupational training programs. In contrast, for the LPN and Pharmacy Technician programs, these skills were not considered prerequisite for any courses. Only the Automotive Master Technician program reviewers identified any of the Critique/Evaluate standards as prerequisite to a majority of courses (specifically "Consider informational text critically" and "Consider both literary and informational texts critically," each prerequisite to a third of the courses).

Evidence that the NAEP objectives "Describe problem and solution or cause and effect" and "Compare and contrast ideas, perspectives, problems, or situations" were important in most—or, in one case, all—of the courses in Computer Support Specialist, HVAC, and Automotive Master Technician programs was found in the artifacts from these programs. No evidence was found that these skills were prerequisites for any course in the LPN or Pharmacy Technician programs. The NAEP objectives "Summarize major ideas" and "Draw conclusions and provide

supporting information" were found to be prerequisite to HVAC, LPN, and Automotive Master Technician courses, and, to a lesser extent, entry-level Pharmacy Technician courses. The NAEP objective "Determine the importance of information within and across texts" was found to be prerequisite to LPN, Pharmacy Technician, and Automotive Master Technician training programs, and the NAEP objective "Distinguish facts from opinions" was found to be prerequisite to LPN and Automotive Master Technician programs.

Reading prerequisites that are not currently measured by NAEP were evident in programs in four occupations. These include:

- comprehending and following written instructions, and writing documentation (Computer Support Specialist);
- comprehending and following written instructions; reading charts, graphs, and diagrams; and conceptual understanding sufficient to apply scientific concepts (HVAC);
- identifying, recalling, and discussing information; applying knowledge, demonstrating evidence of and reflecting on one's knowledge; and conceptualizing and integrating (LPN); and
- reading materials on a computer screen rather than on paper, and deciphering text that includes spelling/grammatical errors in a context-appropriate way and without difficulty (entry-level Pharmacy Technician).

In summation, the study found that postsecondary job training programs do not require grade 12 NAEP objectives equally. In addition, after incorporating the exclusions, evidence from some programs indicated that grade 8 objectives were prerequisite.

Research Question #2: *What mathematics and reading KSAs are students expected to have mastered at the conclusion of the job training programs in each occupation?*

For mathematics, the evidence was judged to indicate that similar KSAs were to be taught in both entry-level and concluding-level Pharmacy Technician programs, including:

- "Solve problems involving rates such as speed, density, population density, or flow rates" (evident as new material in 45% of the entry-level courses and 73% of the concluding-level courses);
- "Solve problems involving conversions within or between measurement systems, given the relationship between the units" (evident as new material in 40% of the entry-level courses and 60% of the concluding-level courses);
- "Write algebraic expressions, equations, or inequalities to represent a situation" (evident as new material in 30% of the entry-level courses and 47% of the concluding-level courses);
- "Solve problems involving special formulas such as: $A = P(I + r)^t$, $A = Pe^{rt}$" (evident as new material in 40% of the entry-level courses and 47% of the concluding-level courses);

- "Use proportions to solve problems, including rates of change" (evident as new material in 40% of the entry-level courses and 47% of the concluding-level courses);
- "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" (evident as new material in 40% of the entry-level courses and 53% of the concluding-level courses);
- "Understand that numerical values associated with measurements of physical quantities are approximate, are subject to variation, and must be assigned units of measurement" (evident as new material in 35% of the entry-level courses and 20% of the concluding-level courses);
- "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" (evident as new material in 25% of the entry-level courses and 33% of the concluding-level courses);
- "Analyze situations, develop mathematical models, or solve problems using linear, quadratic, exponential, or logarithmic equations or inequalities symbolically or graphically" (evident as new material in 40% of the entry-level courses and 33% of the concluding-level courses); and
- "Verify solutions or determine the reasonableness of results in a variety of situations" (evident as new material in 20% of the entry-level courses and 27% of the concluding-level courses).

Concluding-level Pharmacy Technician courses contained fewer mathematics prerequisites than did entry-level courses. Slightly more NAEP objectives were prerequisites to entry-level mathematics courses (9 objectives rated as prerequisite in at least 20% of courses) than concluding-level mathematics courses (8 objectives rated as prerequisite in at least 20% of courses).

In reading, the concluding-level course artifacts contained no evidence of grade 12 NAEP objectives taught in these courses.

Research Question #3: *How do the prerequisites for job training programs (KSA expectations for entry) in each occupation relate to descriptions of minimal academic preparedness on NAEP (as described by the BPDs from the JSS studies)?*

The findings from this study confirm the observations from the JSS studies. Little evidence was found in course artifacts to suggest that most NAEP objectives are prerequisite to job training programs. Preparedness expectations in the BPDs from the JSS studies were found to be higher than the expectations for the prerequisites that are evident in course artifacts reviewed in this study.

Far fewer mathematics objectives were identified in the evidence than were rated by panelists, prior to the JSS studies, as important for students, and far fewer were

identified than those included in the BPDs. The objectives for which there was evidence were heavily concentrated in the Number Properties and Operations domain, and these objectives are generally considered to be easier and less challenging than others. Only 10% of the grade 12 NAEP mathematics item pool includes this category of items (Loomis, 2012; National Assessment Governing Board, 2008a).

