APPENDICES

Alignment between the 2013 NAEP Grade 8 Mathematics Assessment and ACT EXPLORE Mathematics Assessment

November 6, 2015

PRESENTED TO:
National Assessment Governing Board
Munira Mwalimu, Contract Officer
800 North Capitol Street NW,
Suite 825
Washington, DC 20002

Project Officer:
Michelle Blair,
National Assessment Governing Board

PRESENTED BY:
NORC at the University of Chicago
Dr. Rolf Blank, Project Director
55 East Monroe Street, 30th Floor
Chicago, IL 60603

Consultant: Dr. Norman L. Webb,
Wisconsin Center for Education
Products and Services

NORC at the UNIVERSITY of CHICAGO

[Page intentionally blank]

Table of Contents

[Page intentionally blank]

Appendix A: Design Document for NAEP Test-to-Test Studies

Design of Content Alignment Studies in Mathematics and Reading for 12th Grade NAEP and other Assessments to be used in Preparedness Research Studies[1]

The purpose of this paper is to provide a detailed design to guide implementation of content alignment studies for the grade 12 National Assessment of Educational Progress (NAEP) in reading and mathematics with respect to other assessments that the National Assessment Governing Board plans to use to provide indicators for reporting preparedness of 12th graders on NAEP in these subjects. The alignment studies are to form a part of the evidence in a series of research studies designed to explore NAEP's capacity to produce and report valid data on the preparedness of 12th graders for post-secondary activities.

This design document addresses all key points that must be considered for implementing a content alignment study between two tests. NAEP is a highly visible assessment program, and the alignment studies are central to the 12th grade preparedness research. Because different assessments will be used, the Governing Board faces the challenge of developing alignment studies that produce comparable information. The Board wants to generate as much information as possible about the content relationship and alignment between NAEP and the other assessments of interest while also assuring that the information comparing NAEP across assessments is comparable. Whatever the process used to judge the content alignment between two assessments, the process should be transparent and replicable.

[1] The National Assessment Governing Board contracted the services of Norman L. Webb, Senior Research Scientist Emeritus, Wisconsin Center for Education Research, University of Wisconsin-Madison to develop this design document for use in a series of content alignment studies for the Grade 12 National Assessment of Educational Progress in reading and mathematics. Mr. Webb delivered a complete draft to the Governing Board on December 19, 2008. The draft document was reviewed extensively in January and February, 2009; and the Governing Board approved the design for implementation in the content alignment studies at the March 2009 meeting. Several modifications were made by Governing Board Staff to clarify specific points, to more fully reflect the Board's goals for the studies, and to respond to recommendations from reviewers. Staff thanks Mr. Webb for his generous assistance throughout this process and the many reviewers who helped the Board to reach closure on the choice of methodologies.

Alignment

Alignment in the current context of No Child Left Behind generally attends to the agreement in content between state curriculum standards and state assessments. In general, two or more documents have content alignment if they support and serve student attainment of the same ends or learning outcomes. More specifically, *alignment* is the degree to which expectations and assessments are in agreement and serve in conjunction with one another to guide the system toward students learning what they are expected to know and do (Webb, 1997, p. 3).

It is important to point out that alignment is an attribute of the relationship between two or more documents and less an attribute of any one of the documents. The alignment between a set of curriculum standards and an assessment could be improved by changing the standards, the assessment, or both. Alignment is intimately related to test "validity," most closely with content validity and consequential validity (Messick, 1989, 1994; Moss, 1992). Whereas validity refers to the appropriateness of inferences made from information produced by an assessment (Cronbach, 1971), content alignment refers to the degree to which content coverage is the same between an assessment and other curriculum documents.

Methods for Conducting Alignment Studies

Three methods represent the most prevalent approaches for judging the alignment between assessments and standards (Le Marca, Redfield, Winter, & Despriet, 2000). All three approaches employ from five to eight content experts as the panelists whose alignment judgments are used to determine the degree of alignment. One way that the approaches differ is in the judgments made by the panelists. In the process developed by Webb (2002), panelists assign the depth-of-knowledge level (level of complexity) to each objective underlying each content standard. Next the panelists map each item to the standards. The two steps in mapping items to content statements include having panelists independently assign a DOK level to an item on the assessment and then assign the item to up to three objectives. Panelists are to map an item to an objective only if content knowledge expected to satisfy the objective is necessary, at least in part, to answer the item correctly.

The Survey of the Enacted Curriculum (SEC) process, developed by Porter and colleagues, uses a comprehensive matrix of content topics by cognitive levels to analyze the content from different documents using a common content language (Porter, 2002 & 2006). Panelists map each objective underlying the standards to the cell in the matrix representing the most appropriate topic and cognitive level. Panelists can assign one objective to more than one cell as appropriate. Panelists also map each item to the appropriate topic-by-cognitive-level cell. The alignment, reported as an index value between 0 and 1, is the aggregation of the proportion of cells in common between the mapping of the content standards, the assessment, and/or the teacher's instructional objectives to the matrix. In this way it is possible to compare standards with assessments, and each of these with the enacted curriculum as described by the teacher.

The Achieve, Inc. protocol for analyzing the alignment between an assessment and content standards uses panelists to produce information on four alignment criteria—content centrality, performance centrality, range and balance, and challenge (Rothman, Slattery, Vranek, & Resnick, 2002). The analysis begins with a content expert verifying the state's own alignment between the assessment and standards such as would be described in a test blueprint. Then panelists analyze and reach consensus on the relationship between each item and its assigned standard and objective as specified by the blueprint. Panelists reach consensus on the four alignment criteria for each item (content centrality, performance centrality, range and balance, and challenge). For content and performance centrality, panelists can agree that the item fully addresses the intent of the assigned objective, partially addresses the intent, or in no way addresses students' knowledge as expressed by the objective. Results are reported as the percentage of items with full, partial, or no content and performance centrality; whether the collection of the items is appropriately challenging to students at the given grade level; and whether some topics are over- or under- represented.

The three alignment procedures vary in terms of the information produced on the relationship between assessments and standards. The findings of the relationship between the assessment and standards from the Webb process are reported using four alignment criteria—Categorical Concurrence, Depth-of-Knowledge Consistency, Range-of-Knowledge Correspondence, and Balance of Representation. A distinguishing factor of the Webb process is that specific decision rules are used to determine if the alignment between content standards and the assessment is acceptable. The SEC process produces an index, ranging in value between 0 and 1, representing the overall alignment between the standards, the assessment, and the classroom curriculum. Findings from SEC are also reported as topographical maps and in other data displays, one for each document (standards, assessment, and curriculum) analyzed. The topographic maps can be viewed side-by-side to determine the variation in emphasis from classroom to assessment program to standards of topics by cognitive levels. Results derived from the Achieve, Inc. protocol are reported in a narrative including some tables showing results for the alignment attributes. The narrative reports the degree of alignment as determined through the consensus process, how the alignment could be improved, and any other relevant information.

Any of these three methods could be used to analyze the alignment between two assessments. However, the purpose for analyzing the NAEP with assessments of post-secondary education preparedness is to provide supporting information for the valid use of other assessments with grade 12 NAEP to interpret results and report findings regarding students' preparedness for higher education and workplace training. The Webb process, the most popular approach among states for comparing standards and assessments (Porter, 2006), provides independent judgments among panelists on the degree of alignment using multiple criteria—topic, complexity, range, and balance. The assessments can be mapped directly to the NAEP assessment framework. This produces information on the content within an objective or subtopic that is or is not targeted and it uses the terminology of the actual framework. Mapping both assessments to the same framework (e.g mapping both the NAEP and SAT mathematics assessments to the NAEP mathematics framework), the assessments can be compared according to the number of assessment items mapped to each content area, subtopic, and more detailed content levels; distribution of items from each assessment within each content area by levels of complexity; proportion of subtopics with at least some items from each assessment; and
balance in emphasis (over or under) by assessment items of any objectives under a subtopic and content area in relationship to other objectives.

Both SEC and Webb system panelists independently analyze the assessments; but rather than mapping the items directly to an assessment framework, as in the Webb system, SEC panelists map items to a common framework or "language system." An advantage of the SEC is that an assessment would only need to be mapped to the SEC content-by-cognitive level framework. With the Webb process, an assessment would have to be mapped to each framework used in the comparison. After an assessment has been mapped with the SEC method, the assessment could be compared to any other document (assessment, framework, or curriculum) that has also been mapped to the SEC framework. A disadvantage to this method is that the alignment between documents is reported as a single index describing a holistic relationship between documents. However, graphic representations of the mappings can be displayed to represent comparability of specific topics by cognitive levels for any of the alignments examined.

The Achieve system depends heavily on verifying the alignment of the assessment to a blueprint or framework, and the protocol would require major modifications to be adapted for an assessment to assessment analysis. The Achieve methodology would be less suitable for the goals of the Governing Board than either of the other two common alignment procedures.

Both the Webb process and the SEC have advantages and disadvantages. Both have computerized tools that can be used to enter and analyze data. Both produce measures of reliability among panelists. The SEC would require fewer analyses, but would produce less information on the degree of alignment. The Webb process will require mapping assessments to different frameworks, but will produce more detailed information. Both methods are transparent and replicable. Of these two systems, the Webb process is more suited to the Governing Board's goal of maximizing information about the degree to which the NAEP assessments are aligned with other assessments.

Alignment of NAEP Assessments to Other Assessments

Different methods can be used for judging the alignment of the NAEP assessments in reading and mathematics with assessments measuring preparedness for post-secondary activities. The Webb process is a content analysis. Two assessments are aligned to the degree that the two assessments are judged by a group of panelists to target the same content knowledge at a similar level of complexity. Note that content complexity is different from content difficulty. Content complexity is influenced by the structure of the content and performance expectations. An assessment item is more complex if the item requires knowledge of multiple concepts and ideas, if the answer can be derived in many ways, and if generalization is required. Difficulty is a psychometric term related to student performance on an item and is reported as the percentage of students who correctly answer an item. Difficulty is related to complexity, but it can depend on other factors such as the speediness of the test, opportunity to learn, and item format.

Most tests of student content knowledge are composed of a sample of items from some content domain. It is possible to have distinct tests that serve common purposes and produce comparable measures of students' content knowledge. For two or more tests to have content alignment and similar content coverage, the tests should sample content knowledge from the same content domain.

Alignment criteria (Webb, 1997) used to analyze the alignment between tests and curriculum documents can also be used to judge the alignment between two or more tests:

- Categorical Concurrence—The same or consistent categories of content appear in both assessments.
- Depth-of-Knowledge Consistency—The same depth of content knowledge is elicited from students by both assessments.
- Range-of-Knowledge Correspondence—A comparable span of knowledge within topics and categories is targeted by both assessments.
- Balance of Representation—A similar emphasis, indicated by the number and weighting of assessment items, is given to different content topics and subtopics on each assessment.

In judging the alignment between two assessments, these alignment criteria should be applied relative to a content domain. A test of students' content knowledge generally is designed to produce information on student performance related to a content domain by sampling content knowledge. The results from the assessment are used to make inferences about student knowledge relative to a content domain, as generally described in an assessment framework or blueprint. Because of the vastness of the possible items that could be used to assess students' knowledge of a domain, it is unlikely that any two assessments targeting the same domain will have precisely the same items. Thus, any item-by-item comparison between two assessments could result in a minimal match between the assessments. The likelihood of an item-by-item match between two assessments would be expected to decrease as the differences in the purposes of the two assessments increase. NAEP is designed to monitor educational progress in the nation, whereas other tests of interest to 12^{th} grade NAEP preparedness research are designed with a more narrow purpose of predicting success of students in higher education or placing students in college courses, for example.

The approach for analyzing the alignment of the NAEP mathematics and reading assessments to other assessments, as described here, is designed to compare the assessments by how the items represent content domains. For mathematics, five content areas specified in the 2009 NAEP Mathematics Framework (National Assessment Governing Board, 2008a) serve well as content domains for comparing the alignment between two or more tests:

1. Number Properties and Operations
2. Measurement
3. Geometry
4. Data Analysis, Statistics, and Probability
5. Algebra

Exhibit 1: Content areas specified in the 2009 NAEP Mathematics Framework.

For reading, the cross-section of the aspects of reading and the context of reading specified in the NAEP Reading Framework for 2009 (National Assessment Governing Board, 2008b) can serve as content domains. The aspects of reading in the Reading Framework are:

1. Locate and recall
2. Integrate and interpret
3. Critique and evaluate

The text types are represented in the text matrix below.

Grade 12 Reading Text Matrix

	Genre/Type of Text	Text Structures and Features	Author's Craft
Fiction	• Satire • Parody • Allegory • Monologue Plus increasingly complex application of grades 4 and 8	Organization • Differentiation of plot structures for different purposes and audiences Elements • Interior monologue • Unreliable narrators • Multiple points of view Plus increasingly complex application of grades 4 and 8	• Dramatic irony • Character foils • Comic relief • Unconventional use of language Plus increasingly complex application of grades 4 and 8
Literary Non-Fiction	• Classical essay Plus increasingly complex application of grades 4 and 8	Increasingly complex application of grade 4	• Denotation • Connotation Plus increasingly complex application of grades 4 and 8
Poetry	• Sonnet • Elegy Plus increasingly complex application of grades 4 and 8	Elements • Complex themes • Multiple points of view • Interior monologue • Soliloquy • Iambic pentameter Plus increasingly complex application of grades 4 and 8	• Denotation • Connotation • Irony • Tone • Complex symbolism • Extended metaphor and analogy Plus increasingly complex application of grades 4 and 8
Exposition	• Essay (e.g., political, social, historical, scientific, natural history) • Literary analysis Plus increasingly complex application of grades 4 and 8	Increasingly complex application of grade 4	• Denotation • Connotation • Complex symbolism • Extended metaphor and analogy • Paradox • Contradictions and incongruities • Ambiguity Increasingly complex application of grades 4 and 8

Exhibit 2: Type of Text, Text Structures and Features, and Author's Craft for Grade 12 from the 2009 NAEP Reading Framework.

For mathematics, the content areas are further delineated by subtopics and objectives. These more precise statements of content knowledge can then be used to compare the range or span of knowledge within content areas assessed by a test. For reading, the element of texts, reading skills, and reading passages add more detailed specifications, although neither the framework nor specifications provides detailed objectives for student achievement. The preliminary achievement levels definitions for reading are a potential source of this level of detail for reading.

The process for analyzing the alignment between NAEP and other assessments is designed to determine the *degree* of alignment. Most likely, two assessments will overlap in content coverage with some content common to both assessments and other content unique to each assessment (Exhibit 3).

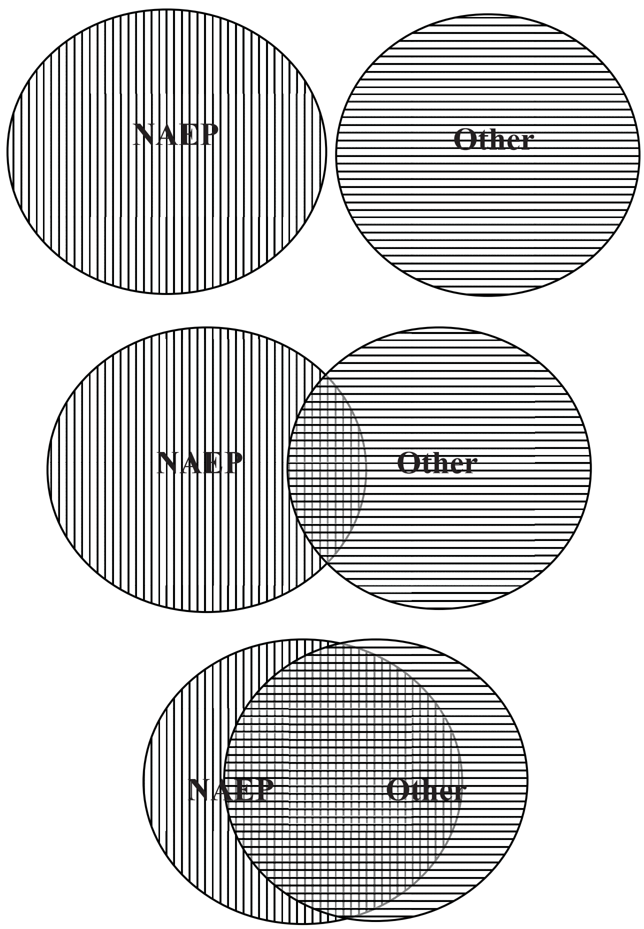


Exhibit 3: Depiction of different degrees of alignment between NAEP assessment and another assessment.

The purpose of the alignment analysis is to determine both the extent of the overlapping content knowledge targeted by each assessments and the extent of the content knowledge that is unique to each assessment. The alignment criteria provide a basis for reporting what is common between two assessments and what is different—the categories or topics, the depth-of-knowledge or cognitive level, the range or breadth, and the degree of emphasis. The process includes using the NAEP framework as a representation of the content along with using the framework of the other assessment as a representation of the content. This will allow each assessment to be compared using the language system of the NAEP framework and the language system of the framework for the other assessment referred to hereafter as *Pexam*. This bidirectional analysis will be particularly helpful in determining the categorical concurrence, range, and balance of each assessment relative to each framework and to each other. It is possible that the analysis will show there is little or no alignment between the NAEP assessments and any Pexam.

Determining the Degree of Alignment Using the Four Criteria

The categorical-concurrence criterion provides a very general indication of alignment if both documents incorporate the same content. *The criterion of categorical concurrence between assessments is met if the same or consistent categories of content appear in both assessments.* This criterion is judged by determining the number of items each assessment includes for each content area and subtopic. Two assessments agree in categorical-concurrence if the proportion of items from each assessment assigned to each content category is similar.

Two assessments can be aligned not only on the basis of the content covered by each, but also on the basis of the complexity of knowledge required by each. *Depth-of-knowledge consistency between two assessments indicates alignment if the cognitive demand of the two assessments is approximately equal.* For consistency to exist between two assessments, as judged in this analysis, the proportion of items at each level of complexity should be similar for the main content categories and subcategories.

For two assessments to be aligned, the breadth of knowledge required on both should be the same, or very nearly so. The range-of-knowledge criterion is used to judge whether a span of knowledge expected of students on one assessment is the same as, or very nearly the same as, the span of knowledge expected of students on the other assessment. The range criterion considers the proportion of subcategories (e.g. subtopics or objectives) under a content category (e.g. content area or standard) with at least one corresponding assessment item. The range of knowledge is comparable between two assessments if the proportion of subtopics assessed is the same or similar.

In addition to comparable depth and breadth of knowledge, aligned assessments require that knowledge be distributed equally in both. The range-of-knowledge criterion only considers the number of subcategories within a content category hit (a subtopic with a corresponding item); it does not take into consideration how the hits (or assessment items/activities) are distributed among the subcategories (e.g. subtopics or objectives). *The balance-of-representation criterion is used to indicate the degree to which one content subcategory is given more emphasis on one assessment than the other assessment.* An index is used to judge the distribution of assessment items among subcategories underlying a content category. An index value of 1 signifies perfect balance and is obtained if the corresponding items related to a content category are equally distributed among the course-level expectations for the category. Index values that approach 0 signify that a large proportion of the items only correspond to one or two of all of the subcategories with at least one assigned item. Two assessments have comparable balance of representation if the distribution of items among subcategories is the same as determined by a comparable index value.

The overall alignment between two assessments is determined by similar values on all four alignment criteria.

Design of Alignment Study

The major components of an alignment study to be addressed in this design include:

- specification of the content domains for the comparison of two assessments
- specification of the criteria to be used to determine the degree of alignment between two assessments
- process for panelists to conduct the analysis
- means for analyzing and reporting the findings

The Webb alignment process will be used for analyzing the alignment between the 12th grade NAEP in mathematics and reading and the post-secondary assessments (Pexams). This process includes using the depth-of-knowledge (DOK) levels definitions (see Appendices B and C) in mathematics and reading to assign levels of complexity to assessment items and objectives; having a group of trained panel members conduct the analysis; assigning levels of complexity to objectives or expectations in each assessment framework; assigning DOK levels and content objectives to assessment items; and analyzing and reporting the results using four alignment criteria (categorical concurrence, depth-of-knowledge consistency, range-of-knowledge correspondence, and balance of representation). The Web Alignment Tool (WAT) (http://wat.wceruw.org/) is recommended for collecting the data from panelists and conducting analyses, but the choice of analysis instrument is not critical to the outcome of the study so long as all the data are collected and computations are performed in the same manner.

A key reason for analyzing the alignment between two assessments is to determine the extent to which the two assessments target the same content domains or the extent to which inferences can be drawn from students' performance on one assessment regarding their capacity to perform in a comparable content domain on another assessment. The NAEP frameworks for both mathematics and reading specify the content domains to be used in developing items and selecting them for the NAEP. Using these NAEP frameworks as the content structure provides one means of analyzing alignment and drawing conclusions about alignment between the NAEP assessments and other assessments mapped to the NAEP framework. Using the framework of the other assessments to be compared to NAEP provides another basis for the analysis of the relationship between the two assessments.

In the Webb alignment approach, panelists map items from an assessment directly to the assessment framework. After the items are mapped to the framework, it is then possible to describe the content categories (objectives, topics, and so forth) that were not targeted by the assessment. The purpose of mapping items to the assessment framework is not to evaluate the quality of the items or the validity of the assessment; rather, it is to establish a basis for comparing the two assessments. This process of mapping items to frameworks results in additional information on the match of an assessment to a framework that is more detailed than would be the case if the alignment were based on framework objectives or other higher-level attributes of the framework or item specifications. Four item mapping/coding procedures for each subject assessment are called for in this design:

1. NAEP items to the NAEP framework
2. Pexam items to the NAEP framework
3. Pexam items to the Pexam framework
4. NAEP items to the Pexam framework

<u>Panels</u>

The study is to have two groups of six to eight panel members each for each subject independently analyze the assessment frameworks and the assessment items during a period of approximately five days. The panels should be equivalent in terms of area of content expertise, level of content expertise (secondary/post-secondary), and demographic attributes. Racial-ethnic and geographic diversity should characterize the panels.

Data are to be analyzed to determine the consistency in the results for the two groups. The two groups will initially and primarily operate independently. The results from the two groups will serve as a replication of the alignment judgments.

Having two groups complete the alignment analysis concurrently allows a real-time check on the replicability (i.e., the reliability) of the findings. If the findings from both groups are comparable, then greater confidence is assigned to the results. Having the groups perform the analysis at the same time allows the opportunity for on-site adjudication and resolution regarding how specific aspects of assessments are to be interpreted. Decision rules must be developed in advance so that instructions can be prepared to train panelists and avoid ambiguous situations that may be confusing and inefficient. In the event that questions arise, however, the alignment results will be based on the on-site resolution and adjudicated data collected for the two panels.

To evaluate the content alignment of 12^{th} grade NAEP to the other assessments, several tasks must be accomplished. The following tasks are to be included in each study. An agenda is included in Appendix A to provide an estimate of the amount of time needed for the various tasks included in this study.

<u>Tasks</u>

Task 1 Date and location for conducting the studies set, including arrangements for required meeting facilities.

Task 2 Qualified panel members (6-8 for each of two replicate panels for each subject) recruited and confirmed; one expert group facilitator for each replicate panel (2 for each subject) contracted.

Task 3 Materials prepared for training panelists and collecting and recording data. Data analysis software (e.g. WAT) prepared by entering the components of each framework into the software which will have been customized to capture findings in Task 4 (comparisons of test specification documents) and to capture findings of partial coverage along with codes for panelists' rationales for alignment judgments.

Task 4 Comparative analysis of the pairs of test blueprints (NAEP and Pexam) conducted by an expert for each subject.
Task 5 Panel members trained in DOK level definitions and assignment of items to key framework components for each assessment for each subject.
Task 6 Panel members trained to use the WAT (or comparable software) features and procedures.
Task 7 Panel members assign DOK levels to NAEP framework components and reach consensus on these. DOK agreement is reached between the DOK levels assigned by the replicate groups.
Task 8 Panel members map 2009 NAEP item pool to the grade 12 NAEP framework objectives for the subject.
Task 9 Panel members respond to de-briefing questionnaire about alignment of NAEP item pool to NAEP framework.
Task 10 Facilitators review codings and determine whether there are discrepancies in assigning items to objectives and in the results on the four alignment criteria; panelists adjudicate discrepancies.
Task 11 Panel members map each of two forms of the Pexam to grade 12 NAEP framework.
Task 12 Panel members respond to de-briefing questionnaire about alignment of Pexam items to NAEP framework
Task 13 Facilitators review codings and determine whether there are discrepancies in assigning items to objectives and in the results on the four alignment criteria; panelists adjudicate discrepancies
Task 14 Panel members complete final debriefing questions about the content similarities and differences between the NAEP items and the Pexam items relative to the NAEP framework.
Task 15 -
Task 22 Same as Tasks 7-14, using Pexam framework for mapping items for evaluation of alignment.
Task 23 Alignment study team analyzes the data collected at the study and the document comparisons of the NAEP and Pexam assessment frameworks.
Task 24 Alignment study team writes the final reports indicating how the NAEP and Pexam assessments are aligned and how the two assessments are not aligned. There will be one report for each subject assessment.

Some of the tasks listed above are explained in more detail below.

Task 4 Comparative Analysis of Test Blueprints: An expert for each subject will conduct a comparative analysis of the pairs of test blueprints (NAEP and Pexam). The comparative analysis of the test blueprints for NAEP and the available blueprints for all other tests to be included in the analysis is to be done prior to the item analysis. The main purpose of the blueprint comparative analysis is to identify the similarities and differences in the content specifications, item types, reading passages, and other specifications used in the design of each assessment. The comparative analysis is to specify the content organization for identifying items to be included on the NAEP assessment and the Pexam comparison assessments. For example, the mathematics framework for NAEP organizes the mathematics domain into five content areas which are further divided into subtopics and objectives (National Assessment Governing Board, 2008a). The reading framework for NAEP organizes the reading domain by type of texts (fiction, non-fiction, expository, etc.) and features of texts. Within the cells formed by the types of texts and the features of texts, content is further specified by skills and elements--such as theme, major characters, and major events). (National Assessment Governing Board, 2008b).

In the comparative analysis, a side-by-side chart of the content organization is to be prepared that will display how the content structure used for the construction of each assessment is the same or different. The content comparative analysis is to identify differences in the topics included in one set of specifications but not in the other, such as the range and type of numbers for mathematics and the elements in reading. The analysis is also to indicate the grain size, or degree of specificity, in identifying the content for each assessment and how these are similar or different. It is possible that the content specifications between NAEP and another assessment address the same topics, but that one set of specifications does so at a more sophisticated level of specificity. In addition, the content comparative analysis is to determine how the performance specified in one framework is expected to differ from the performance in the other framework. One framework may specify that students are to be assessed on *writing a variety of numbers*, whereas the other framework specifies that students are to be assessed on *reading and writing numbers*. Finally, the content comparative analysis using a side-by-side chart should point out any inconsistencies found within each of the frameworks included in the analysis. For example, a standard may state that students are to analyze characteristics of real numbers, whereas all of the underlying objectives only require that students represent or use applications involving rational numbers.

The comparative analysis should also identify other characteristics of items as specified in the assessment framework and test specifications documents. The characteristics should include:

1. Number and proportion of items for each item format (multiple choice, short constructed-response, extended constructed-response, and any other types of items)
2. Scoring rubrics and rules for constructed-response items
3. Resources available to students (e.g. calculators, dictionaries, etc.)
4. Reading difficulty and grade-level targeted by items
5. Information about reading passages (original source, authentic texts, length, number of items per passage, organization of items within passages, etc.)
6. Information about test administration (when the assessments are administered, amount of time targeted for the assessments, time constraints, accommodations allowed, and the like)

The comparative analysis should be fully documented and presented in an interim report. (See the *Reports* section on page 25.)

<u>Task 5 Training of Panel Members:</u> Panel members need to be fully trained for the alignment tasks. The training should begin with an overview of the alignment process. The overview should include instruction in the following features of the process:

1. What is meant by alignment between an assessment and an assessment framework and between two assessments
2. The four alignment criteria used to determine the degree of alignment
3. Levels used for each criterion to specify the acceptable alignment overall
4. The steps in the alignment evaluation process

5. The general definition of depth-of-knowledge (DOK) used to identify content complexity, as well as specific definitions for the assessment
6. Illustrations of DOK levels assigned to content expectations (framework level) and specific objectives and items
7. Illustrations of DOK levels assigned to assessment items of each type
8. Coding rules, including the maximum number of content expectations to which one item may be coded, the implications for coding items to more than one content expectation, requirements for coding an item to a specific content expectation
9. How to produce good notes to document coding rationales, questions, and so forth
10. Source-of-challenge issues that should be noted, such as construct irrelevant features that may inadvertently cause an item to be more or less difficult or shift the cognitive demand away from the intended target.
11. The use of generic objectives in the event that a panelist judges that an item does not fit any content objective or expectation
12. Login procedures and navigation guidance for the data entry and analysis software (e.g., the WAT)
13. Other administrative details

The subject matter facilitators should determine when the group has a sufficient understanding of the DOK levels. It is not necessary for all panel members to have a precise understanding of the DOK levels until panelists are about to assign DOK levels to the NAEP objectives and elements/skills in the NAEP framework (or the first DOK assignment task).

<u>Task 6 Use of the Software/Analysis Tool:</u> The panel members should logon to the WAT (<u>http://wat.wceruw.org/</u>) or similar software analysis tool selected for this purpose. The analysis tool must be configured before the alignment panelists are convened so that members of each group are registered in the system and ready for login. Quality control procedures and advance planning are essential for the successful use of this tool by panelists.

<u>Task 7 Assign DOK Levels to NAEP Objectives:</u> Panel members in each of the two replication groups will independently assign DOK levels to the objectives under the content areas and subtopics for mathematics or the elements and skills under the contexts and aspects for reading. Panelists will use the WAT or other software/analysis tool to record the DOK levels assigned to each objective/element/skill in the NAEP framework.

Once all of the panelists have coded the DOK for each objective/element/skill, the group facilitator will print the results, listing the code assigned for each panel member. Any objective/element/skill without full agreement should be discussed to reach consensus for the group on the assigned DOK level. Reaching true consensus among panel members is an important goal because the process affords the panel members the opportunity to discuss the fine points for each objective/element/skill. The group facilitator must be trained in the process and assure that all panel members provide input.

After the two groups have determined the DOK levels for each objective/element/skill listed in the NAEP framework, the two group facilitators will meet to review the results and identify any differences between the two groups. The group facilitators will discuss the rationales provided in each group and decide on the DOK level with the most compelling reasons. In the absence of a compelling reason, the DOK level assigned by the majority across the two groups will be used. Note that this adjudication process is conducted by the group facilitators and requires time in the agenda when panelists are not convened. The final DOK level assignments will be reported to panel members and panelists have the opportunity for discussion.

<u>Task 8 Map the NAEP Items to the NAEP Assessment Framework:</u> Next, the panel members should independently map the full 2009 NAEP item pool to the NAEP framework. To assure that the panel members are comfortable with this process, the group facilitator should select several items from the assessment for panel members to code for practice (individually, with pencil and paper). The sample items should be selected to represent the range of content, item formats, and other aspects of the assessment. The group facilitator will then have the panel members review and discuss briefly the codes assigned to map these items to assure panelists understand and agree on the procedures for coding items.

Once the facilitator is comfortable that panel members are correctly mapping items to the objectives/elements/skills, the panelists continue mapping the items by assigning a DOK level to each item and mapping the item to up to three objectives. A questionnaire should be developed to document the level of understanding and confidence panelists have before starting the coding process and after they have completed the task. In assigning an item to an objective, it is important that at least some of the content addressed in the objective is *necessary* in order to answer the item correctly. An item should not be mapped to an objective if the content knowledge in the objective is only relevant—and not necessary. For example, a question may require students to interpret the slope between two points although students could correctly answer the question by constructing an equation. This item should be assigned only to an objective about “determining the slope of a line” and not to an objective about “writing a linear equation.”

It is critical that panel members apply the rule that content knowledge as expressed in an objective is absolutely necessary to answer the item correctly in order to map an item in the objective. If content knowledge from more than one objective is absolutely necessary to correctly answer an item, then the item can be assigned to one primary objective and up to two secondary objectives. When an item is assigned to multiple objectives, the item is weighted by the number of objectives. That is, the computations for Categorical Concurrence, Range, and Balance will incorporate all of the assigned objectives. If one item is assigned to two objectives, then both objectives are counted as a hit for Categorical Concurrence.

Panel members typically need about two minutes to code a multiple-choice item and about five minutes to code a constructed-response item. For constructed-response items, the panelists should consult the scoring rubric and the anchor items to assign codes.

<u>Task 9 Panel Members Respond to a De-Briefing Questionnaire:</u> Panel members should individually respond to a small set of questions after the items have been coded to the NAEP objectives. These debriefing questions are designed to elicit from the panel members more detailed information about how the collection of the items aligned to the objectives. Questionnaires should be structured to include both Likert-type scale responses and open-ended

responses. Questions to be used include, but are not limited to the following. Additional questions may be recommended.

(a) For the objectives under each content area, did the items cover the topics identified by the objective? If not, what topics were not assessed?
(b) For the objectives under each content area, did the items cover the most important performance (DOK levels) you expected by the objectives? If not, what performance was not assessed?
(c) What is your general evaluation of the alignment between the content areas and the assessment: Highly Aligned; Moderately Aligned; Minimally Aligned; Not at all Aligned? If less than moderately aligned, what are some of the overlapping or non-overlapping features of the assessments that caused you to reach this determination?
(d) What additional comments do you have about the alignment between the assessment and the framework?

Question (a) determines if an important part of an objective/element/skill was not assessed in any way. It is possible for an assessment to have items that only partially target the full intent of an expectation. For example, a mathematics objective may expect students to represent real numbers using exponents, scientific notation, absolute values, graphs, and the number line. However, if the assessment had items that only targeted the use of the scientific notation, then the objective would only have been partially addressed. The typical coding scheme for the Webb method does not require that panelists indicate the degree to which objectives are only partially addressed, and that will be changed as a part of Task 3 to collect this information for the NAEP content alignment studies, along with the rationale of each panelist for this judgment. Coding for partial coverage will help to maximize information about the relationship between the two assessments, particularly since mapping one assessment to another assessment's framework will likely yield several partial hits. The intent of the first debriefing question is to have the panelists identify parts of objectives that were not assessed in any way, such as the use of exponents in this example.

The second question (b) is similar to the first debriefing question, but it seeks to ascertain if panelists judge that the assessment is targeted to the performance identified by the objective. Having panel members give their overall evaluation of the alignment between the assessment and the assessment framework provides a holistic judgment by people who have just finished thinking very deeply about the relationship of the two. This evaluation provides more detailed information to enhance the interpretations of the alignment data. This evaluation is not intended as an indicator of the validity of the assessment instrument.

<u>Task 10 Facilitators Determine Discrepancies and Panelists Adjudicate:</u> After all panelists have completed mapping all of the NAEP items to the NAEP framework, the group facilitator should review the codings from the group and conduct an adjudication process for discrepancies in either assigning items to objectives/elements/skills or DOK levels to items. Discrepancies that should be discussed are those items that have not been assigned by more than half of the panelists to the same objective/element/skill or items that have been assigned to three different DOK levels or to two non-contiguous DOK levels.

Content complexity is a continuum. The Webb alignment process uses the average DOK among the panelists for analysis. It is reasonable for panelists to assign adjacent DOK levels to an item indicating that the complexity of an item is probably between a DOK level 1 and a DOK level 2 or between a DOK level 2 and a DOK level 3. However, if some panelists are assigning a DOK level 1 (recall or recognition in mathematics) to an item while others are assigning a DOK level 3 (strategic thinking) to the same item then this difference requires discussion. After discussing these items, panel members may change their item codes, but it is not necessary to change if they feel strongly that their original judgments were correct. The adjudication process could reveal a more appropriate objective/element/skill for an item than the panelist initially selected, or it could reveal that the panelist made an error in recording his or her coding for an item.

Reports should be reviewed to determine discrepancies between the replicate panels. This review should begin only after both groups have completely finished coding the assessment items to the assessment framework and after the adjudication process. The summary reports for each of the four alignment criteria should be used to determine if the two groups are in agreement. Under Categorical Concurrence, the average number of items assigned to each content area for mathematics and aspects of reading by text type for reading should be reviewed. Under the Depth-of-Knowledge Consistency, the average percentage of items for each content area that were below the DOK level of the assigned objective/element/skill, at the DOK level, or above the DOK level should be reviewed. Under Range-of-Knowledge Correspondence, the percentage of objectives/elements/skills that had at least one corresponding item should be reviewed.

For Balance of Representation, any index value lower than .7 should be reviewed because an index value below .7 would indicate that the majority of items were coded to only one or two objectives. The balance-of-representation criterion is used to indicate the extent to which one "knowledge" expectation is given more emphasis on the assessment than another. This index only considers the "knowledge" expectations for a standard that has at least one hit—i.e., one related assessment item per expectation. The index is computed by considering the difference in the proportion of expectations and the proportion of hits assigned to each expectation. An index value of 1 signifies perfect balance and is obtained if the hits (corresponding items) related to a standard are equally distributed among the expectations for the given standard. Index values that approach 0 signify that a large proportion of the hits are accounted for by only one or two of the expectations. If most items relate to one expectation and only one or a few items relate to the remaining expectations, this would be described as a unimodal distribution and the index value would be less than 0.5. A bimodal distribution would have an index value of around 0.55 or 0.6. Index values of 0.7 or higher indicate a relatively even distribution of items across all of the expectations. An index value of 0.7 or higher is recommended as the target criterion for balance-of-representation. Index values between 0.6 and 0.7 indicate the balance-of-representation criterion has only been "weakly" met.

Any differences between the two groups of panelists of more than five percentage points, should be investigated further. This criterion has emerged from numerous studies as a good indicator of the level of agreement, or lack thereof, which signals the need for further evaluation and explanation. If the results are within these margins, the results for the two groups will be deemed to replicate judgments. If the differences are greater, the standard agreement tables and the item agreement tables should be examined to identify the group differences in the mapping of items to the objectives/elements/skills. The group facilitators should first try to resolve any large discrepancies by reviewing documentation of panelists' opinions collected throughout the process. Facilitators will identify areas of disagreement to be discussed by the combined group of panel members for the subject. If the discussion does not lead to common agreement between groups, the differences will be resolved by the two group facilitators.

<u>Task 11 Map Two Forms of the Pexam to the NAEP Framework:</u> The same procedures should be followed in mapping items from the Pexam to the NAEP assessment framework as were followed for Task 8 (mapping the NAEP assessment to the NAEP assessment framework).

<u>Task 12 Panel Members Respond to a De-Briefing Questionnaire:</u> Panel members should individually respond to a small set of questions after the Pexam items have been coded to the NAEP framework (see Task 9).

<u>Task 13 Facilitators Determine Discrepancies and Panelists Adjudicate:</u> See Task 10 for a description of identification of discrepancies between panelists in coding Pexam items to NAEP framework and of panelists' participation in a discussion and adjudication process.

<u>Task 14 Panelists Identify Differences between Assessments in Final Debriefing for Mapping to NAEP Framework:</u> The mapping of the assessment items to the NAEP assessment framework will conclude with panelists individually responding to debriefing questions regarding each assessment. Questionnaires will be constructed to elicit responses to these questions, as well as to document the level of understanding, confidence, and comfort with which panelists performed the tasks. Panel members should respond to questions regarding the following aspects of the alignment of items to the NAEP framework. Additional questions may be recommended.

(a) What were major differences between the two assessments in item types, content coverage, and complexity of items relative to the NAEP framework?
(b) Based on the content analysis completed for the NAEP framework, what similarities and differences are expected in the content knowledge of students who perform well on each assessment, who perform moderately, and who perform poorly?
(c) What similarities and differences were identified between the two assessments?

<u>Tasks 15 Assign DOK levels to Pexam Assessment Framework Expectations:</u> Tasks 7-14 involve panelists mapping the item pools of the two assessments to the NAEP framework. Beginning with Task 15, panelists are repeating the same tasks with the Pexam framework. The tasks for this alignment can vary by major content topics included, the structure of the content, the level of specificity (grain size), and the type of performance expressed. Mapping the Pexam items and the 2009 NAEP item pool to the Pexam assessment framework will produce another view of the alignment between the two assessments. Each assessment framework is a representation of a domain of knowledge. The extent to which the mappings of two or more assessments to a common domain of knowledge are similar will help to determine the degree of alignment. Mapping the NAEP and the Pexam items directly to the framework of each assessment will reveal similarities and differences in the DOK levels of items in relationship to the framework, range, and balance as described in the section above on determining the degree of alignment using the four alignment criteria. The bi-directional alignment design maximizes

information regarding the alignment between two assessments, i.e., the degree and nature of both overlap and non-overlap between the two assessments.

The consensus process used by panelists to assign DOK levels to the NAEP assessment frameworks will be used in coding items to the Pexam assessment framework. It is likely that the Pexam assessment frameworks will not have the same level of detail as the NAEP assessment framework, so the amount of time required for this part of the process will be different. Reaching consensus on the DOK levels of objectives is still important to facilitate discussion of the framework's objectives.

Task 23 Analysis of Alignment Data: After the content alignment panels have completed their work, data should be analyzed to describe the proportion of the objectives in each the NAEP and Pexam assessment frameworks by DOK levels. The two frameworks should be compared on the proportion of objectives distributed across the different levels of complexity. This comparison should be made for each content area and general topic underlying a content area. The data on the DOK levels of the objectives in the two assessment frameworks should be interpreted in the context of the comparative content analysis of the two frameworks and test blueprints completed in Task 4. In the comparative content analysis (Task 4), an expert is to produce information on the alignment of two assessments, based on the framework documents and test specifications. The data collected from the content alignment panelists will produce information based on the actual assessment items. The analysis in Task 4 is at a higher level and reflects the "intended" assessment, whereas the analysis by alignment panelists is at a more detailed level and reflects the "actual" assessment—how the framework was operationalized by the pool of assessment items.

It is possible that items match a sub-area of an assessment framework but not the next more detailed level of organization called for by the framework, such as an "objective." In that case, a "generic objective" is identified for coding the item within a specific sub-area. If two or more panel members assigned an item to a generic objective (i.e. subtopic or content area for mathematics NAEP and text feature or literary type for reading NAEP), the items should be listed for evaluation. Generic objectives indicate the absence of complete alignment. A large number of items mapped to a generic objective indicates holes in the assessment framework—an issue of granularity for which the items only target the general ideas expressed by the framework area and not the explicit content described by the objectives. To the extent possible, such gaps should be identified in advance by the alignment contractor so that discussions can be conducted on site with panelists regarding these items and potential gaps.

Data must be recorded for each panel member to report the number of items coded to each objective/element/skill under a content area. Data analyses should include computations of averages for the different alignment criteria across panelists including the number of items assigned to an objective/element/skill and the DOK level of the item in relationship to the DOK level of the assigned objective/element/skill. Data recorded by individual panelists are averaged across panel members to produce the average number of items coded to an objective/element/skill. The variables to be computed include:

- Categorical Concurrence:
- Frequency of items by:
  Content area
  Subtopics/reading text features and literary types
  Objectives/element/skill
  Other content area
- Depth-of-Knowledge Consistency
- Frequency of items by DOK level within:
  Content area
  Subtopics/aspects/context
  Objectives/elements/skills
- Range-of-Knowledge Correspondence
- Percentage of objectives/elements/skills under a content area with one or more items
- Balance of Representation
- Balance index value for each content area

The values of each of these variables should be compared between the two assessments as mapped to the NAEP assessment framework and the two assessments as mapped to the Pexam assessment framework. The software analysis package (e.g. WAT) should be used to produce a cross-study data table that creates a table with items from each assessment mapped to the same objectives/elements/skills. The information recorded in the cross-study tables can be used to compare the distribution of items by objective for the two assessments (Exhibit 4). The example illustrated in Exhibit 4 shows that the two forms are very comparable on the Categorical Concurrence alignment criterion for Standard M.S.6.1 because the total number of items on each form assigned to each objective is very similar (only varies by one item for each objective).

Objective	Group DOK Consensus	NAEP Item ID (Freq Coded)					Pexam Item ID (Freq Coded)				
M.S.6.1	2										
M.S.6.1	2										
M.O.6.1.1	1										
M.O.6.1.2	2	8-(6)	9-(3)	40-(6)			39-(6)	41-(3)			
M.O.6.1.3	1										
M.O.6.1.4	3	13-(2)	22-(6)	39-(6)	41-(2)		15-(4)	17-(4)	32-(6)	38-(6)	
M.O.6.1.5	2	19-(6)					26-(5)	35-(6)			
M.O.6.1.6	1	6-(5)	27-(4)				2-(6)	31-(6)			
M.O.6.1.7	2	28-(6)	33-(5)	37-(6)	43-(6)		1-(3)	20-(6)	42-(4)		

Exhibit 4: Sample cross-study table produced by WAT contrasting items from NAEP and Pexam mapped to the same objective by number of panelists (given in the parentheses).

Additional data analyses should be produced that show for each item on each assessment analyzed the objective/element/skill as mapped by each panelist. These data should be used to determine the consistency among panelists in mapping an item to an objective/element/skill and the number of objectives to which each item was mapped. These data should be used to assess the breadth in content targeted by specific items (items assigned to multiple objectives/elements/skills) and the level of interrater agreement in assigning an item to objectives/elements/skills. Given appropriate training and understanding on the part of the panelists, a lack of agreement is most likely due to overlapping objectives/elements/skills in the assessment framework and/or more robust items that provide students an opportunity to apply a number of different approaches to answering the item correctly. Panel members' notes on specific items are used to identify the source of low interrater agreement, if that is revealed.

Information from the framework content analysis should be used to describe the format of each assessment to provide a context for the analytic data generated from the analysis of the assessments by the panels. For example, the item formats used in each assessment should be described. This discussion should include the number and proportion of items included on an assessment that targeted specific content areas. If items have different score points, the comparison should be weighted to reflect this fact. For example, constructed response items in NAEP typically have a higher number of possible points than multiple choice items. Information that should be reported includes, but is not limited to, the following.