In addition, fewer reading objectives were identified in the evidence than were rated by JSS study panelists as important for students, and fewer than were described by the BPDs. Most prerequisite KSAs were rated as similar to and well-described by the KSAs described by the BPDs. The majority of reading courses in each occupation, except HVAC, required KSAs that were rated as being well-described by the BPDs. In HVAC programs, the majority of courses were rated as requiring fewer or less complex/difficult prerequisites than those in the BPDs. In only one occupation, Computer Support Specialist, was a course identified that required KSAs more complex/difficult than those described in the BPDs.

Research Question #4: *How do the prerequisites for job training programs (KSA expectations for entry) in each occupation relate to the content assessed by NAEP (as determined by NAEP items representing minimal academic preparedness)?*

Mathematics prerequisites identified correspond to the KSAs assessed by items falling below the Proficient level on the NAEP mathematics scale. All reading prerequisites correspond to the KSAs assessed by items near Proficient (just above or just below) on the NAEP reading scale. Because there were relatively few items containing the prerequisite KSAs evidenced in the artifacts, the larger range on the NAEP reading scale may represent, in part, the gaps between appropriate (informational text) items.

Many of the grade 12 NAEP objectives were not evident in the course artifacts. Between 83 (LPN) and 101 (Automotive Master Technician) of the 130 mathematics objectives were not evident as prerequisite in any course in a given occupation. Between six (Pharmacy Technician) and 25 (HVAC) of the 37 reading objectives were not evident as prerequisite in any course in a given occupation.

Compared to the JSS BPDs, the mathematics prerequisite KSAs identified in this study correspond to NAEP items requiring lower levels of proficiency. In reading, the prerequisite KSAs are also—but to a lesser extent—measured by NAEP items lower in proficiency than the corresponding KSAs in the BPDs, with the greatest differences in the entry-level Pharmacy Technician (lower than JSS) and HVAC (slightly higher than JSS) programs.

The exclusions necessary to make objectives applicable to a course often removed the complex mathematics knowledge and skills that differentiate the grades 8 and 12 frameworks, and as a result, some prerequisite KSAs for the job training

programs appear to be better described by the grade 8 objectives than by the grade 12 objectives.

Overall, the prerequisites based on artifact analysis do not match, and are generally less rigorous than, the BPDs.

Limitations

As the first research of its type, the methods used in this study are promising, and they confirm observations and anecdotal information from the JSS studies. Little evidence was found in course artifacts to suggest that most NAEP objectives are prerequisite to job training programs. However, NAEP measures only academic knowledge and skills, and the KSAs required by job training programs may not be academic or content-specific.

Implementing beneficial refinements in methodology following the pilot study introduced some incomparability between the Automotive Master Technician findings and other occupational-area findings. As a result, not all Automotive Master Technician data were comparable to data from the other four occupations.

Reviewers' ability to understand the language used in the frameworks (in particular, the reading framework) varied. They had difficulty differentiating between similar standards (e.g., *cause and effect*, *sequence of events*, *causal relations*), suggesting a need for additional framework interpretation training.

Every submitted document required review and verification, and not every course provided artifacts that contained sufficient information for analysis. The Pharmacy Technician programs, in particular, exhibited a high degree of variability across courses, perhaps due to the inclusion of both proprietary and public/private programs. Recruitment of occupational-area course artifact submitters was challenging. That, combined with the elimination of course packets that did not contain enough information to include in the study, resulted in having fewer courses to review for each program than was specified in the study design.

As helpful as they were to reviewers for accurately rating the evidence found in artifacts, decision rules and exclusions proved complicating. Decision rules created by review teams introduced minor inconsistencies in how some objectives were interpreted across teams, as did differences in decision-rule implementation and application across teams. While non-NAEP KSAs and exclusions (partial, but not complete, alignment to some objectives) were noted during independent reviews, adjudication of exclusions or additional KSAs were not part of the study design.

Recommendations

A primary conclusion of this study is that, although the prerequisite KSAs for the five occupations studied are largely included in the grade 12 NAEP, NAEP is much larger and broader than these prerequisite KSAs.

The following recommendations are provided for Governing Board consideration:

1. NAEP's current emphasis on academic mathematics, as opposed to either applied or practical mathematics, increases the complexity of using the objectives as a measure of job training program preparedness. Additional applied and practical mathematics items would reduce that complexity. Likewise, in the NAEP reading assessment, more informational and applied passages would be helpful in assessing job training program preparedness.
2. The objectives are written in a way that that is not easily understood and applied by job training course instructors who are less conversant with the academic language of NAEP framework objectives. For example, ability to "analyze text" means that one can think critically; possessing mathematics skills in general means that one can persist and solve problems.
3. Suggested additional KSAs for assessing job training program preparedness include:
    a. Able to decipher text with minimal difficulty when spelling/grammatical errors are made,
    b. Able to follow written procedures,
    c. Troubleshooting skills, and
    d. Research process knowledge and skills.

When provided with textbooks as reference materials in the pilot study, many reviewers became reliant upon them as the sole (or best) source of prerequisite KSA evidence. While this analysis is not in the design of this study, examining textbooks to identify the representative prerequisites for entry-level courses is worth exploring.

Finally, future studies using non-academic participants may benefit from a glossary of NAEP framework terms for mathematics.

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Appendices