- Item format
  - Proportion of multiple-choice
  - Proportion of constructed response
  - Proportion of extended response
- Item context
  - Passage characteristics

Alignment Determination

The content alignment between the NAEP assessment and another assessment should be established by comparing the values under the different alignment criteria for each of the assessments. These data will be presented to the Governing Board for use in evaluating and reporting results of other studies in the 12th grade preparedness research program. Working with technical experts, the Board will determine quantitative criteria to be applied to the results for determining the extent to which two assessments are aligned. Values to be considered in determining the extent to which two assessments are aligned include:

(a) The number and proportion of items that map to each content area
(b) The DOK levels of the items within each content area
(c) The proportion of objectives under a content area targeted by items
(d) The relative emphasis to subtopics and objectives under a content area
(e) The structure of knowledge represented in the assessment framework for each assessment as indicated by the format of items, the item context, and other test characteristics

All of these factors need to be considered together and reported to determine the *degree* of alignment. Of course, some factors are more important than others, and the relative weights to assign to these factors will need to be determined by the Board.

Panelists

A replication of the alignment, two groups conducting the alignment concurrently, is required to strengthen the confidence in the findings. Porter, et al (2008) report that five raters provide the requisite level of reliability in a content alignment study. For the NAEP studies, however, two groups of six -eight content experts each are recommended for each subject. (The recommendation is that 8 panelists be recruited for each replicate panel to help ensure that a minimum of 6 panel members are available in the event of last-minute attrition.) As discussed above, the two groups will conduct the analysis simultaneously so that results can be compared and differences adjudicated on site. Conducting such a replication at two separate times would likely produce some variation in results, most likely at the item level rather than with the alignment criteria. The timing logistics would then make it difficult to determine the reasons for these variations. Further, previous experience indicates that panelists develop decision rules for their coding when faced with assessment frameworks that have over lapping objectives or when the objectives in an assessment framework lack clarity. These issues increase the importance of holding replicate panels simultaneously; having two groups independently, but at the same time, conduct the analysis will help reveal such decision rules and determine how these rules impact the results. To the extent possible, potential ambiguity will be identified in advance and panelists will be trained to code items in a consistent way. However, strict decision rules should be avoided as these may discourage the use of panelist expertise.

The experts for a content area who will serve as panel members should be selected because of their deep knowledge of the subject matter (mathematics or reading) and experience in analyzing curricula and assessments. Caution must be exerted in selecting persons for the panel to assure there is no bias with regard to any one of the assessments to be analyzed. Fifty to sixty percent of the panelists (in each of the two replicate panels) should come from post-secondary activities relevant to the Pexam (e.g. mathematicians, mathematics educators, language arts professors, and reading educators). Examples of individuals from the secondary education sector to serve as panelists include curriculum coordinators, content area assessment specialists, state content consultants, and high school teachers in the subject area. Intimate knowledge of each assessment should be equally represented by panelists on each panel. Individuals who have participated in other alignment studies are eligible to serve on these panels. Persons who are employed by commercial testing companies are not eligible to serve as panelists. Geographic regions and racial-ethnic groups should be represented proportionally to assure diversity of the group of panelists. Content expertise and knowledge, however, should be the primary criterion for selection of panelists.

Quality Control

Having two groups of panelists conduct the alignment analysis simultaneously for each subject will provide evidence of the reliability of the findings and increase confidence in the final results. The two groups should be trained together so the training is standardized, but the alignment analyses should be conducted independently.

As mentioned earlier, two forms of each Pexam assessment and the entire 2009 NAEP item pool for each subject should be analyzed. It is assumed that the Pexam assessment forms are parallel with very little variation in the distribution of items among content topics and by item format. Forms of the Pexam can be analyzed for comparability so that the forms selected for use in the alignment analysis are similar. The difference in the number of items between the 12th grade NAEP (approximately 200 for mathematics) and a form of the Pexam (probably less than 100 items) is not critical in determining the alignment between the two assessments because results are primarily reported by proportion of items on the assessment. When the two forms are analyzed, four panelists should start analyzing one form first with the other panelists starting with the other form so that the two forms are reviewed in a different sequence.

Timeline for Conducting the Alignment Analysis

The estimated time required for conducting the alignment analysis from the approval of the proposal to submitting the final report is seven months. This time span could be compressed if some of the preparation tasks are implemented concurrently. The alignment study, data analysis, and report writing will require about three months to complete. Careful review of the report is important, and ample time must be allotted for this part of the process.

The major tasks and the estimated time for each task are listed below. Time estimates are stated as the duration needed to complete a task. Some tasks can be accomplished simultaneously.

1. Set time, location, and venue for the analysis (4 weeks)
2. Identify group facilitators and panelists (4 weeks)
3. Identify materials and equipment needed for the analysis (2 weeks)
4. Enter NAEP framework into analysis software (1 week)
5. Print and compile materials needed for coding (3 days)
6. Alignment Study (1 week)
7. Analyze data by tabulating variables for alignment criteria and comparing values between tests (2 weeks)
8. Incorporate qualitative information on tests and NAEP (2 weeks)
9. Draft report (2 weeks)
10. Review report (4 weeks)
11. Final report (4 weeks)

Logistics for the Study

The facility selected for the study must accommodate the use of a computer with appropriate network and/or internet access for each panel member. A general session room will also be required along with one additional break out room for one of the replication panels. A room set classroom style for ease of computer use is recommended for the panelists. An additional room to store materials and to conduct analyses of results, review questionnaires, and so forth is recommended.

The process and analysis will be greatly facilitated if software specifically designed for conducting alignment studies is used, such as the Web Alignment Tool (WAT). The WAT can be used by panelists to enter data and by staff for analyzing data and producing data tables. The computers should be hard-wired to a server rather than using a wireless. Most conference hotels can accommodate the requirements for this sort of study.

The Governing Board staff will acquire secure materials for NAEP and the other test programs and facilitate acquisition of other necessary assessment materials for the study. The alignment study contractor will be responsible for identifying necessary materials and for maintaining the security of all test materials.

Process Leadership

One person, the project director, should have ultimate responsibility for conducting the alignment study and exercising leadership on site. This person should be identified by the alignment contractor and serve as the primary contact person for Governing Board staff. The project director should be responsible for identifying the specific procedures to be used and should have overall responsibility for assuring that all tasks are completed on time and according to the agreed-upon study design. The project director should be responsible for overseeing the data analysis and report writing and for the production of all contract deliverables associated with the content alignment study.

The alignment contractor should clearly identify the staffing requirements for the project and who will be responsible for conducting each of the tasks. At a minimum the project director should be assisted by two subject matter group facilitators for each of mathematics and reading. One of the subject matter group facilitators should have responsibility for training all of the panelists in the content group together. There will be a facilitator for each alignment panel group when the replicate groups are formed.

The group facilitators will need to be content experts who are well versed in the alignment analysis process. The group facilitators should be experienced in training panelists in the alignment methodology and facilitating the alignment process.

Reliability, Panelist Agreement, and Replication of Results

Panelists will engage in two major judgments when coding items to an assessment framework: the assignment of a DOK level to a test item and the assignment of an item to an objective(s) under the assessment framework. For both of these judgments, consistency among panelists is critical to meaningful findings. An average measure intraclass correlation (Shrout and Fleiss, 1979) should be used as one measure of the panelists' agreement in assigning DOK levels to items. The average DOK level assigned to an item by the panelists should be used as one of the variables in the analysis. The pairwise comparison is a more stringent statistic and should also be used. If variance in assigning DOK levels to items among panelists is low, then computation of the intraclass correlation is inappropriate. The pairwise comparison provides a more meaningful measure of agreement in this case. Pairwise comparisons can also be used as one measure to judge the agreement among panelists in assigning items to objectives, elements, subtopics, and the content area.

Alignment judgments by panelists will not be in complete agreement, and several sources of variance should be analyzed. The effectiveness of the training, the composition of the alignment panel, the depth of discussion among the panelists, and the sequential order of aligning different forms of assessments can all generate variations in the final results and impact the apparent degree of alignment between two tests. Conducting a replication study will add confidence to the findings, identify information that is consistent across the groups, and identify inconsistencies across groups and studies. The most rigorous replication study design would require a second panel to independently conduct the analysis in its entirety. The recommended design using concurrent replicate panels allows adjudication of differences through discussion between members of the two panels. If the variation between the two panels appears to be random and minor, then the results from the two panels can be averaged or aggregated.

Materials

Materials from different sources are required for the study. Copies for each panelist, for group facilitators, and for observers will be needed.

<u>Required NAEP Materials</u>
Assessment frameworks and test specifications for reading and mathematics

- NAEP 12th grade item pool for each subject
- Scoring guides and scoring rubrics for each item
- Anchor papers to represent each score point for each constructed response item
- Point value assigned to each item

<u>Required Pexam Materials</u>

- Test blueprints
- Test objectives
- Two test forms of each test to be analyzed
- Scoring guide and scoring rubrics for each item
- Anchor papers to represent each score point for each constructed-response item
- Point value assigned to each item

<u>Additional Materials</u>

- Training materials (DOK definitions, illustrative items)
- Software for data entry and analysis
- Presentation materials
- Evaluation forms
- Computers, printers, photocopiers

Evaluations by Panelists

Panelists will be given evaluation questions after the training, after major tasks, and at the end of the study. The questionnaires will include both structured response items (Likert-type scales) and open-ended questions. These questions will focus on panelists' evaluation of the following aspects of the study:

1. Training and instructions
2. Materials, both advanced and on site
3. The alignment process, including the qualifications of panelists, composition of panels, alignment criteria, coding of items, quality and quantity of information provided, and adjudication procedures
4. Procedures for data communications, especially the ease of using the software
5. Logistics, including meeting facilities, agenda, travel arrangements

Evaluation questions after the training include:

1. How well do you feel the training prepared you to apply the Depth of Knowledge Levels?
2. How well do you feel the training prepared you for the adjudication process?
3. Overall, how well did the training prepare you for the alignment process?

Evaluation questions to be answered at the end of the study:

1. How well did the process capture the content similarities of the assessments?
2. How well did the process capture the content differences between the assessments?
3. To what degree was the pair of assessments aligned?
4. Considering the items in each assessment, how did the assessments differ and how were they the same?

Reports

An interim report is to be presented regarding the expert comparison of the two assessment frameworks conducted as Task 4. This report should present the results of the evaluation and specify how the information will be used to structure the data entry and reporting software, to identify and eliminate ambiguous objectives or other framework aspects, to train panelists for coding items, and to report results of the alignment study. Any other aspects of the alignment study that should be addressed must be identified in this report. An overall evaluation of the alignment of the two assessments, based on the comparative analysis of frameworks, should be stated.

A comprehensive report is to be prepared to describe the methodology used and the results of the alignment between each NAEP assessment and the Pexam assessment. The methodology section of the report is to describe the qualifications of the group facilitators and panelists, the structure of the assessment framework used in the analyses, the training of panelists, the alignment criteria used in the analysis, and the coding procedures. The comparative analysis of the assessment frameworks for the assessments should provide the context for reporting the findings on the alignment between the assessments. The results section will summarize the DOK levels assigned to the objectives of the assessment framework, the description of the results of mapping each test to the assessment framework, the degree of alignment between each NAEP subject item pool and each Pexam. The conclusions will delineate the parts of the two assessments that are aligned and the parts that are not aligned. Within each category, variability in level of alignment and non-alignment should be identified.. An Executive Summary will present the major points and conclusions from the report. Data tables produced from the analysis are to be included as appendices to the report.

References

Ananda, S. (2003). Rethinking issues of alignment under No Child Left Behind. San Francisco: WestEd.

Bhola, D. S., Impara, J. C., & Buckendahl, C. W. (2003). Aligning tests with states' content standards: Methods and issues. *Educational Measurement: Issues and Practice*, 22(3), p21-29.

Council of Chief State School Officers (2006). Aligning Assessment to Guide the Learning of All Students: Six Reports on the Development, Refinement, and Dissemination of the Web Alignment Tool. Washington, D.C.: Author.

Cronbach, L. J. (1971). Test validation. In R. L. Thorndike (Ed.), *Educational measurement* (2nd ed.,pp. 443-507). Washington, DC: American Council on Education.

La Marca, P. M., Redfield, D., Winter, P. C., Bailey, A., & Hansche, L. (2000). *State Standards and State Assessment Systems: A Guide to Alignment.* Washington, DC: Council of Chief State School Officers.

Messick, S. (1994, March). The interplay of evidence and consequences in the validation of performance assessments. *Educational Researcher*, 23(2), 13-23.

Moss, P. A. (1992). Shifting conceptions of validity in educational measurement: Implications for performance assessment. *Review of Educational Research*, 62(3), 229-258.

National Assessment Governing Board (2008a). Mathematics Framework for the 2009 National Assessment of Educational Progress. Washington DC: Author.

National Assessment Governing Board (2008b). Reading Framework for the 2009 National Assessment of Educational Progress. Washington DC: Author.

Porter,A. C. (2002). Measuring the content of instruction: Uses in research and practice. *Educational Researcher*, 31 (7); 3-14.

Porter, A. (2006). Measuring alignment. *National Council on Measurement in Education Newsletter*, 14 (4), December, 2006.

Porter, A. C., & Smithson, J. L. (2002, April). Alignment of assessments, standards and instruction using curriculum indicator data. Paper presented at the Annual Meeting of American Education Research Association, New Orleans, LA.

Porter, A.C., Polikoff, M.S., Zeidner, T., & Smithson, J.L. (2008). The quality of content analyses of state student achievement tests and content standards. *Educational Measurement: Issues and Practice,* 27 (4), 2-14.

Shrout, P.E. & Fleiss, J.L. (1979) Intraclass Correlations: Uses in Assessing Rater Reliability. *Psychological Bulletin*, 2, 420-428.

Smithson, J. L. & Porter, A.C. (2004). From policy to practice: the evolution of one approach to describing and using curriculum data. In M. Wilson (Ed.), *Towards Coherence Between Classroom Assessment and Accountability. The 2004 yearbook of the National Society for the Study of Education*. Chicago: University of Chicago Press.

Valencia, S. W., & Wixson, K. K. (2000). Policy-oriented research on literary standards and assessment. In M. L. Kamil, P. B. Mosenthal, P. D. Pearson, & R. Barr (Eds.), Handbook of reading research: Vol. III. Mahwah, NJ: Lawrence Erlbaum.

Webb, N. L. (1997). Criteria of alignment of frameworks, standards, and student assessments for mathematics and science education. Council of Chief State School Officials and National Study for Science Education Monograph, No. 6. Madison: Wisconsin Center for Education Research.

Webb, N. L. (1999). Alignment of science and mathematics standards and assessments in four states (Research Monograph No. 18). Madison: University of Wisconsin–Madison, National Study for Science Education.

Webb, N. L. (2202. Alignment study in language arts, mathematics, science, and social studies of state standards and assessments for four states. Washington, D.C.: Council of Chief State School Officers.

Appendix A
Example of Agenda

<u>Day 1: Training in General Session</u>

1. Introductions and administrative details (one hour)
2. Training (5 hours)
   a. Purpose and importance of the study
   b. Overview of the process
   c. Training in specific tasks
3. Instructions for log in to the WAT or other software for this purpose (one hour)
4. Evaluation of training (.25 hours)

<u>Day 2</u>: (Parallel Replicate Panel Groups

1. Code DOK levels of NAEP framework (2-3 hours)
2. Map NAEP items to NAEP framework (4-5 hours)
3. Break (Facilitators check item coding and identify discrepancies for discussion and adjudication process)
4. Adjudicate coding of NAEP items to NAEP framework (1 hour)
5. Evaluation of NAEP items-to-NAEP framework coding (.25 hour)
6. Evaluation of process and understanding of procedures (.25 hour)

<u>Day 3:</u>

1. Map Pexam Form 1 to NAEP framework (2.5 hours)
2. Map Pexam Form 2 to NAEP framework (2.5 hours)
3. Break (Facilitators check item coding and identify discrepancies for discussion and adjudication process)
4. Adjudicate coding of Pexam items to NAEP framework (1 hour)
5. Evaluation of Pexam items-to-NAEP framework coding (.25 hour)
6. Evaluation of process and understanding of procedures (.25 hour)

<u>Day 4:</u>

1. Code DOK levels of Pexam framework (2-3 hours)
2. Map Pexam Form 1 to Pexam framework (2.5 hours)
3. Map Pexam Form 2 to Pexam framework (2.5 hours)
4. Break (Facilitators check item coding and identify discrepancies for discussion and adjudication process)
5. Adjudicate coding of Pexam items to Pexam framework (1 hour)
6. Evaluation of Pexam items-to-Pexam framework coding (.25 hour)
7. Evaluation of process and understanding of procedures (.25 hour)

<u>Day 5:</u>

1. Map NAEP assessment items to Pexam framework (4-5 hours)
2. Break (Facilitators check item coding and identify discrepancies for discussion and adjudication process)

3. Adjudicate coding of NAEP items to Pexam framework (1 hour)
4. Evaluation of NAEP items-to-Pexam framework coding (.25 hour)
5. Evaluation of process and understanding of procedures (.25 hour)
6. Overall debriefing (1 hour0
7. 1.5 hours debriefing across assessments
8. Evaluation of overall alignment process, evidence generated, criteria applied, and holistic conclusion regarding alignment of the assessments; recommendations regarding alignment and appropriate uses of evidence; evaluation of process and understanding of procedures (.5 hour)

Appendix B

Depth-of-Knowledge Definitions for Mathematics[2]

Level 1 (Recall) includes the recall of information such as a fact, definition, term, or a simple procedure, as well as performing a simple algorithm or applying a formula. That is, in mathematics, a one-step, well defined, and straight algorithmic procedure should be included at this lowest level. Other key words that signify Level 1 include “identify,” “recall,” “recognize,” “use,” and “measure.” Verbs such as “describe” and “explain” could be classified at different levels, depending on what is to be described and explained.

Level 2 (Skill/Concept) includes the engagement of some mental processing beyond a habitual response. A Level 2 assessment item requires students to make some decisions as to how to approach the problem or activity, whereas Level 1 requires students to demonstrate a rote response, perform a well-known algorithm, follow a set procedure (like a recipe), or perform a clearly defined series of steps. Keywords that generally distinguish a Level 2 item include “classify,” “organize,” ”estimate,” “make observations,” “collect and display data,” and “compare data.” These actions imply more than one step. For example, to compare data requires first identifying characteristics of the objects or phenomenon and then grouping or ordering the objects. Some action verbs, such as “explain,” “describe,” or “interpret,” could be classified at different levels depending on the object of the action. For example, interpreting information from a simple graph, or requiring mathematics information from the graph, also is at Level 2. Interpreting information from a complex graph that requires some decisions on what features of the graph need to be considered and how information from the graph can be aggregated is at Level 3. Level 2 activities are not limited solely to number skills, but can involve visualization skills and probability skills. Other Level 2 activities include noticing and describing non-trivial patterns; explaining the purpose and use of experimental procedures; carrying out experimental procedures; making observations and collecting data; classifying, organizing, and comparing data; and organizing and displaying data in tables, graphs, and charts.

Level 3 (Strategic Thinking) requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. In most instances, requiring students to explain their thinking is at Level 3. Activities that require students to make conjectures are also at this level. The cognitive demands at Level 3 are complex and abstract. The complexity does not result from the fact that there are multiple answers, a possibility for both Levels 1 and 2, but because the task requires more demanding reasoning. An activity, however, that has more than one possible answer and requires students to justify the response they give would most likely be at Level 3. Other Level 3 activities include drawing conclusions from observations; citing evidence and

[2] Mr. Webb has used the DOK definitions for conducting alignment studies, and he judged the definitions to be applicable to an alignment study with NAEP assessments. The definitions shall be used as described; however, recommendations may be made for approval of changes to the definitions in cases where this is necessitated by virtue of the content of the Pexam.

developing a logical argument for concepts; explaining phenomena in terms of concepts; and using concepts to solve problems.

Level 4 (Extended Thinking) requires complex reasoning, planning, developing, and thinking, most likely over an extended period of time. The extended time period is not a distinguishing factor if the required work is only repetitive and does not require applying significant conceptual understanding and higher-order thinking. For example, if a student has to take the water temperature from a river each day for a month and then construct a graph, this would be classified as Level 2. However, if the student is to conduct a river study that requires taking into consideration a number of variables, this would be at Level 4. At Level 4, the cognitive demands of the task should be high and the work should be very complex. Students should be required to make several connections—relate ideas within the content area or among content areas—and to select one approach among many alternatives on how the situation should be solved, in order to be at this highest level. Level 4 activities include developing and proving conjectures; designing and conducting experiments; making connections between a finding and related concepts and phenomena; combining and synthesizing ideas into new concepts; and critiquing experimental designs.

Appendix C

<u>Depth-of-Knowledge Definitions for Reading</u>[3]

***Reading Level 1*. Level 1 requires students to receive or recite facts or to use simple skills or abilities. Oral reading that does not include analysis of the text, as well as basic comprehension of a text, is included. Items require only a shallow understanding of the text presented and often consist of verbatim recall from text, slight paraphrasing of specific details from the text, or simple understanding of a single word or phrase. Some examples that represent, but do not constitute all of, Level 1 performance are:**

Support ideas by reference to verbatim or only slightly paraphrased details from the text.
Use a dictionary to find the meanings of words.
Recognize figurative language in a reading passage.

Reading Level 2. Level 2 includes the engagement of some mental processing beyond recalling or reproducing a response; it requires both comprehension and subsequent processing of text or portions of text. Inter-sentence analysis of inference is required. Some important concepts are covered, but not in a complex way. Standards and items at this level may include words such as summarize, interpret, infer, classify, organize, collect, display, compare, and determine whether fact or opinion. Literal main ideas are stressed. A Level 2 assessment item may require students to apply skills and concepts that are covered in Level 1. However, items require closer understanding of text, possibly through the item's paraphrasing of both the question and the answer. Some examples that represent, but do not constitute all of, Level 2 performance are:

Use context cues to identify the meaning of unfamiliar words, phrases, and expressions that could otherwise have multiple meanings.
Predict a logical outcome based on information in a reading selection.
Identify and summarize the major events in a narrative.

Reading Level 3. Deep knowledge becomes a greater focus at Level 3. Students are encouraged to go beyond the text; however, they are still required to show understanding of the ideas in the text. Students may be encouraged to explain, generalize, or connect ideas. Standards and items at Level 3 involve reasoning and planning. Students must be able to support their thinking. Items may involve abstract theme identification, inference across an entire passage, or students' application of prior knowledge. Items may also involve more superficial connections between texts. Some examples that represent, but do not constitute all of, Level 3 performance are:

---

[3] As for mathematics, the DOK levels for reading describe levels of content complexity that can be used for analyzing the NAEP and other reading assessments. The reading levels are based on Valencia and Wixson (2000, pp. 909-935). The definitions shall be used as described; however, recommendations may be made for approval of changes to the definitions in cases where this is necessitated by virtue of the content of the Pexam.

Explain or recognize how the author's purpose affects the interpretation of a reading selection.
Summarize information from multiple sources to address a specific topic.
Analyze and describe the characteristics of various types of literature.

Reading Level 4. Higher-order thinking is central and knowledge is deep at Level 4. The standard or assessment item at this level will probably be an extended activity, with extended time provided for completing it. The extended time period is not a distinguishing factor if the required work is only repetitive and does not require the application of significant conceptual understanding and higher-order thinking. Students take information from at least one passage of a text and are asked to apply this information to a new task. They may also be asked to develop hypotheses and perform complex analyses of the connections among texts. Some examples that represent, but do not constitute all of, Level 4 performance are:

Analyze and synthesize information from multiple sources.
Examine and explain alternative perspectives across a variety of sources.
Describe and illustrate how common themes are found across texts from different cultures.

Appendix D

Example Comparing a NAEP Mathematics Subdomain with a Standard from Another Test

NAEP Mathematics	Test A Mathematics	Similarities and Differences
Number Properties and Operations		
1) Number Sense	N. NUMBER SENSE	Test A: Number sense is one of five standards. NAEP: it is subtopic under one of five content areas.
	N.1. Analyze the structural characteristics of the real number system and its various subsystems. Analyze the concept of value, magnitude, and relative magnitude of real numbers.	
d) Represent, interpret, or compare expressions for real numbers, including expressions using exponents and logarithms.	N.1.1. Students are able to represent numbers in a variety of forms and identify the subsets of rational numbers. • Exponents • Scientific notation • Absolute value • Radicals (perfect squares) • Graph on a number line	Both frameworks state students are to represent real numbers using exponents. NAEP only includes logarithms. Test A explicitly states radicals and number line graphs.
f) Represent or interpret expressions involving very large or very small numbers in scientific notation.		NAEP incorporated in Test A N.1.1.
g) Represent, interpret, or compare expressions or problem situations involving absolute values.	N. 2. Apply number operations with real numbers and other number systems.	Test A explicitly states absolute value as a form to be represented. NAEP expects specific applications of absolute value in problem situations
	N.2.1. Students are able to read, write, and compute within any subset of rational numbers. • Solve problems involving discount, markup, commission, profit, and simple interest.	NAEP more explicitly uses computation with real numbers under subtopic number operations.
i) Order or compare real numbers, including very large or small real numbers.		

	N.3. Develop conjectures, predictions, or estimations to solve problems and verify or justify the results.	NAEP as a subtopic for estimation.
	N.3.1. Students are able to use various strategies to solve multi-step problems involving rational numbers. • Explain strategies and justify answers. • Formulate rules to solve practical problems involving rational numbers. • Use estimation strategies to make predictions and test the reasonableness of the answer.	Test A includes using estimation strategies to make predictions. NAEP attends to level of accuracy and verifying results. Test A expects students to solve problems involving rational numbers. NAEP under subtopic Number Operations expects students to use real numbers.

Appendix E

The following chart includes some steps that have been useful in previous alignment studies to facilitate the consensus process.

Facilitating the Consensus Process	
1.	Read each objective aloud before discussing it.
2.	As you go through the objectives, actively solicit comments from all panel members. Pay special attention to making sure that each panel member feels involved. (Not every panelist needs to address every objective, but make sure that everyone is included in the process.)
3.	Use the print-out to call on people who coded DOK levels differently from the coding of other members of the group, and ask them to explain why they coded the objective to the particular DOK level. Be sure they use the DOK definitions to justify their answers.
4.	Once two panel members have described how they have coded an objective differently, ask a third panel member to highlight the differences between these two interpretations.
5.	Restate and summarize points of agreement and disagreement among panelists to determine if your interpretation is accurate.
6.	If there is a difference in interpretation of the objective's *terminology* or *expectations*, discuss alternatives by asking for volunteers with direct experience in applying an objective.
7.	Provide an opportunity for panelists to change their codes after the discussion.
8.	If panelists remain divided on the DOK level of an objective, focus attention on the most likely skills or content knowledge required in the objective, not the more extreme possibilities the objective might allow.
9.	The facilitator should not dominate the consensus process. Even if the facilitator has strong feelings about the DOK level of an objective, it is important to have panel members raise the points and reach agreement on level.

Appendix B: Mathematics Framework Analysis Report

Deliverable: Mathematics Framework Analysis Report

A Comparison of the 2013 Grade 8 NAEP Mathematics Framework and ACT EXPLORE College Readiness Standards for Mathematics

OCTOBER 2015

PRESENTED TO:
National Assessment Governing Board (Governing Board)
Munira Mwalimu, Contract Officer
Michelle Blair, Contract Officer's Representative

PRESENTED BY:
NORC at the University of Chicago
Dr. Rolf Blank
Project Director
55 East Monroe Street, 30th Floor
Chicago, IL 60603
(301) 634 9325
Consultants: Dr. Raven McCrory, Michigan State University
Dr. Norman L. Webb, Wisconsin Center for Education Products and Services

NORC at the UNIVERSITY of CHICAGO

Table of Contents

List of Tables

I. INTRODUCTION

The purpose of this report is to analyze the similarities and differences between the 2013 Grade 8 NAEP Mathematics Framework (NAGB, 2012) and the ACT College Readiness Standards for the EXPLORE test (ACT, 2009). Documents used for the analysis are versions published before changes for the 2014-15 administrations of the tests. The analysis includes a short description of key features of each test followed by a crosswalk to highlight similarities and differences across the two frameworks that might impact the types and content of items on the tests.

II. ACT EXPLORE

a. Development of the standards

ACT does not publish a test development blueprint or framework, but rather provides a set of College Readiness Standards (CRS) that are grouped by score ranges. The CRS are derived from actual test takers, using EXPLORE (the test for 8th and 9th graders) normative data along with PLAN data (the test for 10th graders) and ACT data (the college admission test for 11th and 12th graders). Scores from the EXPLORE are to be used by students in 8th and 9th grades to devise a plan to reach post-high school goals. According to EXPLORE/ACT documents (ACT 2009, 2011, 2013), ACT analyzed these normative data along with college admission criteria and information about actual college course placement to describe the skills and knowledge needed to achieve each score range. The score-range standards describe what a student scoring in the given range is likely to know and be able to do. For example, 80% of students scoring 17 (the CRS benchmark) were able to "solve some routine two-step arithmetic problems" (Std BOA302 in the numbering system used in this report). The standards are cumulative: a student scoring 17 is likely able to do all the work described in the 16-19 score-range as well as all standards below that score range (13 -15). No standards are provided for scores below 13.

Scores from the EXPLORE and the PLAN are placed on a common scale. EXPLORE scores range from 1 – 25; PLAN from 1 – 32. Consequently, the scores on both the EXPLORE and PLAN were reviewed "side-by-side" to develop the score ranges. The scores on the ACT test range from 1-36 as an extension of the scale used for EXPLORE and PLAN. The ACT test scores are used by the ACT Course Placement Service to provide colleges and universities with cut-off scores to place students in courses. These cut-off scores also were used to develop the score ranges for the CRS. ACT, Inc. documents emphasize that these are curriculum-based tests derived from what is actually taught in schools.

The standards include content in four mathematical areas: Pre-algebra, Elementary Algebra, Geometry, and Statistics & Probability. These are shown in Table 1.

Table 1: Percent and Number of Items for EXPLORE Mathematics Test by Content Areas

Content Area	Description	% of Test	# of Items
PA: Pre-Algebra:	Basic ops using whole numbers, decimals, rationals, and integers. Place value, Square roots, scientific notation, factors, ration and proportion, percent.	33.3	10
EA: Elementary Algebra	Operations with algebraic expressions: eval alg exp by substitution, use variables to express relationships, solve linear equations in one variable, use real number lines to represent numbers, and graph points in coordinate plane.	30.0	9
G: Geometry	Use of scales and measurement systems, plane and solid geometric figures, associated relationships and concepts, concept of angles and their measures, parallelism, relationships of triangles, properties of a circle, and the Pythagorean theorem. At a level preceding formal geometry	23.4	7
SP: Statistics & Probability	Elementary counting, basic probability; data collection, representation, and interpretation; reading and relating graphs, charts, and other representations of data. At a level preceding formal statistics	13.3	4

(from Your Guide to EXPLORE: What It Measures, Its Purposes and Foundations, How It is Developed, 2011, ACT, p. 8.)

The standards, however, are not organized by topic but rather by strand, seven of which are included in the CRS. They are:

BOA: Basic Operations and Applications

PSD: Probability, Statistics, and Data

NCP: Number Concepts and Properties

XE1: Expressions, Equations, and Inequalities

GRE: Graphical Representations

PPF: Properties of Plane Figures

MEA: Measurement

EXPLORE CRS consist of 55 standards across the seven strands, divided into four score ranges, from 13– 25. ACT documents state that although the strands overlap, each standard has been assigned to a primary strand. Documents also point out that “lack of a CRS statement in a score range indicates that there was insufficient evidence with which to determine a descriptor" (ACT 2009, p. 7). Test items cover four cognitive levels shown in Table 2. The two highest cognitive levels are collapsed to form one level for reporting the number items by cognitive level. The cognitive levels are not reflected in the CRS *per se,* but the test is written to include proportions of items close to those shown in the table.

Table 2: Proportion of Items on the EXPLORE Mathematics Test by Cognitive Levels

Cognitive Level	Description	% of Test	# of Items
1. Knowledge & skills	Use one or more facts, definitions, formulas, or procedures to solve problems that are presented in purely mathematical terms	26.7	8
2. Direct application	Use knowledge and skills to solve straightforward problems set in real-world situations	26.7	8
3. Understanding concepts 4. Integrating conceptual understanding	Reasoning from a single concept or the integration of several concepts to reach an inference or a conclusion.	46.7	14

(from Your Guide to EXPLORE: What It Measures, Its Purposes and Foundations, How It is Developed, 2011, ACT, pp. 7, 16)

b. Test context and administration

The EXPLORE Mathematics Test consisted of 30 items drawn from a larger pool, and was taken in 30 minutes. The EXPLORE is a domain-sampled test with forms created by sampling from the mathematics domain. Equivalence of forms is achieved both by meeting multiple constraints on the number of items in each content area, the cognitive scope of the items, and match to a difficulty distribution in addition, as well as through fine-tuning using equivalent-population equating. The Mathematics test was administered along with the English, Reading, and Science tests. The complete test took 2.5 hours and was usually administered in one sitting. The test was given year round, at the discretion of the district/school. There was no penalty for answering incorrectly, and the test was not speeded. That is, most students finished in the allocated time.

Calculators were recommended to be used when taking the EXPLORE test but not required. Students could use calculators they were most comfortable with including four-function, scientific, or graphing calculators except for those explicitly prohibited such as those with built in or downloaded algebra computer system functionality. The EXPLORE test included items where a calculator was recommended for use, items where a calculator was not recommended, and items without such a specific calculator recommendation. The materials stated that memorization of formulas was not required, and in the examples, formulas were provided when needed.

c. Supplemental information beyond the standards

The CONNECT booklet from ACT includes *Ideas for Progress* (ACT, Inc., 2009, pp. 8-13) in conjunction with each score range within each strand. The *Ideas for Progress* describe to teachers learning experiences that could benefit students at a score range. These ideas clarify and add detail to what the standards mean and help for designing lesson plans. For example, the score range 1-12 for Basic Operations and Applications (BOA) includes the following *Ideas for Progress*

- practice and apply estimation and computation using whole numbers and decimals
- choose the appropriate method of computation to solve multistep problems (e.g., calculator, mental, or pencil and paper)
- practice selecting appropriate units of measure (e.g., inches or feet, hours or minutes, centimeters or meters) and converting between units
- model and connect physical, verbal, and symbolic representations of money

These *Ideas for Progress* suggest a connection to NAEP standards that is not apparent from the first level (score range 13-15) of the BOA standards. In the accompanying tables (Appendix A), references to the *Ideas for Progress* at all score bands are included where they illuminate a connection to NAEP that is not apparent from the CRS standards alone. The *Ideas for Progress* are presented in Appendix D.

III. NAEP

a. Development of the standards

The 2013 grade 8 NAEP test included 153 items in four content areas, three levels of complexity, and three item designs. The content areas along with the distribution of items on the test are shown in Table 3.

In the NAEP framework, the category *Number Properties and Operations* includes rational numbers in all forms and "naturally occurring" irrational numbers such as pi and square roots. It also includes number sense: "comfort in dealing with numbers effectively [including] firm intuitions about what numbers tell us; an understanding of the ways to represent them symbolically…; ability to calculate, either exactly or approximately, and by several means;… and skill in estimation" (NAGB, 2010, p. 8).

Items were written at three levels of complexity (low, medium, high) and were distributed by testing time among these levels as shown in Table 4.

Table 3: Percent of Items for the Mathematics NAEP Grade 8 by Content Areas

Content Area	Description	% of Items
Number Properties and Operations	Computation and understanding of number concepts.	20
Measurement	Use of instruments, application of processes, and concepts of area and volume.	15
Geometry	Spatial reasoning and applying geometric properties. Symmetry and transformations. Number lines.	20
Data Analysis, Statistics, and Probability	Collecting, organizing, summarizing, and interpreting data. Graphical displays and statistics. The study of potential patterns in outcomes that have not yet been observed.	15
Algebra	Representations and relationships. Expressions, functions and variables. Proportionality and rates.	30

From 2011 Mathematics Framework, (NAGB, 2010, p. 6)

Table 4: Percent of Items for the Mathematics NAEP Grade 8 by Cognitive Levels

Level	Description	% of Testing Time
Low	Recall or recognize concepts or procedures. Items specify what student should do	25
Medium	Requires greater flexibility of thinking and choice. Student decides what to do and how to do it. Concepts and processes from various domains in a single item	50
High	Students us reasoning, planning, analysis, judgment and creative thought. Sometimes require justification or mathematical argument.	25

From 2011 NAEP Framework (NAGB, 2010, pp. 38-50).

Items were also written in three different formats: multiple choice (with 4 choices), short constructed- response, and extended constructed-response. The test was divided evenly in time between multiple choice and constructed-response. Short constructed-response items were scored at two or three levels: correct, incorrect or partially correct. Extended constructed-response items had multiple parts and required more than a short answer. They were scored at either four or five levels. Scoring rubrics were used for all constructed-response items (NAGB, 2010, p. 51).

b. Test context and administration

The NAEP mathematics test is administered every other year (odd years) to 8th graders. It is administered between January and March to a stratified national probability sample. Schools are sampled by region, students sampled within school. Samples are drawn for both public and non-public schools. In 2013, 170,100 8th graders from 6,520 schools took the mathematics test (National Center for Education Statistics, 2014, p. 3). The mathematics test took under 60 minutes for a student to complete, and was administered in “blocks” of items that differed from booklet to booklet. In 2011, the test was administered in two 25 minute sections, with 14-17 items on each section (NCES, 2013, p. 7). For 2013, the mathematics item pool included 153 items.[1]

The NAEP 8th grade mathematics test required a calculator. For students who did not bring one, NAEP provided a four function calculator and trained test takers on its use as part of the protocol.

At grades 8 and 12, students were allowed to bring whatever calculator, graphing or otherwise, they were accustomed to using in the classroom with some restrictions for test security purposes. For students who did not bring a calculator to use on the assessment, NAEP provided a scientific calculator. (Web site, http://nces.ed.gov/nationsreportcard/mathematics/whatmeasure.aspx)

On about two thirds of the grade 8 mathematics items, students were not allowed to use calculators. On the other one-third of the items, the problem was difficult to solve without a calculator. The test was designed not to give advantage to GRAPHING calculators. Calculator-inactive; calculator-neutral, and calculator-active items were included.

[1] Personal conversation with NAGB staff. http://nces.ed.gov/nationsreportcard/tdw/analysis/2007/scaling_determination_number_math2007.aspx. The NAEP web sites contain an enormous amount of information and data. It is not easy, however, to find answers to specific questions, such as how many items are in the pool or in a test booklet. There are many broken links, and a search engine that makes it difficult to filter out unwanted information

- A calculator inactive question is one whose solution neither requires nor suggests the use of a calculator.
- A calculator is not necessary for solving a calculator neutral question; however, given the option, some students might choose to use one.
- A calculator is necessary or very helpful in solving a calculator active question; a student would find it very difficult to solve the problem without the aid of a calculator (Web site)[2]

Some items required manipulatives (e.g., algebra tiles), which were provided.

IV. NAEP/ACT Framework Comparison

a. General comparison

Probably the most important difference between the two frameworks is the way they handle three aspects of the test specification: 1) Number domain or type (fraction, decimal, percent, ratio, proportion; rational, real); 2) applications; and 3) reasoning. In CRS, number domains are spread across multiple strands, and described in the content area descriptions (Table 1). In NAEP, number domains or types are often a key part of the standard. For example, Standards I.4.a, b, c & d refer to fractions, ratios, proportional reasoning and percentages respectively. In contrast, CRS BOA 301, 302, 401, and 501 refer to increasingly complex problems and can be applied to any type or domain of numbers.

Similarly, applications are specifically mentioned in NAEP standards, but covered in CRS by the second cognitive level (Table 2). Thus, items written for any standard in CRS could be applications (problems written in real-world contexts). The NAEP standards include specific reference to applications (e.g., I.1.e, "meaningful contexts"), while the CRS include "application" as one of the three cognitive levels, with 27% of test items falling into that category.

Reasoning is represented in NAEP standards explicitly (e.g., I.6.a & b) but is not explicit in CRS, which includes reasoning items under the third cognitive level, "Understanding concepts & Integrating conceptual understanding" (Table 2). Thus, NAEP standards include reasoning

[2] http://nces.ed.gov/nationsreportcard/mathematics/whatmeasure.aspx

standards (added after 2009) such as I.6.a & b, while the CRS include reasoning only as a manifestation of the third cognitive level, "Understanding Concepts, Integrating Conceptual Understanding." Since the EXPLORE test did not include constructed-response items, it is possible that reasoning was represented on that test in very different ways than on NAEP where written explanations of reasoning could be elicited in short or extended constructed-response items.

Another important difference is found in the standards for Geometry, Data/Statistics/Probability, and to a lesser extent in Algebra. In these areas, the NAEP framework specifies a much broader range of topics, skills, and knowledge than the CRS framework. Several standards in NAEP have no counterpart in CRS (e.g., NAEP II.2 and II.3 and many of the NAEP III.x standards). CRS geometry standards focus on length, area, perimeter, and properties of angles and triangles. The ACT CRS make no mention of symmetry, transformations, solid geometry, or coordinate geometry at the 8th grade level, except for locating points in the coordinate plane.

Finally, the two sets of standards use different kinds of language at different levels of detail. For example, the verbs used in the standards are more varied in the NAEP standards than in the EXPLORE CRS. Table 5 lists all verbs from both sets of standards, illustrating differences in how standards are expressed.

Because of these differences along with others outlined above, it is difficult to find exact matches across the two frameworks.

Table 5: Vocabulary Comparison: Verbs

NAEP	ACT
	add
analyze	
apply	
calculate	calculate
	compute
choose	
compare	
complete	
demonstrate	
describe	
determine	determine
Distinguish between	
draw	
establish	
estimate	estimate
evaluate	evaluate
	exhibit
explain	
express	
find	find
generalize	
graph	
Identify	identify
interpret	

NAEP	ACT
justify	
	locate
make	
	manipulate
model	
order	order
perform	perform
predict	
provide	
read	read
recognize	recognize
rename	
represent	
select	
solve	solve
	substitute
	subtract
test	
translate	translate
use	Use
validate	
verify	
visualize	
	work with
write	write

b. Comparison of administration and context

Table 6: Overview of NAEP/ACT-CRS Comparison

	NAEP 8th Grade Mathematics Framework	ACT EXPLORE Assessment Specifications
Percentage distribution of Items by Content Area	Number Properties and Operations (20%) Measurement (15%) Geometry (20%) Data Analysis, Statistics, and Probability (15%) Algebra (30%)	Pre-Algebra (10 items, 33.3%) Elementary Algebra (9 items, 30%) Geometry (7 items, 23.4%) Statistics/Probability (4 items, 13.3%)
Mathematical Complexity of Items	Cognitive Level by testing TIME: Low (25%) Medium (50%) High (25%)	Knowledge & Skills (8 items, 26.7%) Direct Application (8 items, 26.7%) Understanding Concepts, Integrating Conceptual Understanding (14 items, 46.7%)
Number of Items	A total of 153 items are divided into blocks Approximately 30 items per test booklet (two blocks) are administered to a student over 90 minutes including time for instructions. Multiple test booklets are developed to insure equating and domain coverage)	One form includes 30 items taken in 30 minutes
Item Types and % of items	Type of item by testing TIME. 50% Multiple Choice 50% Constructed-Response (short and extended combined)	All multiple choice.
Assessment Time	The test is administered in approximately one hour, divided into two 25 minute sections plus administration time.	30 minutes
When Given	Given every other year, January – March, odd years.	Schools and/or districts choose when to administer the test. Normed scores are provided for both fall and spring administrations.
Testing Population	A national probability sample of schools and students is selected for each administration. Typically, 30 8th grade students per school are selected from the sample of schools. In addition to public schools, a national sample of non-public schools is also selected. The samples include schools from all 50 states, the District of Columbia, and Department of Defense schools.	Schools and/or districts participate by choice.
Calculator Use	Calculators are required for some items, and provided if needed.	Calculators are required.
Item Scoring	Average scores are reported on a scale of 0–500 for mathematics. Scores are divided into three achievement levels Basic Proficient Advanced Percentage of students reaching each level is reported.	Percentages of students below the benchmark and at or above the benchmark are reported. Since all items are multiple choice, they are machine scored. Multiple test booklets are equated by design and through statistical methods. Scores are reported on a scale of 1-25.

c. Standards Comparison

Appendix A is the side-by-side table showing NAEP/CRS matches with comments about similarities and differences. Appendix B is the crosswalk sorted by CRS category. Appendix C is an EXCEL spreadsheet with the matches – it is sortable so that one can browse by either NAEP or CRS item. Appendix D is an enumeration of the "Ideas for Progress" from the CRS framework, referenced in Appendix A.

V. References

ACT, Inc., 2009. Connecting College Readiness Standards to the Classroom for Mathematics Teachers. Iowa City, IA: Author.

ACT, Inc., 2011. *Your Guide to EXPLORE: What It Measures, Its Purposes and Foundations, How It is Developed*. Iowa City, IA: Author. Downloaded October, 2014, http://www.act.org/explore/pdf/YourGuideEXPLORE.pdf

ACT, Inc., 2013. *EXPLORE Technical Manual*. Iowa City, IA: Author. Downloaded October, 2014, http://www.act.org/explore/pdf/TechManual.pdf

National Assessment Governing Board (NAGB), 2007. Assessment and item specifications for the NAEP 2009 Mathematics Assessment. Washington, D.C: U.S. Government Printing Office. Downloaded October, 2014. https://www.nagb.org/content/nagb/assets/documents/publications/frameworks/mathematics/2009-mathematics-specification.pdf

National Assessment Governing Board (NAGB), 2010. *NAEP 2011 Mathematics Framework for the National Assessment of Educational Progress*. Washington, D.C: U.S. Government Printing Office. Downloaded October, 2014. https://www.nagb.org/publications/frameworks/mathematics/2011- mathematics-framework.html

National Assessment Governing Board (NAGB), 2012. *Mathematics Framework for the 2013 National Assessment of Educational Progress*. Washington, D.C: U.S. Government Printing Office. Downloaded October, 2014. https://www.nagb.org/content/nagb/assets/documents/publications/frameworks/mathematics/2013-mathematics-framework.pdf

National Center for Education Statistics (NCES), 2013. *U.S. States in a Global Context Results From the 2011 NAEP-TIMSS Linking Study (NCES 2013-460).* U.S. Department of Education. Institute of Education Sciences. Washington, DC: U.S. Government Printing Office.

National Center for Education Statistics, 2014. The Nation's Report Card: A first look 2013 mathematics and reading (NCES 2014-451). Institute of Education Sciences, U.S. Department of Education, Washington, D.C. Downloaded March, 2015. http://nces.ed.gov/nationsreportcard/subject/publications/main2013/pdf/2014451.pdf

Appendix A. Side by Side Comparison Table: NAEP – ACT CRS

For ease of reference and identification, NAEP standards are numbered a.bc where a is the number corresponding to the Roman numeral originally assigned (I – V), b is the subtopic, and c is the standard item, numbered sequentially within subtopic. For example, 1.12 is I.1.b. IP refers to items in the "Ideas for Progress" document from ACT/CRS in Appendix D.

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
1.00	**I. Number Properties & Operations**		
1.10	**1) Number Sense**	BOA: Basic Operations and Applications GRE: Graphical Representation NCP: Number: Concepts & Properties	
1.11	a) Use place value to model and describe integers and decimals.	BOA201: Perform one-operation computation with whole numbers and decimals NCP302: Identify a digit's place value	Except for NCP302, CRS does not explicitly address place value. Using place value concepts is implicit in many of the "solve" standards, and is mentioned explicitly in the IP for NCP in the 13-15 score range (NCP2xx)
1.12	b) Model or describe rational numbers or numerical relationships using number lines and diagrams.	GRE201: Identify the location of a point with a positive coordinate on the number line NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor	CRS groups whole numbers and rational numbers together in many of the standards, only rarely calling out fractions or decimals separately.
1.14	d) Write or rename rational numbers.	NCP201: Recognize equivalent fractions and fractions in lowest terms	The difference between "write or rename" and "recognize" could be reflected in different types of items.
1.15	e) Recognize, translate or apply multiple representations of rational numbers (fractions, decimals, and percents) in meaningful contexts.	BOA301: Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent BOA302: Solve some routine two-step arithmetic problems BOA401: Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average. GRE201: Identify the location of a point with a positive coordinate on the number line	CRS doesn't mention percents explicitly except as shown in BOA301 & 401. It is mentioned in IP's for BOA in both the 13-15 (2xx) and 16-19 (3xx) score ranges. Applications are generally included in the test design through allocation of problems (27%) to the "direct application" category.
1.16	f) Express or interpret numbers using scientific notation from real- life contexts.	NCP504: Work with scientific notation	

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
1.17	g) Find or model absolute value or apply to problem situations.	NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor	CRS is less specific: "Exhibit knowledge of…" vs "find or model".
1.18	h) Order or compare rational numbers (fractions, decimals, percents, or integers) using various models and representations (e.g., number line).	GRE201: Identify the location of a point with a positive coordinate on the number line NCP502: Order fractions	The only representation mentioned in CRS is the number line, although examples in the CONNECTING report include many other representations.
1.19	i) Order or compare rational numbers including very large and small integers, and decimals and fractions close to zero.	GRE201: Identify the location of a point with a positive coordinate on the number line GRE301: Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor NCP502: Order fractions NCP504: Work with scientific notation	Small and large integers, fractions close to zero are not explicit in CRS.
1.20	**2) Estimation**		
1.21	a) Establish or apply benchmarks for rational numbers and common irrational numbers (e.g., π) in contexts.	GRE201: Identify the location of a point with a positive coordinate on the number line GRE301: Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent	Irrational numbers are not mentioned in CRS. Π is included in an example, in a volume formula. Benchmarks fractions are not mentioned in CRS. IP for BOA in the 1-12 score range refer to estimating using whole numbers and decimals. Contexts are covered in the cognitive level 2.
1.22	b) Make estimates appropriate to a given situation by: Identifying when estimation is appropriate, Determining the level of accuracy needed, Selecting the appropriate method of estimation, or Analyzing the effect of an estimation method on the accuracy of results.	MEA201: Estimate or calculate the length of a line segment based on other lengths given on a geometric figure NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.	Most of the points are not mentioned in CRS, but may be implicit in the NCP domain. Estimation is mentioned in several of the IPs (BOA 1-12, MEA 1- 12) and thus some competence in estimating is assumed by the 13 and higher score range standards. The test description includes students' knowing when to use calculators.

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
1.23	c) Verify solutions or determine the reasonableness of results in a variety of situations, including calculator and computer results.		
1.24	d) Estimate square or cube roots of numbers less than 1,000 between two whole numbers.	NCP505: Work with squares and square roots of numbers	CRS does not give a range of numbers or specify exactly what a student should be able to do with square roots. Cube roots are not mentioned.
1.30	**3) Number operations**		
1.31	a) Perform computations with rational numbers.	BOA201: Perform one-operation computation with whole numbers and decimals BOA 202 Solve problems in one or two steps using whole numbers BOA301: Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent BOA302: Solve some routine two-step arithmetic problems BOA401: Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average BOA501: Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour)	NAEP does not explicate the level of difficulty of computations, while CRS has standards that specify increasing levels of complexity: one-step, two-step, three-step, multi-step. CRS does not divide standards by type of number (integer, fraction, decimal) while NAEP standards often specify number domain.
1.34	d) Describe the effect of multiplying and dividing by numbers including the effect of multiplying or dividing a rational number by: Zero, or A number less than zero, or A number between zero and one, One, or A number greater than one.	NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.	CRS is not specific about these particular categories of numbers. The NCP category seems to include such knowledge.
1.35	e) Interpret rational number operations and the relationships between them.	NCP502: Order fractions	

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
1.36	f) Solve application problems involving rational numbers and operations using exact answers or estimates as appropriate.	BOA301: Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent BOA302: Solve some routine two-step arithmetic problems BOA401: Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average	CRS does not include explicit mention of estimates or approximations. CRS explicates the level of content complexity of the problems, not explicitly stated for NAEP.
1.40	**4) Ratios and proportional reasoning**	BOA: Basic Operations and Applications NCP: Number : Concepts & Properties	
1.41	a) Use ratios to describe problem situations.	BOA401: Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average	NAEP is seeking a description while CRS asks for a solution. These are cognitively different, but given that CRS applies the three cognitive levels to all strands, one might see such a problem here.
1.42	b) Use fractions to represent and express ratios and proportions.		Ratio and proportion are mentioned in the CRS description of Pre-Algebra content domain, but not connected to fractions in the standards. Any of the BOA standards could include problems that deal with ratios and proportion represented as fractions. The IP for BOA score range 16-19 (3xx) includes reference to solving problems involving rates and proportions.
1.43	c) Use proportional reasoning to model and solve problems (including rates and scaling).	BOA401: Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average BOA501: Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour). XEI 502. Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions)	CRS does not specify "proportional reasoning." The IP for BOA score range 20-23 (4xx) refers to reasoning with proportions. The CRS XEI standard is clearly about modeling with an algebraic expression. Note that it is at the most advance score band for 8th grade (24-25)
1.44	d) Solve problems involving percentages (including percent increase and decrease, interest rates, tax, discount, tips, or part/whole relationships).	BOA301: Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent BOA401: Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average	Number type (decimal, percent, fraction) and application are covered by the domains and cognitive levels in CRS and are not necessarily mentioned in the standards *per se*.
1.50	**5) Properties of number and operations**		

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
1.51	a) Describe odd and even integers and how they behave under different operations.	NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor	Odd and even are not mentioned in CRS, although knowledge of primes probably implies some knowledge of even and odd numbers. The IP for NCP in the 13-15 (3xx) score band mentions "elementary number theory concepts" which would include even and odd numbers.
1.52	b) Recognize, find, or use factors, multiples, or prime factorization.	NCP301: Recognize one-digit factors of a number NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor NCP501: Find and use the least common multiple NCP503: Work with numerical factors	IP for NCP grade band 16-19 (4xx) includes factoring.
1.53	c) Recognize or use prime and composite numbers to solve problems.	NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor	Could be covered by one or more of the BOA standards for problem solving, but the use of prime and composite numbers is not explicit in these standards.
1.54	d) Use divisibility or remainders in problem settings.		Could be covered by one or more of the BOA standards for problem solving, but the use of divisibility and remainders is not explicit.
1.55	e) Apply basic properties of operations.	BOA401: Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average BOA501: Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).	The IP for NCP in the 16-19 (3xx) score range includes "recognize, identify, and apply field axioms (e.g., commutative)." CRS does not explicitly note operations.
1.60	**6) Mathematical reasoning using numbers**		These standards could be reflected in problems from any of the BOA and NCP categories, under the complexity categorization.
1.61	a) Explain or justify a mathematical concept or relationship (e.g., explain why 17 is prime).		
1.62	b) Provide a mathematical argument to explain operations with two or more fractions.		
2.00	**II. Measurement**	MEA: Measurement BOA: Basic Operations and Applications	Possibly also NCP: Number: Concepts & Properties
2.10	**1) Measuring physical attributes**		

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
2.12	b) Compare objects with respect to length, area, volume, angle measurement, weight, or mass.	MEA201: Estimate or calculate the length of a line segment based on other lengths given on a geometric figure	CRS standards build up from length to perimeter to area, but do not include standards for volume, weight, or mass. These might be included as application problems in BOA standards. CRS specifies that no formula memorization is required, so when asked, problems about various measurements likely include formulae.
2.13	c) Estimate the size of an object with respect to a given measurement attribute (e.g., area).		Not included in CRS, but could be an application problem.
2.15	e) Select or use appropriate measurement instrument to determine or create a given length, area, volume, angle, weight, or mass.		Not included in CRS, but could be an application problem.
2.16	f) Solve mathematical or real-world problems involving perimeter or area of plane figures such as triangles, rectangles, circles, or composite figures.	MEA201: Estimate or calculate the length of a line segment based on other lengths given on a geometric figure MEA301: Compute the perimeter of polygons when all side lengths are given MEA302: Compute the area of rectangles when whole number dimensions are given MEA401: Compute the area and perimeter of triangles and rectangles in simple problems. MEA402: Use geometric formulas when all necessary information is given. MEA501: Compute the area of triangles and rectangles when one or more additional simple steps are required. MEA502: Compute the area and circumference of circles after identifying necessary information.	CRS gives these very specific measurement skills, while NAEP is looking for a more general level of knowledge and skill. CRS just expects computation and not problem solving. CRS does not note explicitly composite figures.
2.18	h) Solve problems involving volume or surface area of rectangular solids, cylinders, prisms, or composite shapes.	MEA402: Use geometric formulas when all necessary information is given.	CRS does not include standards about volume or surface area, but such problems could be included (with formulae given) in application problems for the BOA or NCP standards. CRS suggest computation and not problem solving.
2.19	i) Solve problems involving rates such as speed or population density.	BOA401: Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average. BOA501: Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour.	
2.20	**2) Systems of measurement**		

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
2.21	a) Select or use an appropriate type of unit for the attribute being measured such as length, area, angle, time, or volume.		Not included in CRS.
2.22	b) Solve problems involving conversions within the same measurement system such as conversions involving square inches and square feet.	BOA203: Perform common conversions (e.g., inches to feet or hours to minutes) BOA501: Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour.	
2.23	c) Estimate the measure of an object in one system given the measure of that object in another system and the approximate conversion factor. For example: Distance conversion: 1 kilometer is approximately 5/8 of a mile. Money conversion: U.S. dollars to Canadian dollars. Temperature conversion: Fahrenheit to Celsius.	BOA501: Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour.	Measurement estimations are not specified in CRS. Problems like these could be rate problems in one of the BOA levels of problem solving.
2.24	d) Determine appropriate size of unit of measurement in problem situation involving such attributes as length, area, or volume.		Not included in CRS.
2.25	e) Determine appropriate accuracy of measurement in problem situations (e.g., the accuracy of each of several lengths needed to obtain a specified accuracy of a total length) and find the measure to that degree of accuracy.		Precision in measurement is not included in CRS.
2.26[3]	f) Construct or solve problems (e.g., floor area of a room) involving scale drawings.		Constructing or solving problems with scale drawings is not included in CRS.
2.30	**3) Measurement of triangles**		

[3] Objective 2.26 (II.2.f) appears in the 2009 framework (NAGB, 2007, p. 18) and the 2011 framework (NAGB, 2010, p. 16), but was incorrectly left from the 2013 mathematics framework (NAGB, 2012). This objective was included in this analysis and study.

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
2.31	a) Solve problems involving indirect measurement such as finding the height of a building by comparing its shadow with the height and shadow of a known object.		Not included in CRS.
3.00	**III. Geometry**	PPF: Properties of Plane Figures MEA: Measurement	
3.10	**1) Dimension and shapes**		
3.11	a) Draw or describe a path of shortest length between points to solve problems in context.		Not included in CRS.
3.12	b) Identify a geometric object given a written description of its properties.		Not included in CRS.
3.13	c) Identify, define, or describe geometric shapes in the plane and in three-dimensional space given a visual representation.		Not included in CRS.
3.14	d) Draw or sketch from a written description polygons, circles, or semicircles.		Not included in CRS.
3.15	e) Represent or describe a three-dimensional situation in a two-dimensional drawing from different views.		Not included in CRS.
3.16	f) Demonstrate an understanding about the two- and three-dimensional shapes in our world through identifying, drawing, modeling, building, or taking apart.		Not included in CRS.
3.20	**2) Transformation of shapes and preservation of properties**		
3.21	a) Identify lines of symmetry in plane figures or recognize and classify types of symmetries of plane figures.		Not included in CRS.

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
3.23	c) Recognize or informally describe the effect of a transformation on two-dimensional geometric shapes (reflections across lines of symmetry, rotations, translations, magnifications, and contractions).		Not included in CRS.
3.24	d) Predict results of combining, subdividing, and changing shapes of plane figures and solids (e.g., paper folding, tiling, cutting up and rearranging pieces).		Not included in CRS.
3.25	e) Justify relationships of congruence and similarity and apply these relationships using scaling and proportional reasoning.		Not included in CRS.
3.26	f) For similar figures, identify and use the relationships of conservation of angle and of proportionality of side length and perimeter.		Not included in CRS.
3.30	**3) Relationships between geometric figures**		
3.32	b) Apply geometric properties and relationships in solving simple problems in two and three dimensions.	PPF501: Use several angle properties to find an unknown angle measure	Not included explicitly in CRS.
3.33	c) Represent problem situations with simple geometric models to solve mathematical or real-world problems.		Not included in CRS.
3.34	d) Use the Pythagorean theorem to solve problems.	PPF402: Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).	
3.36	f) Describe or analyze simple properties of, or relationships between, triangles, quadrilaterals, and other polygonal plane figures.	PPF401: Find the measure of an angle using properties of parallel lines. PPF402: Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).	

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
3.37	g) Describe or analyze properties and relationships of parallel or intersecting lines.	PPF301: Exhibit some knowledge of the angles associated with parallel lines. PPF401: Find the measure of an angle using properties of parallel lines.	
3.40	**4) Position, direction, and coordinate geometry**		
3.41	a) Describe relative positions of points and lines using the geometric ideas of midpoint, points on common line through a common point, parallelism, or perpendicularity.		Not included in CRS.
3.42	b) Describe the intersection of two or more geometric figures in the plane (e.g., intersection of a circle and a line).		Not included in CRS.
3.43	c) Visualize or describe the cross section of a solid.		Not included in CRS.
3.44	d) Represent geometric figures using rectangular coordinates on a plane.		Not included in CRS.
3.50	**5) Mathematical reasoning in geometry**		
3.51	a) Make and test a geometric conjecture about regular polygons.		Not included in CRS.
4.00	**IV. Data analysis, statistics, and probability**	PSD: Probability, Statistics, & Data Analysis	
4.10	**1) Data representation**		
	The following representations of data are indicated for each grade level. Objectives in which only a subset of these representations is applicable are indicated in the parenthesis associated with the objective.		

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
	Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.		
4.11	a) Read or interpret data, including interpolating or extrapolating from data.	PSD303: Read tables and graphs. PSD304: Perform computations on data from tables and graphs. PSD402: Translate from one representation of data to another (e.g., a bar graph to a circle graph).	CRS does not mention interpolating or extrapolating, but such problems could be included as applications in PSD304.
4.12	b) For a given set of data, complete a graph and then solve a problem using the data in the graph (histograms, line graphs, scatterplots, circle graphs, and bar graphs).	PSD304: Perform computations on data from tables and graphs. PSD402: Translate from one representation of data to another (e.g., a bar graph to a circle graph).	NAEP does not explicitly expect translation from one representation to another.
4.13	c) Solve problems by estimating and computing with data from a single set or across sets of data.	PSD303: Read tables and graphs. PSD304: Perform computations on data from tables and graphs PSD402: Translate from one representation of data to another (e.g., a bar graph to a circle graph).	CRS does not include estimating with data.
4.14	d) Given a graph or a set of data, determine whether information is represented effectively and appropriately (histograms, line graphs, scatterplots, circle graphs, and bar graphs).		Not included explicitly in CRS. This could be a cognitive level 3 problem within PSD402
4.15	e) Compare and contrast the effectiveness of different representations of the same data.	PSD402: Translate from one representation of data to another (e.g., a bar graph to a circle graph).	Not included explicitly in CRS. This could be a cognitive level 3 problem within PSD402
4.20	**2) Characteristics of data sets**		

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
4.21	a) Calculate, use, or interpret mean, median, mode, or range.	PSD201: Calculate the average of a list of positive whole numbers. PSD202: Perform a single computation using information from a table or chart. PSD301: Calculate the average of a list of numbers. PSD302: Calculate the average, given the number of data values and the sum of the data values. PSD401: Calculate the missing data value, given the average and all data values but one. PSD501: Calculate the average, given the frequency counts of all the data values	
4.22	b) Describe how mean, median, mode, range, or interquartile ranges relate to distribution shape.	PSD502: Manipulate data from tables and graphs	No mention of interquartile range in CRS.
4.23	c) Identify outliers and determine their effect on mean, median, mode, or range.	PSD502: Manipulate data from tables and graphs	No mention of outliers in CRS.
4.24	d) Using appropriate statistical measures, compare two or more data sets describing the same characteristic for two different populations or subsets of the same population.		Not included in CRS.
4.25	e) Visually choose the line that best fits given a scatterplot and informally explain the meaning of the line. Use the line to make predictions.		Not included in CRS.
4.30	**3) Experiments and samples**		
4.31	a) Given a sample, identify possible sources of bias in sampling.		Not included in CRS.
4.32	b) Distinguish between a random and nonrandom sample.		Not included in CRS.
4.34	d) Evaluate the design of an experiment.		Not included in CRS.
4.40	**4) Probability**		

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
4.41	a) Analyze a situation that involves probability of an independent event.		Not included in CRS.
4.42	b) Determine the theoretical probability of simple and compound events in familiar contexts.	PSD403: Determine the probability of a simple event. PSD503: Compute straightforward probabilities for common situations.	
4.43	c) Estimate the probability of simple and compound events through experimentation or simulation.	PSD403: Determine the probability of a simple event. PSD503: Compute straightforward probabilities for common situations.	No reference in CRS to experiments or simulations. IP for PSD score range 13-15 (3xx) includes "conduct simple probability experiments and represent results using different formats." IP for PSD 16-19 includes "conduct simple probability experiments, use a variety of counting techniques (e.g., Venn diagrams, Fundamental Counting Principle, organized lists), and represent results from data using different formats"
4.44	d) Use theoretical probability to evaluate or predict experimental outcomes.		Not included in CRS. See note about probability above, iin 4.43.
4.45	e) Determine the sample space for a given situation.		Not included in CRS. Sample space not mentioned.
4.46	f) Use a sample space to determine the probability of possible outcomes for an event.		Not included in CRS. Sample space not mentioned.
4.47	g) Represent the probability of a given outcome using fractions, decimals, and percents.	PSD305: Use the relationship between the probability of an event and the probability of its complement	Connections among different representations of numbers and probability are not explicit in CRS. However, using the complement implies some connection to fractions, decimals, or percents.
4.48	h) Determine the probability of independent and dependent events. (Dependent events should be limited to a small sample size.)		Not included in CRS. Dependent and independent events not mentioned.
4.49	j) Interpret probabilities within a given context.	PSD402: Translate from one representation of data to another (e.g., a bar graph to a circle graph)	This is not a very good match, although one could argue that the translation requires some interpretation of meaning.
5.00	**V. Algebra**	XEI: Expressions, Equations, & Inequalities GRE: Graphical Representation MEA: Measurement	

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
5.10	**1) Patterns, relations, and functions**		
5.11	a) Recognize, describe, or extend numerical and geometric patterns using tables, graphs, words, or symbols.	PSD402: Translate from one representation of data to another (e.g., a bar graph to a circle graph)	Could be an application of PSD402 in an algebraic context. CRS does not note extend patterns.
5.12	b) Generalize a pattern appearing in a numerical sequence, table, or graph using words or symbols.	NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor. XEI 502. Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).	CRS does not ask for generalization, but that could be a cognitive level 3 problem within the framework. Writing an expression or equation is a form of generalizing.
5.13	c) Analyze or create patterns, sequences, or linear functions given a rule.	XEI 404. Perform straightforward word-to-symbol translations XEI 502. Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions)	
5.15	e) Identify functions as linear or nonlinear or contrast distinguishing properties of functions from tables, graphs, or equations.	XEI 503. Identify solutions to simple quadratic equations	Only mention of non-linear functions is quadratics.
5.16	f) Interpret the meaning of slope or intercepts in linear functions.	XEI 501. Solve real-world problems using first-degree equations	
5.20	**2) Algebraic representations**		
5.21	a) Translate between different representations of linear expressions using symbols, graphs, tables, diagrams, or written descriptions.		
5.22	b) Analyze or interpret linear relationships expressed in symbols, graphs, tables, diagrams, or written descriptions.	XEI 403. Solve routine first-degree equations	
5.23	c) Graph or interpret points represented by ordered pairs of numbers on a rectangular coordinate system.	GRE 401. Locate points in the coordinate plane	

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
5.24	d) Solve problems involving coordinate pairs on the rectangular coordinate system.	XEI 301. Substitute whole numbers for unknown quantities to evaluate expressions XEI501: Solve real-world problems using first-degree equations.	The CRS standard is not as comprehensive/inclusive as the NAEP standard. CRS does not explicitly note coordinate system.
5.25	f) Identify or represent functional relationships in meaningful contexts including proportional, linear, and common nonlinear (e.g., compound interest, bacterial growth) in tables, graphs, words, or symbols.	XEI 501. Solve real-world problems using first-degree equations XEI 503. Identify solutions to simple quadratic equations	Functions are in the CRS for 12th grade, but not for 8th grade. They are in the 25 and up grade bands, which are not tested at grade 8.
5.30	**3) Variables, expressions, and operations**		In these NAEP categories (V.3.x), CRSs are very specific about a few skills, while NAEP seems to expect broader and deeper knowledge and skills.
5.32	b) Write algebraic expressions, equations, or inequalities to represent a situation.	XEI201: Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g). XEI404: Perform straightforward word-to-symbol translations. XEI501: Solve real-world problems using first-degree equations. XEI502: Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).	
5.33	c) Perform basic operations, using appropriate tools, on linear algebraic expressions (including grouping and order of multiple operations involving basic operations, exponents, roots, simplifying, and expanding).	XEI202: Solve equations in the form x + a = b, where a and b are whole numbers or decimals. XEI301: Substitute whole numbers for unknown quantities to evaluate expressions. XEI302: Solve one-step equations having integer or decimal answers. XEI303: Combine like terms (e.g., 2x + 5x). XEI401: Evaluate algebraic expressions by substituting integers for unknown quantities. XEI402: Add and subtract simple algebraic expressions. XEI403: Solve routine first-degree equations.	
5.40	**4) Equations and inequalities**		

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
5.41	a) Solve linear equations or inequalities (e.g., ***ax* + b = c** or ***ax* + b = c*x* + d** or ***ax* + b > c**).	XEI202: Solve equations in the form x + a = b, where a and b are whole numbers or decimals. XEI302: Solve one-step equations having integer or decimal answers. XEI403: Solve routine first-degree equations. XEI501: Solve real-world problems using first-degree equations.	
5.42	b) Interpret "=" as an equivalence between two expressions and use this interpretation to solve problems.		Interpretation is not mentioned in CRS.
5.43	c) Analyze situations or solve problems using linear equations and inequalities with rational coefficients symbolically or graphically (e.g., ***ax* + b = c** or ***ax* + b = c*x* + d**).	GRE301: Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent. GRE401: Locate points in the coordinate plane. XEI501: Solve real-world problems using first-degree equations.	
5.44	d) Interpret relationships between symbolic linear expressions and graphs of lines by identifying and computing slope and intercepts (e.g., know in ***y* = *ax* + b**, that **<u>a</u>** is the rate of change and **<u>b</u>** is the vertical intercept of the graph).	XEI501: Solve real-world problems using first-degree equations.	Slope and intercept are not explicit in CRS, although they are probably implied by standards such as XEI501.
5.45	e) Use and evaluate common formulas (e.g., relationship between a circle's circum-ference and diameter [C = pi d], distance and time under constant speed).	BOA 501 Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour) MEA301: Compute the perimeter of polygons when all side lengths are given. MEA302: Compute the area of rectangles when whole number dimensions are given. MEA401: Compute the area and perimeter of triangles and rectangles in simple problems. MEA402: Use geometric formulas when all necessary information is given. XEI401: Evaluate algebraic expressions by substituting integers for unknown quantities. XEI 403. Solve routine first-degree equations	Given the second cognitive level in CRS, this kind of problem could appear under several different strands as an application problem.

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards EXPLORE Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
5.50	**5) Mathematical reasoning in algebra**		
5.51	a) Make, validate, and justify conclusions and generalizations about linear relationships.		Covered by the third CRS cognitive level, and could appear under any one of the standards.

Appendix B. Crosswalk by CRS Standard

NAEP Standards are numbered abc with a = Roman Numeral designation of strand/topic; b = numerical designation of subtopic; c = numeric conversion of alpha labeled standard. For example, 2.22 converts to II.2b.

ACT Standard	NAEP Standard
BOA Basic Operations & Applications	
BOA 201 Perform one-operation computation with whole numbers and decimals	1.11 1.31
BOA 202 Solve problems in one or two steps using whole numbers	1.31
BOA 203 Perform common conversions (e.g., inches to feet or hours to minutes)	2.22
BOA 301 Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent	1.15 1.31 1.36
BOA 302 Solve some routine two-step arithmetic problems	1.15 1.31 1.36
BOA 401 Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average	1.15 1.31 1.36 1.41 1.43 1.44 1.55 2.19
BOA 501 Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour)	1.43 1.55 2.19 2.22 2.23
FUN Functions (no 8th grade standards provided by CRS)	
GRE Graphical Representation	
GRE 201. Identify the location of a point with a positive coordinate on the number line	1.12 1.15 1.18 1.19 1.21
GRE 301. Locate points on the number line and in the first quadrant	1.19 1.21 5.43
GRE 401. Locate points in the coordinate plane	5.23 5.43
MEA Measurement	
MEA 201. Estimate or calculate the length of a line segment based on other lengths given on a geometric figure	1.22 2.12 2.16
MEA 301. Compute the perimeter of polygons when all side lengths are given	2.16 5.45

ACT Standard	NAEP Standard
MEA 302. Compute the area of rectangles when whole number dimensions are given	2.16 5.45
MEA 401. Compute the area and perimeter of triangles and rectangles in simple problems	2.16 5.45
MEA 402. Use geometric formulas when all necessary information is given	2.16 2.18 5.45
MEA 501. Compute the area of triangles and rectangles when one or more additional simple steps are required	2.16
MEA 502. Compute the area and circumference of circles after identifying necessary information	2.16
NCP Numbers: Concepts & Properties	
NCP 201. Recognize equivalent fractions and fractions in lowest terms	1.14
NCP 301. Recognize one-digit factors of a number	1.52
NCP 302. Identify a digit's place value	1.11
NCP 401. Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor	1.12 1.17 1.19 1.22 1.34 1.51 1.52 1.53
NCP 501. Find and use the least common multiple	1.52
NCP 502. Order fractions	1.18 1.19 1.35
NCP 503. Work with numerical factors	1.52
NCP 504. Work with scientific notation	1.16 1.19
NCP 505. Work with squares and square roots of numbers	1.24
PPF Properties of Plane Figures	
PPF 301. Exhibit some knowledge of the angles associated with parallel lines	3.37
PPF 401. Find the measure of an angle using properties of parallel lines	3.36 3.37
PPF 402. Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°)	3.34 3.36
PPF 501. Use several angle properties to find an unknown angle measure	3.32
PSD Probability, Statistics, & Data Analysis	
PSD 201 Calculate the average of a list of positive whole numbers	4.21
PSD 202 Perform a single computation using information from a table or chart	4.21
PSD 301 Calculate the average of a list of numbers	4.21
PSD 302 Calculate the average, given the number of data values and the sum of the data values	4.21
PSD 303 Read tables and graphs	4.11 4.14
PSD 304 Perform computations on data from tables and graphs	4.11 4.12 4.14
PSD 305. Use the relationship between the probability of an event and the probability of its complement	4.47
PSD 401. Calculate the missing data value, given the average and all data values but one	4.21

ACT Standard	NAEP Standard
PSD 402. Translate from one representation of data to another (e.g., a bar graph to a circle graph)	4.11 4.12 4.14 4.15 4.49 5.11
PSD 403. Determine the probability of a simple event	4.42 4.43
PSD 501. Calculate the average, given the frequency counts of all the data values	4.21
PSD 502. Manipulate data from tables and graphs	4.22 4.23
PSD 503. Compute straightforward probabilities for common situations	4.42 4.43
XEI Expressions, Equations, & Inequalities	
XEI 201. Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g)	5.32
XEI 202. Solve equations in the form x + a = b, where a and b are whole numbers or decimals	5.33 5.41
XEI 301. Substitute whole numbers for unknown quantities to evaluate expressions	5.24 5.33
XEI 302. Solve one-step equations having integer or decimal answers	5.33 5.41
XEI 303. Combine like terms (e.g., 2x + 5x)	5.33
XEI 401. Evaluate algebraic expressions by substituting integers for unknown quantities	5.22 5.33 5.45
XEI 402. Add and subtract simple algebraic expressions	5.33
XEI 403. Solve routine first-degree equations	5.33 5.41 5.45
XEI 404. Perform straightforward word-to-symbol translations	5.13 5.32
XEI 501. Solve real-world problems using first-degree equations	5.16 5.24 5.25 5.32 5.41 5.43 5.44
XEI 502. Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions)	1.43 5.12 5.13 5.32
XEI 503. Identify solutions to simple quadratic equations	5.15 5.25

Appendix C. EXCEL file –– NAEP ACT/CRS

NAEP STD	NAEP GR 8 Mathematics 2013 Framework	ACT STD	ACT STD
1.000	**I. Number Properties & Operations**		
1.100	**1) Number Sense**		
1.110	a) Use place value to model and describe integers and decimals.	BOA201	Perform one-operation computation with whole numbers and decimals
1.110	a) Use place value to model and describe integers and decimals.	NCP302	Identify a digit's place value
1.120	b) Model or describe rational numbers or numerical relationships using number lines and diagrams.	GRE201	Identify the location of a point with a positive coordinate on the number line
1.120	b) Model or describe rational numbers or numerical relationships using number lines and diagrams.	NCP401	Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor
1.140	d) Write or rename rational numbers.	NCP201	Recognize equivalent fractions and fractions in lowest terms
1.150	e) Recognize, translate or apply multiple representations of rational numbers (fractions, decimals, and percents) in meaningful contexts.	BOA301	Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent
1.150	e) Recognize, translate or apply multiple representations of rational numbers (fractions, decimals, and percents) in meaningful contexts.	BOA302	Solve some routine two-step arithmetic problems

Appendix D. ACT “Ideas for Progress” by Strand and Score Range

The CONNECT booklet from ACT includes *Ideas for Progress* (ACT, Inc., 2009, pp. 8-13) in conjunction with each score range within each strand. The *Ideas for Progress* describe to teachers learning experiences that could benefit students at a score range. These ideas clarify and add detail to what the standards mean and help for designing lesson plans.

BOA-IP-1-12

- practice and apply estimation and computation using whole numbers and decimals
- choose the appropriate method of computation to solve multistep problems (e.g., calculator, mental, or pencil and paper)
- practice selecting appropriate units of measure (e.g., inches or feet, hours or minutes, centimeters or meters) and converting between units
- model and connect physical, verbal, and symbolic representations of money

BOA-IP-13-15

- investigate and build understanding of the concept of percentage as a comparison of a part to a whole
- use multiple operations to solve multistep arithmetic problems

BOA-IP-16-19

- solve routine arithmetic problems that involve rates, proportions, and percents
- model and solve problems that contain verbal and symbolic representations of money
- do multistep computations with rational numbers

BOA-IP-20-23

- apply and use number properties to model and solve problems that involve reasoning with proportions
- select and use appropriate units when solving problems that involve one or more units of measure

GRE-IP-1-12

- locate and describe points in terms of their position on the number line

GRE-IP-13-15

- locate and describe objects in terms of their position on the number line and on a grid

GRE-IP-16-19

- sketch and identify line segments, midpoints, intersections, and vertical and horizontal lines

GRE-IP-20-23

- represent and interpret relationships defined by equations and formulas; translate between representations as ordered pairs, graphs, and equations; and investigate symmetry and transformations (e.g., reflections, translations, rotations)

MEA-IP-1-12

- identify line segments in geometric figures and estimate or calculate their measure

MEA-IP-13-15

- distinguish between area and perimeter, and find the area or perimeter when all relevant dimensions are given

MEA-IP-16-19

- find area and perimeter of a variety of polygons by substituting given values into standard geometric formulas

MEA-P-20-23

- apply a variety of strategies to determine the circumference or perimeter and the area for circles, triangles, rectangles, and composite geometric figures

NCP-IP-13-15

- recognize and apply place value, rounding, and elementary number theory concepts

NCP-IP-16-19

- apply elementary number concepts, including identifying patterns pictorially and numerically (e.g., triangular numbers, arithmetic and geometric sequences), ordering numbers, and factoring
- recognize, identify, and apply field axioms (e.g., commutative)

NCP-IP-20-23

- use the inverse relationships for the four basic operations, exponentiation, and root extractions to determine unknown quantities
- perform basic operations with complex numbers

PPF-IP-13-15

- describe, compare, and contrast plane and solid figures using their attributes

PPF-IP-16-19

- describe angles and triangles using mathematical terminology and apply their properties

PPF-IP-20-23

- recognize what geometric properties and relationships for parallel lines to apply to find unknown angle measures
- recognize when to apply geometric properties and relationships of triangles to find unknown angle measures

PPF-IP-20-23

- represent and interpret relationships defined by equations and formulas; translate between representations as ordered pairs, graphs, and equations; and investigate symmetry and transformations (e.g., reflections, translations, rotations)

PSD-IP-1-12

- interpret data from a variety of displays and use it in computation (e.g., mean, median, mode, range)

- organize, display, and analyze data in a variety of ways

PSD-IP-13-15

- solve real-world problems that involve measures of central tendency (e.g., mean, median, mode)
- interpret data from a variety of displays (e.g., box-and-whisker plot) and use it along with additional information to solve real-world problems
- conduct simple probability experiments and represent results using different formats

PSD-IP-16-19

- interpret data and use appropriate measures of central tendency to find unknown values
- find the probability of a simple event in a variety of settings
- gather, organize, display, and analyze data in a variety of ways to use in problem solving
- conduct simple probability experiments, use a variety of counting techniques (e.g., Venn diagrams, Fundamental Counting Principle, organized lists), and represent results from data using different formats

PSD-IP-20-23

- construct and analyze Venn diagrams to help determine simple probabilities

XEI-IP-1-12

- model a variety of problem situations with expressions and/or equations
- use the inverse relationships for the basic operations of addition and subtraction to determine unknown quantities

XEI-IP-13-15

- use mathematical symbols and variables to express a relationship between quantities (e.g., the number of 59¢ candy bars that you can buy for $5 must satisfy $59n \leq 500$)
- evaluate algebraic expressions and solve simple equations using integers

XEI-IP-16-19

- create expressions that model mathematical situations using combinations of symbols and numbers
- evaluate algebraic expressions and solve multistep first-degree equations

XEI-IP-20-23

- identify, interpret, and generate symbolic representations that model the context of a problem
- factor and perform the basic operations on polynomials
- create and solve linear equations and inequalities that model real-world situations
- solve literal equations for any variable

FUN-IP-13-15

- recognize functions as mappings of an independent variable into a dependent variable

FUN-IP-16-19

- evaluate polynomial functions that use function notation
- distinguish between range and domain

Addendum

Post-CAI Addendum: NAEP- EXPLORE Mathematics Framework Analysis

Following the completion of the Content Alignment Institute (CAI) on February 9-13, 2015, several clarification comments were received from ACT staff about the side-by-side chart comparing the College Readiness Standards (CRS) for mathematics to the 2013 Grade 8 NAEP Mathematics Framework. Objectives with a clarification are listed below.

Appendix A: Side-by-Side Comparison Table: NAEP – ACT CRS

(Revisions suggested by review comments of ACT staff)

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards Explore Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
1.00	**I. Number Properties & Operations**		
1.10	**1) Number Sense**	BOA: Basic Operations and Applications GRE: Graphical Representation NCP: Number: Concepts & Properties	
1.18	h) Order or compare rational numbers (fractions, decimals, percent, or integers) using various models and representations (e.g., number line).	GRE201: Identify the location of a point with a positive coordinate on the number line NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor NCP502: Order fractions	The only representation mentioned in CRS is the number line, although examples in the CONNECTING report include many other representations.
1.19	i) Order or compare rational numbers including very large and small integers, and decimals and fractions close to zero.	GRE201: Identify the location of a point with a positive coordinate on the number line BOA301: Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent NCP401: Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor NCP502: Order fractions NCP504: Work with scientific notation	Small and large integers, fractions close to zero are not explicit in CRS.

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards Explore Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
1.20	**2) Estimation**		
1.21	a) Establish or apply benchmarks for rational numbers and common irrational numbers (e.g., π) in contexts.	BOA301: Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent NCP505: Work with squares and square roots of numbers	Irrational numbers are not mentioned in CRS. Π is included in an example, in a volume formula. Benchmarks fractions are not mentioned in CRS. IP for BOA in the 1-12 score range refer to estimating using whole numbers and decimals. Contexts are covered in the cognitive level 2.
2.10	**1) Measuring physical attributes**		
2.13	c) Estimate the size of an object with respect to a given measurement attribute (e.g., area).	MEA201: Estimate or calculate the length of a line segment based on other lengths given on a geometric figure	Not included in CRS, but could be an application problem.
2.30	**3) Measurement of triangles**		
2.31	a) Solve problems involving indirect measurement such as finding the height of a building by comparing its shadow with the height and shadow of a known object.	BOA401: Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, computing with a given average	Not included in CRS.
3.00	**III. Geometry**	PPF: Properties of Plane Figures MEA: Measurement	
3.10	**1) Dimension and shapes**		
3.11	a) Draw or describe a path of shortest length between points to solve problems in context.	MEA201: Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g)	Not included in CRS.
3.36	f) Describe or analyze simple properties of, or relationships between, triangles, quadrilaterals, and other polygonal plane figures.	PPF401: Find the measure of an angle using properties of parallel lines. PPF402: Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°). PPF501: Use several angle properties to find an unknown angle measure	

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards Explore Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
3.37	g) Describe or analyze properties and relationships of parallel or intersecting lines.	PPF301: Exhibit some knowledge of the angles associated with parallel lines. PPF401: Find the measure of an angle using properties of parallel lines. PPF501: Use several angle properties to find an unknown angle measure	
3.40	**4) Position, direction, and coordinate geometry**		
3.44	d) Represent geometric figures using rectangular coordinates on a plane.	GRE401: Locate points in the coordinate plane	Not included in CRS.
4.00	**IV. Data analysis, statistics, and probability**	PSD: Probability, Statistics, & Data Analysis	
4.10	**1) Data representation**		
4.40	**4) Probability**		
4.47	g) Represent the probability of a given outcome using fractions, decimals, and percents.	Deleted PSD305	Connections among different representations of numbers and probability are not explicit in CRS. (Deleted sentence.)
5.00	**V. Algebra**	XEI: Expressions, Equations, & Inequalities GRE: Graphical Representation MEA: Measurement	
5.20	**2) Algebraic representations**		
5.22	b) Analyze or interpret linear relationships expressed in symbols, graphs, tables, diagrams, or written descriptions.	XEI403: Solve routine first-degree equations XEI501: Solve real-world problems using first-degree equations	
5.24	d) Solve problems involving coordinate pairs on the rectangular coordinate system.	XEI 301. Substitute whole numbers for unknown quantities to evaluate expressions XEI501: Solve real-world problems using first-degree equations.	The CRS standard is not as comprehensive/inclusive as the NAEP standard. The CRS does not explicitly note problem solving with the coordinate system.

#	NAEP GR 8 Mathematics 2013 Framework	ACT College and Career Readiness Standards Explore Benchmark 17	Similarities and Differences (IP = "Ideas for Progress")
5.30	**3) Variables, expressions, and operations**		In these NAEP categories (V.3.x), CRSs are very specific about a few skills, while NAEP seems to expect broader and deeper knowledge and skills.
5.40	**4) Equations and inequalities**		
5.45	e) Use and evaluate common formulas (e.g., relationship between a circle's circumference and diameter [**C = pi d**], distance and time under constant speed).	BOA401: Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, computing with a given average BOA501: Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour) MEA301: Compute the perimeter of polygons when all side lengths are given. MEA302: Compute the area of rectangles when whole number dimensions are given. MEA401: Compute the area and perimeter of triangles and rectangles in simple problems. MEA402: Use geometric formulas when all necessary information is given. MEA502: Compute the area and circumference of circles after identifying necessary information XEI401: Evaluate algebraic expressions by substituting integers for unknown quantities. XEI 403. Solve routine first-degree equations	Given the second cognitive level in CRS, this kind of problem could appear under several different strands as an application problem.

Appendix B: Crosswalk by CRS Standard

NAEP Standards are numbered a.bc with a = Roman Numeral designation of strand/topic; b = numerical designation of subtopic; c = numeric conversion of alpha labeled standard. For example, 2.22 converts to II.2b.

Following are the ACT standards with changes based on the post- CAI analysis by ACT staff. Only the standards with changes in the corresponding NAEP standard are listed. The changes are highlighted in yellow.

ACT Standard	NAEP Standard
BOA Basic Operations & Applications	
BOA 301 Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent	1.15 1.19 1.21 1.31 1.36
BOA 401 Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average	1.15 1.31 1.36 1.41 1.43 1.44 1.55 2.19 2.31 5.45
GRE Graphical Representation	
GRE 301. Locate points on the number line and in the first quadrant	1.21 5.43
GRE 401. Locate points in the coordinate plane	3.44 5.23 5.43
MEA Measurement	

ACT Standard	NAEP Standard
MEA 201. Estimate or calculate the length of a line segment based on other lengths given on a geometric figure	1.22 2.12 2.13 2.16 3.11
MEA 502. Compute the area and circumference of circles after identifying necessary information	2.16 5.45
NCP Numbers: Concepts & Properties	
NCP 505. Work with squares and square roots of numbers	1.21 1.24
PPF Properties of Plane Figures	
PPF 501. Use several angle properties to find an unknown angle measure	3.32 3.36 3.37
PSD Probability, Statistics, & Data Analysis	
PSD 305. Use the relationship between the probability of an event and the probability of its complement	
XEI Expressions, Equations, & Inequalities	
XEI 501. Solve real-world problems using first-degree equations	5.16 5.22 5.24 5.25 5.32 5.41 5.43 5.44

Appendix C: Content Alignment Meeting Agenda

Content Alignment Studies of the 2013 National Assessment of Educational Progress (NAEP) for Grade 8 Reading and Mathematics and ACT EXPLORE Assessments of these Subjects

Content Alignment Institute: February 9 -- 13, 2015

Location: NORC at the University of Chicago Offices
4350 East-West Highway, 8th Floor
Bethesda, MD 2081
(301) 634-9300

AGENDA

Day 1, Monday, February 9

8:00 am	Panelists check in at Suite 800, 8th Floor	**Room 832**
8:30	Introductions – Rolf Blank, NORC Objectives of Content Alignment Studies project Overview of Content Alignment Institute	**Room 834**
9:00	Overview of NAEP Grade 8 Mathematics and Reading assessments – Michelle Blair, National Assessment Governing Board	
9:20	Overview of ACT EXPLORE Mathematics and Reading assessments – Beth Sullivan, ACT	
9:40	Presentation on the Content Alignment Process – Norman Webb	
10:30	Break	
10:45	Panelists and Facilitators convene in Math and Reading subject groups Training on content area DOK definitions and how to log-on to WATv2	**Rooms 832, 834**
12:30 pm	LUNCH (served at NORC)	**Room 834**
1:15	Coding groups breakout sessions (4 groups) Assign DOK levels to NAEP Framework objectives	**Rooms 718, 736, 832, 834**
3:00	Break	
3:15–5:00	Reading: Adjudicate NAEP DOK levels coding between groups	
4:00–5:00	Math: Adjudicate NAEP DOK levels coding between groups	
5:00	Adjourn for day	

Day 2, Tues., February 10

8:00 am	Panelists check in at Suite 800, 8th Floor	**Room 832**
8:30	Review Training – Norman Webb	**Room 834**
9:00	Coding groups breakout sessions (4 groups) Code NAEP items to NAEP Frameworks	**Rooms 734, 736, 832, 834**
10:15	Break	
10:30	Continue coding NAEP items to NAEP Frameworks	
12:00 pm	LUNCH (served at NORC)	**Room 832**
1:00	Continue coding NAEP items to NAEP Frameworks	**Rooms 734, 736, 832, 834**
3:00	Break	
3:15	Reading and Math groups: Adjudicate NAEP item coding between groups	
4:45	Individual feedback survey online	
5:00	Adjourn for day	

Day 3, Wed., February 11

8:00 am	Panelists check in at Suite 800, 8th Floor	**Room 832**
8:30	Coding groups breakout sessions (4 groups) Code ACT items to NAEP Framework	**Rooms 718, 736, 818, 834**
10:15	Break	
10:30	Continue coding ACT items to NAEP Framework	
11:00	Adjudicate ACT item coding to NAEP Framework	
12:00 pm	LUNCH (served at NORC)	**Room 832**
1:00	Assign DOK levels to ACT Standards	**Rooms 718, 736, 818, 834**
3:15	Break	
3:30–5:00	Reading: Adjudicate ACT DOK levels coding between groups	
4:00–5:00	Math: Adjudicate ACT DOK levels coding between groups	
5:00	Adjourn for day	

Day 4, Thurs., February 12

8:00 am	Panelists check in at Suite 800, 8th Floor	**Room 832**
8:30	Coding groups breakout sessions (4 groups) Code NAEP items to ACT standards	**Rooms 718, 736, 832, 834**
10:15	Break	
10:30	Continue coding NAEP items to ACT standards	
12:00 pm	LUNCH (served at NORC)	**Room 834**
1:00	Continue coding NAEP items to ACT standards	**Rooms 718, 736, 832, 834**
3:00	Break	
3:15	Reading and Math: Adjudicate coding of NAEP items to ACT Standards	
4:45	Individual feedback survey online	
5:00	Adjourn for day	

Day 5, Fri., Feb. 13

8:00 am	Panelists check in at Suite 800, 8th Floor	**Room 832**
8:30	Coding groups breakout sessions (4 groups) Code ACT items to ACT Standards	**Rooms 736, 818, 832, 834**
10:15	Break	
10:30	Continue coding ACT items to ACT Standards	
10:45	Adjudicate ACT items to ACT Standards – in groups	
12:00 pm	LUNCH (served at NORC)	**Room 834**
1:00	Reading and Math: Adjudicate between groups coding ACT items to ACT standards	**Rooms 736, 818, 832, 834**
1:30	Administration – Wrap-up	
2:00	Adjourn Institute	

Contact: **Rolf K. Blank** | Ph.D., **Project Director**
NORC at the University of Chicago
4350 East-West Highway, Suite 800, Bethesda, MD 20814-4499
blank-rolf@norc.org | office (301) 634 9325 | mobile (703) 969 6291

Appendix C.1: Agenda Side-By-Side Chart (Mathematics)

Agenda Side-By-Side Chart (Mathematics)

DRAFT for Review ONLY Feb 24, 2015 MATHEMATICS TIMELINE

Day	Time	Agenda	Math Group 1 Actual	Math Group 2 Actual
Monday Feb 9	7:30			
	8:00	Registration		
	8:30	Intro		
	9:00	Overviews of NAEP and ACT		
	10:00	Content Alignment Process		
		Break		
		10:45 Training on DOK by subject area (N=16) Log onto WATv2	Trained on DOK by joint groups (N=16) Logged onto WATv2	Trained on DOK by joint groups (N=16) Logged onto WATv2
	11:00			
	Noon			
		12:30 Lunch	Lunch	Lunch
	1:00			
		1:15 Coding of DOK to NEAP objectives within group (N=8)	1:15 Coded DOK to NEAP objectives within group (N=8)	1:15 Coded of DOK to NEAP objectives within group (N=8)
	2:00			
	3:00	Break		
		Continue coding	Coded DOK to NAEP objectives within group including consensus process within group	Coded DOK to NAEP objectives within group including consensus process within group
	4:00	Adjudicate DOK levels between groups (N=16)		
	5:00	Adjourn		
		Debrief with four facilitators		
	5:30			
			5:45 to 6:30 Debriefed with facilitators	
	6:00			

Day	Time	Agenda	Math Group 1 Actual	Math Group 2 Actual
Tuesday Feb 10	7:30	Staff prep		
	8:00	Sign in	Sign in	Signin
	8:30	Review Training by all (N=32)	Review	Review
	9:00 10:00	Code NAEP items to NAEP framework objectives in groups (N=8)	Between group adjudication on DOK of NAEP objectives (N=16)	Between group adjudication on DOK of NAEP objectives (N=16)
		10:15 Break	10:15 Break	10:15 Break
	11:00	Continue coding NAEP items to NAEP framework objectives (N=8)	Trained on five items coded to NAEP objs Coded NAEP items to NAEP framework objectives in groups (N=8)	Trained on five items coded to NAEP objs Coded NAEP items to NAEP framework objectives in groups (N=8)
	Noon	Lunch	Lunch	Lunch
	1:00 2:00	Continue coding NAEP items to NAEP framework objectives (N=8)	Continued coding NAEP items to NAEP framework objectives in groups (N=8) One reviewer noticeably slower than others.	Continued coding NAEP items to NAEP framework objectives in groups (N=8) One reviewer was behind by ¾ of items.
	3:00	Break		
	4:00	Adjudicate NAEP item coding between groups (N=16)	Continued coding NAEP items to NAEP (N=8)	Continued coding NAEP to NAEP (N=8) Some reviewers assigned DOK to ACT CRS
		4:45 Ind feedback survey	Panelists completed survey at 5:15 PM	Panelists completed survey at 5:15 PM
	5:00	Adjourn		
		Debriefing with four facilitators		
	5:30		Adjourned	Adjourned
			5:45 to 6:15 debriefed with facilitators	
	6:00			

Day	Time	Agenda	Math Group 1 Actual	Math Group 2 Actual
Wed Feb 11	7:30		Some reviewers reported early for coding	One reviewer started early to code NAEP to NAEP
	8:00	Sign in		
	8:30 9:00 10:00	Coding ACT items to NAEP objectives by each group (N=8) Overviews of NAEP and ACT Content Alignment Process	Adjudicated NAEP objectives to NAEP assessments within group (N=8)	Adjudicated NAEP objectives to NAEP assessments within group (N=8). One reviewer coded in a different room to finish. NLW entered codings for this reviewer.
		10:15 Break		
		Continue coding EXP to NAEP	Continued adjudication NAEP to NAEP within group	Continued adjudication NAEP to NAEP within group. Reviewer rejoined group. Assigned DOK to ACT CRS
	11:00	Adjudicate between groups coding of EXPLORE to NAEP objectives (N=16)		
	Noon	Lunch	Lunch	Lunch
	1:00 2:00	Assign DOK to ACT College Readiness Standards (CRS)	Coded EXPLORE Form 1 to NAEP Objectives	Coded EXPLORE Form 1 to NAEP Objectives (N=7 of 8) Completed 2:45
	3:00		Coded EXPLORE Form 2 to NAEP Objectives	Coded EXPLORE Form 2 to NAEP Objectives through break to 3:40
		3:15 Break	3:15 Break	3:15 Break
		Continue coding DOK to ACT CRS	Within group adjudication EXP 1&2 to NAEP objects (N=8)	3:40 Within group adjudication EXP 1&2 to NAEP objects (N=8)
	4:00	Adjudicate between groups ACT CRS DOK assignment	Adjudicated between groups DOKs for NAEP to NAEP (N=16)	Adjudicated between groups DOKs for NAEP to NAEP (N=16)
	5:00	Adjourn		
	5:30	Debriefing with facilitators	Debriefed with facilitators	Debriefed with facilitators

Day	Time	Agenda	Math Group 1 Actual	Math Group 2 Actual
Thurs Feb 12	7:30			
	8:00	Sign in		
	8:30	Code NAEP assessment to ACT CRS	Between group Adj EXP 1&2 to NAEP	Between group Adj EXP 1&2 to NAEP
	9:00	Overviews of NAEP and ACT Content Alignment Process	Assigned DOK to ACT CRS. Reached consensus within group (N=8)	Assigned DOK to ACT CRS. Reached consensus within group (N=8
	10:00			Started coding NAEP to ACT CRS
		10: 15 Break		
		Continue coding NAEP assessment to ACT CRS	Between group adjudication of ACT CRS (N=16) NLW settled lack of agreement on XEI 502 (DOK 2)	Between group adjudication of ACT CRS (N=16) NLW settled lack of agreement on XEI 502 (DOK 2)
	11:00			
	Noon	Lunch		
	1:00	Continue coding NAEP assessment to ACT CRS	Coded NAEP items to ACT CRS	Coded NAEP items to ACT CRS
	2:00			
	3:00	Break	Break	Break
		Adjudicate coding of NAEP assessment to ACT CRS	Coded NAEP items to ACT CRS and within gr adj	Coded NAEP items to ACT CRS and within gr adj. Some started coding EXPLORE Form 1 to ACT CRS.
	4:00	4:45 Complete fb survey online	Panelists did online survey when time. Many did it after session or next day.	Panelists did online survey when time. Many did it after session or next day.
	5:00	Adjourn		
	5:30	Debriefing with facilitators	Debriefed with facilitators	Debriefed with facilitators
	6:00			

Day	Time	Agenda	Math Group 1 Actual	Math Group 2 Actual
Friday Feb 13	7:30			
	8:00	Sign in		
	8:30	Code EXPLORE Forms 1 and 2 to ACT CRS Overviews of NAEP and ACT		
	9:00		Adjudicated NAEP items to ACT CRS between groups (N=16)	Adjudicated NAEP items to ACT CRS between groups (N=16)
			9:30 Coded EXP Form 1 to ACT CRS w in group adj (N=8)*	9:30 Coded EXP Form 1 to ACT CRS (7 of 8 completed) * Final panelist continued until done.
	10:00			
		10:15 Break		
		Continue coding EXPLORE Forms 1 and 2	10:30 Coded EXP Form 2 to ACT CRS w in group adj (N=8)*	10:30 Coded EXP Form 2 to ACT CRS w in group adj (N=8)*
		Adjudicate EXP Forms 1 and 2 to ACT CRS within groups (N=8)		
	11:00		Between group adjudication of EXP Forms 1&2 to NAEP objs. (N=16)	Between group adjudication of EXP Forms 1&2 to NAEP objs. (N=16)
				Reviewers made changes to codings
	Noon	Lunch		
			Reviewers made changes to codings	
	1:00	Adjudicate EXP Forms 1 and 2 to ACT CRS between groups (N=16)		First two reviewers left
			1:15 Administration Wrap-up	1:15 Administration Wrap-up
		1:30 Administration Wrap-up	1:30 Panelists continued to make changes into WATv2	1:30 Panelists continued to make changes into WATv2
	2:00	Adjourn Institute		

Note: No between group adjudication was done for EXPLORE Forms 1 &2 to the ACT CRS because there agreement between groups was sufficient (EXP Form 1 28/30 items on objectives and 27/30 on DOK and EXP Form 2 29/30 items and 27/30 on DOK).

Appendix D: Content Alignment Recruitment List (Organizations)

Content Alignment Recruitment List (Organizations)

Professional Education Associations and Education Agencies

American Federation of Teachers

International Reading Association

Modern Language Association

National Council of Supervisors of Mathematics (NCSM)

National Council of Teachers of English

National Council of Teachers of Mathematics

National Education Association

National Math and Science Initiative

State Supervisors of English Language Arts

State Supervisors of Mathematics Education

School Science and Mathematics Association

TESOL

The Center on English Learning & Achievement (CELA)

The K–12 Mathematics Curriculum Center

Council of Chief State School Officers

- ELA State Collaborative
- Math State Collaborative

The Dana Center, University of Texas-Austin

District of Columbia Public Schools

Arlington County Public Schools (VA)

Fairfax County Public Schools (VA)

Montgomery County Public Schools (MD)

American Educational Research Association, Division H (Research, Evaluation, and Assessment in Schools)

Appendix E: Letters

Appendix E.1: Recruitment Letter

November 3, 2014

Dear Educators and Leaders,

The National Assessment Governing Board (Governing Board) of the U.S. Department of Education, is funding an important study to expand what we know about the achievement of 8th graders across the country. The Governing Board oversees the National Assessment of Educational Progress (NAEP), regarded as the Nation's Report Card, and the Board is conducting research on the academic preparedness of students for college and job training.

In September 2014, the Governing Board contracted with NORC at the University of Chicago to conduct Content Alignment Studies of the Grade 8 Reading and Mathematics Assessments with the ACT Explore Assessments in these subjects.

We are seeking your help to identify and nominate mathematics and reading educators who can be an integral part of this important study, by serving as panelists in a 5-day Content Alignment Institute. Institute panelists will review and analyze the subject content included in two national assessments: NAEP and ACT Explore. Both assessments provide key information on student achievement and may indicate the extent to which students are on track toward being prepared for college and careers by the end of grade 12. We need educators who have significant experience with mathematics or reading instruction or assessment at the 8th grade level, and are interested in working with a team of educator colleagues. Institute panelists will work in 8-person teams, and can include classroom teachers, curriculum coordinators, instructional coaches, content area assessment specialists, or district- or state-level specialists.

The Institute will be held **February 9 (8:30 am start) through February 13, 2015 (3:00 pm end),** at the NORC offices just outside Washington, DC in Bethesda, Maryland. Our experience in conducting many prior assessment studies shows that educators find their participation in these studies to be a first-class hands-on professional learning experience. All travel, hotel, meal, and ground transportation expenses will be paid by the project. Each participant will receive a $300 Institute honorarium, and, as needed, the cost of substitute staff will be paid to the sending school or district of participating panelists. Please see the attached document for more information on the project and how to submit your Institute panelist nominations to project director Rolf Blank **by November 21, 2014**.

Thank you for your support and consideration. We look forward to hearing from you.
Sincerely,

/Cornelia S. Orr/

Cornelia S. Orr, Ph.D.
Executive Director,
National Assessment Governing Board

/Rolf K. Blank/

Rolf K. Blank, Ph.D.
NORC Project Director

Appendix E.2: Panelist Letter for CAI

January 28, 2015

Dear NAEP/ACT EXPLORE Alignment Study Participant:

Thank you for agreeing to take part in this very important project. We are looking forward to working with you **February 9-13 (Monday through Friday) 2015** for the Content Alignment Institute to be convened at the NORC facilities located at:

4350 East-West Highway, Suite 800
Bethesda, Maryland 20814

You have already received communication from NORC regarding travel and hotel arrangements for the Institute in February. This email has additional information and materials in preparation for the Content Alignment Institute (CAI).

We very much appreciate your willingness to devote the week to this important study for the National Assessment Governing Board (Governing Board). During the week, you will be trained on a process that has been used to study the alignment between content standards and assessments for a number of states over the past 15 years. For this project, the process has been adapted slightly for analyzing the alignment between the 2013 NAEP grade 8 assessments and the ACT EXPLORE. The training will include instruction on the Depth-of-Knowledge (DOK) levels definitions that will be used in the study for analyzing content complexity. After you have been trained on the process and the DOK definitions, you will be asked to:

1. Assign a DOK level to each of the expectations in the NAEP grade 8 framework
2. Code the NAEP grade 8 assessment to the NAEP standards and objectives
3. Code two forms of the ACT EXPLORE to the NAEP standards and objectives
4. Assign a DOK level to each of the standards in the ACT College and Career Readiness Standards
5. Code the NAEP grade 8 assessment to the ACT College and Career Readiness Standards
6. Code two forms of the ACT EXPLORE to the ACT College and Career Readiness Standards

The design of the study includes mapping the assessment from each group to the set of standards representing each assessment. This information will then be used to draw inferences on how the two assessments are aligned.

On Monday, February 9, **we will begin the Content Alignment Institute at 8:00 AM** with registration (Please report promptly at 8:00 to Room 800 at 4350 East-West Highway, Bethesda, MD—note that the meeting will NOT include breakfast).

At 8:30 AM we start with introductions and information you will need to do the analysis. There will be two groups of eight panelists for each of the content areas: reading and mathematics. The two panels will code data independently as a replication of each other. Each group will be led by a facilitator*:

Reading Group 1

Reading Group 2

Mathematics Group 1

Mathematics Group 2

Norman Webb, the CAI Technical Coordinator leading the content analysis, has worked with all four facilitators for a number of years and we are pleased that they will be providing leadership during the Institute. You will learn your group assignment at the beginning of the Institute on February 9.

The amount of work we have to complete during the five days is such that you will be busy nearly all of the time. **We will begin each day at 8:30 AM. Please arrive at NORC offices by 8:00am each day to ensure timely check in each day. We will end each day at 5:30 PM.** On Friday, February 13, we will conclude the Institute by 2:00 PM.

All of the coding will be done using the WATv2, an on-line software designed by the Wisconsin Center for Education Research (WCER) for conducting alignment studies. Laptop computers will be provided so you do not need to bring your own. There is nothing you are required to do prior to arriving at the Institute. For those who want some background information, we are sending a list of resources about the assessments and content alignment studies.

You should already be in contact with NORC staff to make your travel arrangements. Reservations have been made for all panelists at the Hilton Garden Inn, 7301 Waverly Street, Bethesda, Maryland, 20814, 301-654-8111. The hotel room will be direct billed, and you will just need to supply a credit card for incidentals upon your arrival at check-in. You will be reimbursed for transportation (airport to hotel) and meals according to the daily per diem. Please see additional materials provided regarding transportation to and from the airport to the hotel, as well as instructions for reimbursement.

We are very pleased with the quality of panelists who have agreed to participate in the Content Alignment Institute. The group will represent a large proportion of the states and include a range [1]of backgrounds and experiences. The data you will provide will be used by the Governing Board to determine to what the degree the grade 8 NAEP assessments correspond to the ACT EXPLORE as one measure of how well grade 8 students are making progress towards being prepared for college or careers after high school.

If you have any questions about the Institute, please contact NORC staff at ContentAlignmentInstitute@norc.org or 1**-866-315-7124.**

Safe travels and see you on Monday, February 9.

Norman Webb
CAI Technical Coordinator
Wisconsin Center for Education Products and Services
nlwebb@wisc.edu

Rolf Blank
Project Director

Cindy Simko, Associate Director
NORC at University of Chicago

*Some areas of this document have been redacted for confidentiality requirements.

Appendix F: Alignment Institute Security Protocol and Procedures

Alignment Institute Security Protocol and Procedures

The following security protocol was used to conduct the Content Alignment Institute (CAI) from February 9 to 13, 2015. No security breaches were experienced.

The CAI was conducted at the NORC facility at 4350 East West Highway in Bethesda, Maryland. The reserved conference rooms include one large room for the plenary training session on day one (32 panelists plus facilitators), two rooms for subject area training on day one (16 panelists plus facilitators, and four breakout rooms for the following four days (8 panelists per room plus facilitator). The conference rooms are located on two floors of the building. The building internet hard-wire connections will be used for linking all of the panelists PCs to the internet which will provide them access to the WATv2 online data input and analysis system at WCEPS

The WATv2, a web-based tool, was used at the CAI for all data collection. All data entered in the WATv2 was stored on a server maintained at WCEPS. Access to the administrative functions is restricted and is password protected. The panel facilitators had access to data entered by members of his or her group. The technical coordinator, who will have administrative access, had access to data entered by all panelists. This allowed the technical coordinator to monitor the data entry process in real time and to intervene if some problem or issue arose.

The assessment items reviewed during the CAI were kept secure at all times. Individuals reviewing items all signed non-disclosure agreements for both NAEP and ACT EXPLORE items. Hard copies of the items were maintained by the NORC Project Director and when not in use, were stored in a locked room at the NORC facilities. A record of each set of assessment items assigned for review by a panelist were maintained by the Project Director, and when completed, each set of items was returned and stored in a locked room at the NORC facility.

NORC arranged for each facilitator and panelist to have access to a personal computer that will be wiped clean of all other data. The computers met the federal regulations for Section 508 compliance. All of the data were entered through the PCs into the WATv2 online system, and data were *not* stored or saved on the laptops, thus providing a secure data environment.

Appendix G: Content Alignment Institute Slides

Appendix G.1: Introduction Slides

Content Alignment Studies of the 2013 National Assessment of Educational Progress (NAEP) for Grade 8 Reading and Mathematics and ACT Explore Assessments of these Subjects

Content Alignment Institute: February 9 - 13, 2015

WELCOME EDUCATORS!

PROJECT OVERVIEW

OBJECTIVES:

1. Content Alignment Studies: What is the degree of alignment between Grade 8 NAEP Mathematics, Reading and ACT EXPLORE assessments in Math, Reading?

2. We analyze subject content of Assessments to Expectations /Standards for NAEP and ACT EXPLORE.

3. Larger Goal: How well assessments measure preparedness for HS courses and college.

4. Content Alignment Institute – Educators provide the data for Content Analysis using a well-tested method used in state and national studies.

5. NORC and WCEPS organize and lead the content analysis, and report findings to the National Assessment Governing Board.

Who We Are

Panelists –Reading (16) and Mathematics (16)

Facilitators: John Fortier, Cynthia Jacobson, Linda McQuillen, Mary L. Raith

Technical Coordinator: Norman Webb (WCEPS), Project Director: Rolf Blank (NORC)
Associate Director: Cindy Simko, Logistics: Rebecca Oran, Tina Weimer

National Assessment Governing Board: Michelle Blair, Sharyn Rosenberg

National Center for Education Statistics/NAEP: Elvie Hausken, Gabrielle Merken; Kim Gattis (AIR)

ACT Project Director: Beth Sullivan

- **Mathematics: Scott Johanningmeier and Darla Simpson**
- **Reading: Rachel Cieslak and Nathan Eilers**

Important items

- Check-in and check-out each day – your signature
- Laptop sign-out, sign-in each day
- NAEP, EXPLORE copies secure – day 2, 3, 4, 5 -- sign-out, sign-in
- Name tags and office entry
- Expenses – per diem food (receipts not required)
- Ground transportation – keep your receipts
- Feedback using surveys – day 2 and day 4

Appendix G.2: CAI Presentation for NAEP

The National Assessment Governing Board and NAEP: An Overview

February 9, 2015

Michelle Blair
Senior Research Associate
National Assessment Governing Board

National Assessment Governing Board

An independent bipartisan board established by Congress in 1988 to set policy for and oversee NAEP:

- Determine the assessment schedule
- Develop frameworks
- Review and approve assessment and survey items
- Design methodology for validity and reliability
- Set achievement levels
- Release assessment results

Membership (26) includes governors, legislators, teachers, principals, state superintendents, state board members, testing and measurement experts, and general public

National Assessment of Educational Progress (NAEP)

- Nationally representative ongoing measure of student achievement
- Reports group-level performance (no results for individual students)
- Provides state-comparable results in several subject areas
- Administered by the National Center for Education Statistics (NCES), which is responsible for NAEP operations

Conducting NAEP requires services from an array of contractors for:

- Test Development
- Sampling and Test Administration
- Scoring, Analysis, and Reporting

NAEP: The Nation's Report Card

Assesses what students know and can do:

SUBJECTS	GRADES
Reading, Mathematics, Writing, Science, U.S. History, Civics, Geography, Economics, the Arts, Technology and Engineering Literacy	**4, 8, and 12**

RESULTS
Student Achievement Data for the **- Nation** **- States** **- 21 Urban Districts**

NAEP Assessment Frameworks

- Describe the content and format of a NAEP assessment
  - What to measure at each grade (content objectives)
  - How to measure it (item types)
  - How achievement levels are to be represented (for Basic, Proficient, and Advanced performance in a subject)
- Written for educators, policymakers, and citizens
- Address considerations from:
  - Current instructional and measurement issues
  - Technology needs and availability
  - Research on cognitive development and learning
  - State standards and assessments
  - International standards and assessments
  - Key reports of national or international significance

5

How are NAEP Assessment Frameworks Developed?

- Educational leaders across the country are assembled for a comprehensive, inclusive, and deliberative process
  The group:
  - Drafts a recommended assessment framework
  - Engages in several levels of outreach to collect and incorporate feedback from the public
  - Presents drafts for Governing Board review
  - Presents final draft for Board approval

After NAEP frameworks are developed:

- NCES works to develop test items aligned to framework
- Governing Board reviews each item for approval

Who takes NAEP?

- National samples
- State samples
- Urban district samples

In a NAEP administration:

- Each student takes only a small portion of the items in a subject area
- NAEP field staff visit schools to test students

How is NAEP Reported?

- Scale scores
- Achievement levels
  - Aligned to generic policy definitions of ***Basic***, ***Proficient***, and ***Advanced****,* and the content of each NAEP framework
  - Reported via cut scores set by a national panel of educators and members of the general public
- Exemplar items
- Interactive formats
- Other online tools
  - NAEP Data Explorer
  - NAEP Sample Questions Tool

NAEP 8th Grade Mathematics

- *Content areas include*:
  - **Number Properties and Operations** – including computation and understanding of number concepts
  - **Measurement** – including use of instruments, application of processes, and concepts of area and volume
  - **Geometry** – including spatial reasoning and applying geometric properties
  - **Data Analysis, Statistics, and Probability** – including graphical displays and statistics
  - **Algebra** – including representations and relationships
- *Items:* 153 items total (50% multiple choice; 50% constructed-response)
- *Testing time*: 50 minutes total, consisting of two 25-minute blocks
- *Calculator-active (allowed):* one-third of the blocks
- *Score scale*: 0 to 500
- *2013 Sample*: 6,520 schools; 170,100 students

NAEP 8th Grade Reading

- *Focused on reading comprehension relative to*:
  - **Literary texts –** include fiction, literary nonfiction, and poetry
  - **Informational texts –** include expository, argumentative and persuasive, procedural, and document texts
- *Items:* 163 items total (40% multiple choice; 60% constructed-response)
- *Testing time*: 50 minutes total, consisting of two 25-minute blocks
- *Score scale*: 0 to 500
- *2013 Sample*: 6,510 schools; 171,800 students

Overview:
NEAP Preparedness Research Program

2002-04	2006	2006-08
12th Grade Blue-Ribbon Panel Report	Contract with Achieve to review NAEP in terms of preparedness	Expert Panel Outlines Recommended Validity Research

2009	2010-13	2014
Board Approval of Validity Research Program	Phase 1: Research Studies Implemented and Compiled	Release Phase 1 Research Results, Begin Phase 2 Research

NAEP Preparedness Research Approach: Multimethod

Over 30 studies across several research areas:

- ★ **Content Comparison**
- ★ **Statistical Linking**
- ★ **Standard Setting**
- ★ **Benchmarking**
- ★ **Higher Education Survey**
- ★ **Course Content Analyses (College and Job Training)**

Benefits of Understanding How NAEP relates to EXPLORE

- EXPLORE:
  - Established measure of being on track for academic preparedness outcomes
  - Backed by several years of ACT research
- Data:
  - Same samples of 8th graders took NAEP and EXPLORE during the 2012-2013 school year
  - Statistical linking of results for NAEP and EXPLORE
- Content comparisons enable understanding:
  - 8th grade student achievement
  - Progress toward academic preparedness for college

13

For More Information…

- National Assessment Governing Board: www.nagb.org
- NAEP: www.nationsreportcard.gov
- NAEP Preparedness Research Study Reports: www.nagb.gov/what-we-do/preparedness-research.html
- NAEP Phase 1 Results and 12th Grade Student Performance: www.nagb.gov/newsroom/naep-releases/grade-12-preparedness.html

Questions?

Contact Information:

Michelle Blair

National Assessment Governing Board Staff, Project Officer

Michelle.Blair@ed.gov

Appendix G.3: ACT EXPLORE Presentation

ACT Explore Overview

ACT Introductions

Content Alignment Institute: February 9 -- 13, 2015

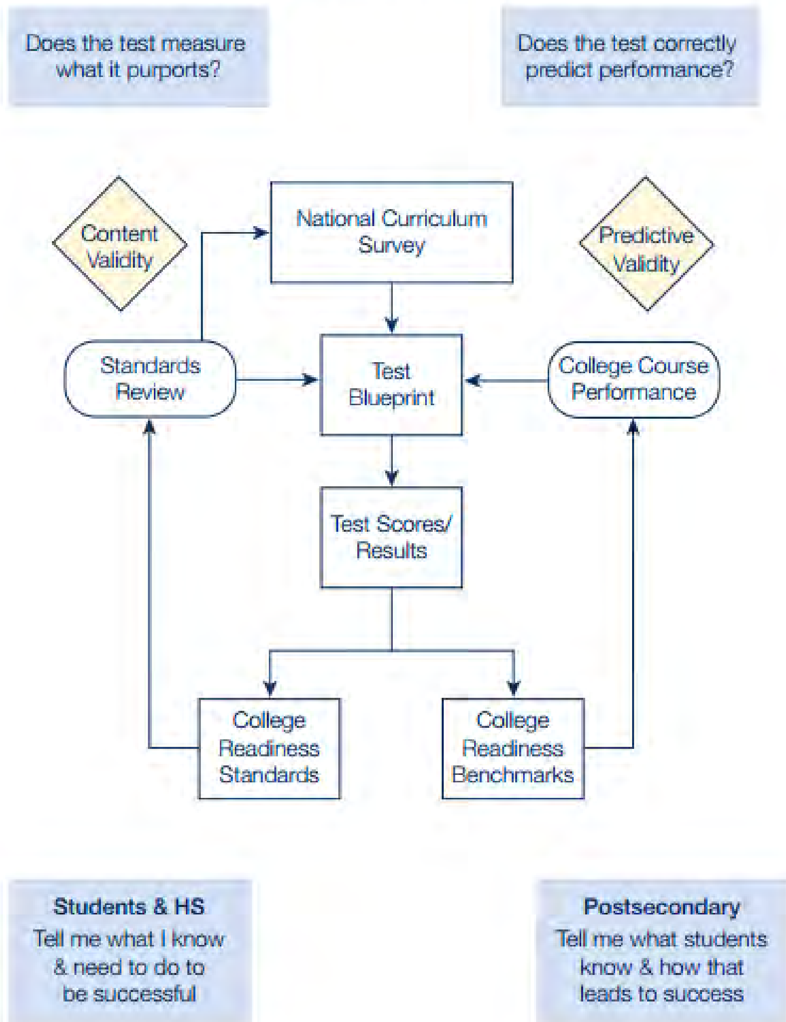
- Project Director: Beth Sullivan
- Mathematics Content Leads: Scott Johanningmeier and Darla Simpson
- Reading Content Leads: Rachel Cieslak and Nathan Eilers

ACT Explore Overview and Purpose

- Four curriculum-based assessments: English, Mathematics, Reading, and Science.
- Assesses academic progress at the eighth- and ninth-grade levels
- Helps students understand and begin to explore the wide range of career options
- Assists students and educators in developing a high school coursework plan
- Output
  - Your Scores
  - Your Plans
  - Your Career Possibilities
  - Your Skills
- Part of an integrated series of assessments which include Explore, Plan ®, and The ACT®
- Scored on a common scale, maximum Explore score is 25

ACT

The Science of ACT Assessments



The ACT National Curriculum Survey®

- Conducted every three to four years
- What are educators teaching?
- What do students need to know and be able to do?
- Guides test blueprints (content specifications)

Test Blueprint - Mathematics

Content Specifications for the ACT Explore Mathematics Test

The items in the Mathematics Test are classified according to four content categories. These categories and the approximate proportion of the test devoted to each are given below.

Mathematics content area	Proportion of test	Number of items
Pre-Algebra	.33	10
Elementary Algebra	.30	9
Geometry	.23	7
Statistics/Probability	.14	4
Total	**1.00**	**30**

a. *Pre-Algebra.* Items in this category are based on operations with whole numbers, integers, decimals, and fractions. The topics covered include place value, square roots, scientific notation, factors, ratio, and proportion and percent. Formal variables are not used.

b. *Elementary Algebra.* The items in this category are based on operations with algebraic expressions. The operations include evaluation of algebraic expressions by substitution; use of variables to express functional relationships, solution of linear equations in one variable, use of real number lines to represent numbers, and graphing of points in the standard coordinate plane.

c. *Geometry.* Items in this category cover such topics as the use of scales and measurement systems, plane and solid geometric figures and associated relationships and concepts, the concept of angles and their measures, parallelism, relationships of triangles, properties of a circle, and the Pythagorean theorem. All of these topics are addressed at a level preceding formal geometry.

d. *Statistics/Probability.* Items in this category cover such topics as elementary counting and rudimentary probability; data collection, representation, and interpretation; and reading and relating graphs, charts, and other representations of data. These topics are addressed at a level preceding formal statistics.

Test Blueprint - Reading

Content Specifications for the ACT Explore Reading Test

The items in the Reading Test are based on the prose passages that are representative of the kinds of writing commonly encountered in middle-school and junior-high school curricula, including the social sciences, prose fiction, and the humanities. The three content areas and the approximate proportion of the test devoted to each are given below.

Reading passage content	Proportion of test	Number of items
Prose Fiction	.33	10
Social Sciences	.33	10
Humanities	.33	10
Total	**1.00**	**30**

a. *Prose Fiction.* The items in this category are based on short stories or excerpts from short stories or novels.

b. *Humanities.* The items in this category are based on passages from memoirs and personal essays, and in the content areas of architecture, art, dance, ethics, film, language, literary criticism, music, philosophy, radio, television, or theater.

c. *Social Sciences.* The items in this category are based on passages in anthropology, archaeology, biography, business, economics, education, geography, history, political science, psychology, or sociology.

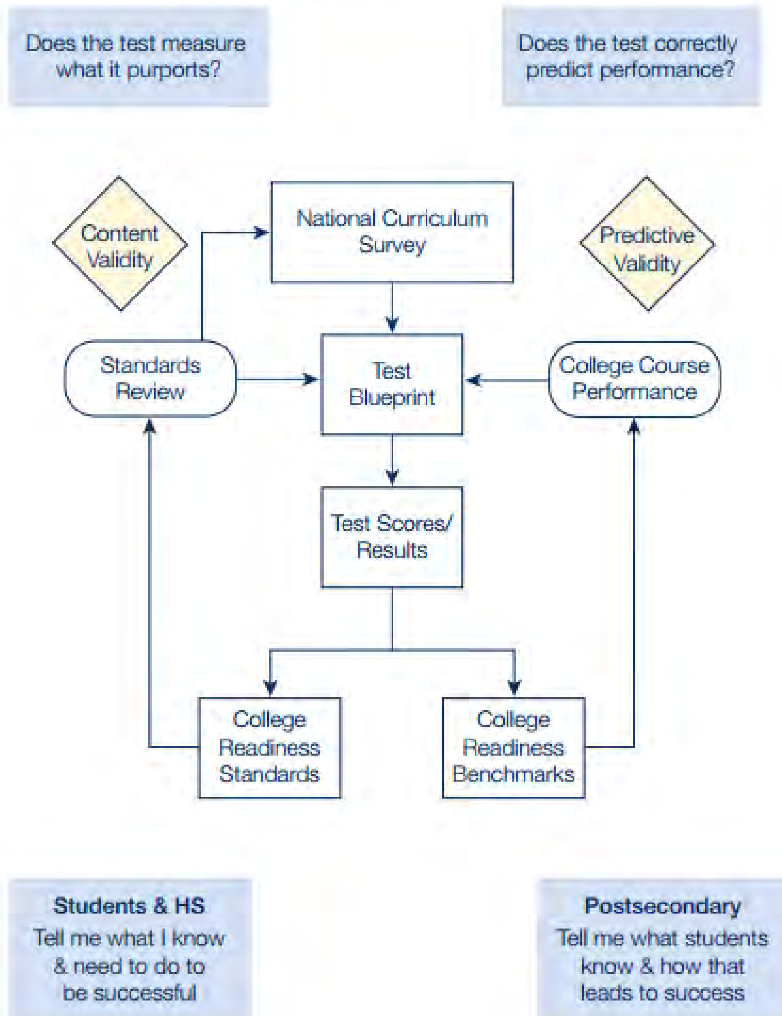
ACT College Readiness Standards

- Outcome of analysis of nationwide sample of student scores and responses
- Defines a progression of skills
- Cumulative
- Organized by strands and score ranges
- Common score scale

ACT

8

The Science of ACT Assessments



Overview

- 30 multiple-choice items
- 30 minutes
- Attempts to measure mathematical reasoning
- Does not focus on memorization or computational skills

Calculator usage

- What is expected?
- What is allowed?
- Calculator taxonomy

ACT EXPLORE Mathematics Assessment

College Readiness Standards

College Readiness Standards — Mathematics

	Basic Operations & Applications (BOA)	Probability, Statistics, & Data Analysis (PSD)	Numbers: Concepts & Properties (NCP)	Expressions, Equations, & Inequalities (XEI)	Graphical Representations (GRE)	Properties of Plane Figures (PPF)	Measurement (MEA)
13–15	**201.** Perform one-operation computation with whole numbers and decimals **202.** Solve problems in one or two steps using whole numbers **203.** Perform common conversions (e.g., inches to feet or hours to minutes)	**201.** Calculate the average of a list of positive whole numbers **202.** Perform a single computation using information from a table or chart	**201.** Recognize equivalent fractions and fractions in lowest terms	**201.** Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$) **202.** Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals	**201.** Identify the location of a point with a positive coordinate on the number line		**201.** Estimate or calculate the length of a line segment based on other lengths given on a geometric figure
16–19	**301.** Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent **302.** Solve some routine two-step arithmetic problems	**301.** Calculate the average of a list of numbers **302.** Calculate the average, given the number of data values and the sum of the data values **303.** Read tables and graphs **304.** Perform computations on data from tables and graphs **305.** Use the relationship between the probability of an event and the probability of its complement	**301.** Recognize one-digit factors of a number **302.** Identify a digit's place value	**301.** Substitute whole numbers for unknown quantities to evaluate expressions **302.** Solve one-step equations having integer or decimal answers **303.** Combine like terms (e.g., $2x + 5x$)	**301.** Locate points on the number line and in the first quadrant	**301.** Exhibit some knowledge of the angles associated with parallel lines	**301.** Compute the perimeter of polygons when all side lengths are given **302.** Compute the area of rectangles when whole number dimensions are given
20–23	**401.** Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average	**401.** Calculate the missing data value, given the average and all data values but one **402.** Translate from one representation of data to another (e.g., a bar graph to a circle graph) **403.** Determine the probability of a simple event	**401.** Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor	**401.** Evaluate algebraic expressions by substituting integers for unknown quantities **402.** Add and subtract simple algebraic expressions **403.** Solve routine first-degree equations **404.** Perform straightforward word-to-symbol translations	**401.** Locate points in the coordinate plane	**401.** Find the measure of an angle using properties of parallel lines **402.** Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°)	**401.** Compute the area and perimeter of triangles and rectangles in simple problems **402.** Use geometric formulas when all necessary information is given
24–25	**501.** Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour)	**501.** Calculate the average, given the frequency counts of all the data values **502.** Manipulate data from tables and graphs **503.** Compute straightforward probabilities for common situations	**501.** Find and use the least common multiple **502.** Order fractions **503.** Work with numerical factors **504.** Work with scientific notation **505.** Work with squares and square roots of numbers	**501.** Solve real-world problems using first-degree equations **502.** Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions) **503.** Identify solutions to simple quadratic equations		**501.** Use several angle properties to find an unknown angle measure	**501.** Compute the area of triangles and rectangles when one or more additional simple steps are required **502.** Compute the area and circumference of circles after identifying necessary information

ACT

College Readiness Standards

	Basic Operations & Applications (BOA)	Probability, Statistics, & Data Analysis (PSD)	Numbers: Concepts & Properties (NCP)	Expressions, Equations, & Inequalities (XEI)
13–15	**201.** Perform one-operation computation with whole numbers and decimals **202.** Solve problems in one or two steps using whole numbers **203.** Perform common conversions (e.g., inches to feet or hours to minutes)	**201.** Calculate the average of a list of positive whole numbers **202.** Perform a single computation using information from a table or chart	**201.** Recognize equivalent fractions and fractions in lowest terms	**201.** Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$) **202.** Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals

College Readiness Standards

	Basic Operations & Applications (BOA)
13–15	**201.** Perform one-operation computation with whole numbers and decimals **202.** Solve problems in one or two steps using whole numbers **203.** Perform common conversions (e.g., inches to feet or hours to minutes)
16–19	**301.** Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent **302.** Solve some routine two-step arithmetic problems
20–23	**401.** Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average
24–25	**501.** Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour)

Overview

- 3 passages (prose fiction, social science, humanities)
- 30 multiple-choice items
- 30 minutes
- Questions provide good coverage of College Readiness Standards and various levels of cognitive complexity

ACT Explore Reading Assessments

- Prose Fiction: Excerpts from short stories and novels
  - Uncomplicated
  - More Challenging

- Informational texts: Excerpts from social science and humanities articles and essays
  - Uncomplicated
  - More Challenging

ACT

ACT Explore Reading Assessments

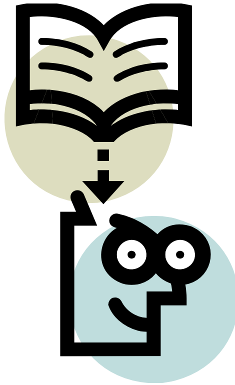
College Readiness Standards for Reading

- Main Ideas and Author's Approach (MID)
- Supporting Details (SUP)
- Sequential, Comparative, and Cause-Effect Relationships (REL)
- Meaning of Words (MOW)
- Generalizations and Conclusions (GEN)

ACT

ACT Explore reading

- Test items require the student to derive meaning from the texts by:
  - Referring to what is explicitly stated
  - Reasoning to determine implicit meanings and to draw conclusions, comparisons, and generalizations



Questions?

Additional information

http://www.act.org/explore/downloads.html

http://www.act.org/explore/pdf/TechManual.pdf

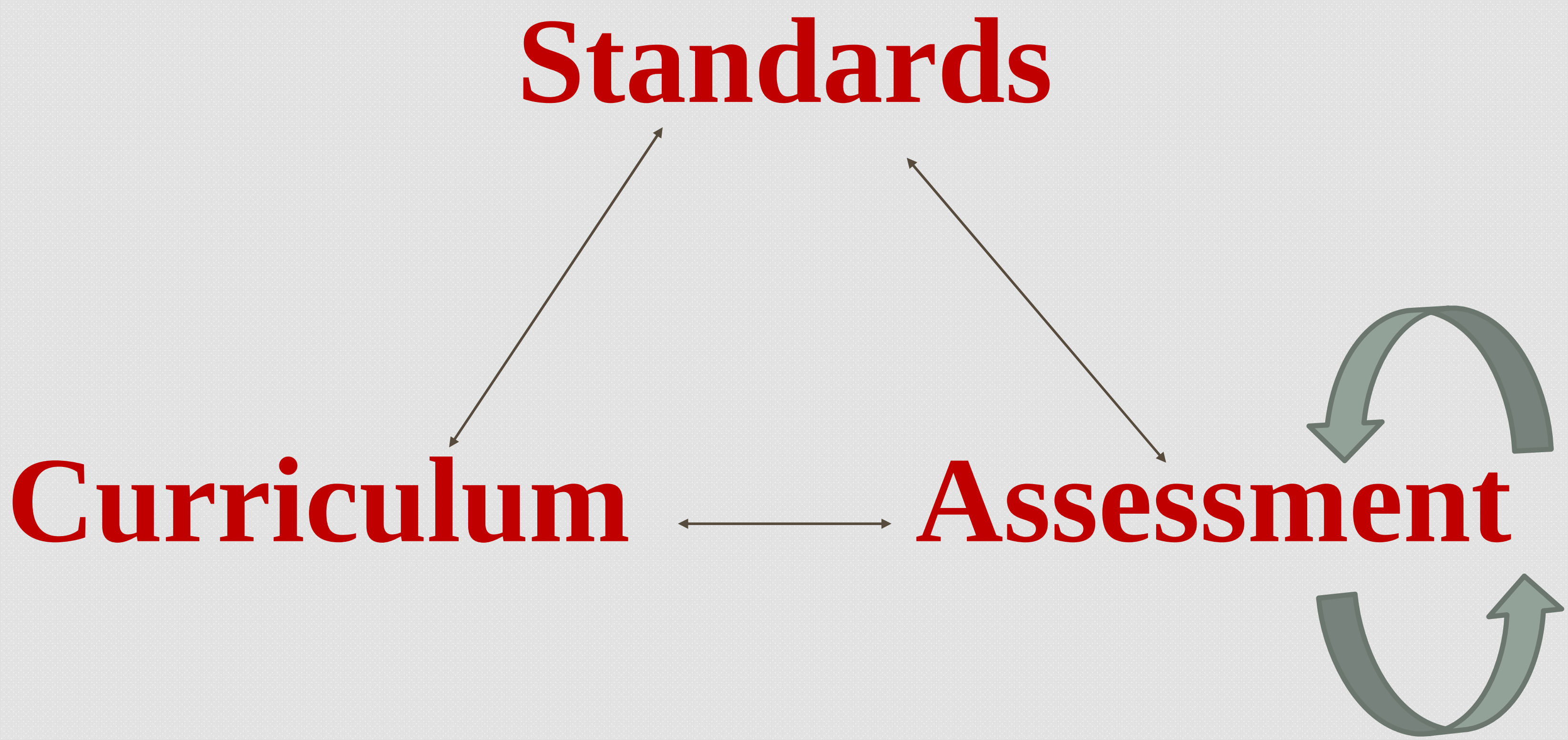
Appendix G.4: Norman Webb Presentation

Content Alignment Study 2013 NAEP and ACT EXPLORE Reading and Mathematics

NORC
4350 West-West Highway, 8th Floor
Bethesda, Maryland
February 9-13, 2015

Alignment

The degree to which expectations and assessments are in agreement and serve in conjunction with one another to guide the system toward students learning what is expected.


Standards
Curriculum
Assessment

Alignment Process

- Identify Standards and Assessments
- Select Panelists (Content Experts)
- Train Panelists on DOK Levels
- Part I: Assign DOK Levels to Standards/Benchmarks
- Part II: Code DOK Levels and Standards of Assessment Items

Study Design

Mathematics

Group 1

Group 2

Reading

Group 1

Group 2

Steps for Study

- Receive training on process and DOK levels
- Assign DOK to NAEP expectations
- Code NAEP assessment items to NAEP expectations
- Code ACT EXPLORE items to NAEP expectations
- Assign DOK to ACT College Readiness Standards
- Code NAEP assessment items to ACT College Readiness Standards
- Code ACT EXPLORE items to ACT CRS

Specific Criteria

Content Focus

A. Categorical Concurrence

B. Depth-of-Knowledge Consistency

C. Range-of-Knowledge Correspondence

D. Balance of Representation

Depth of Knowledge

Level 1 Recall

Recall of a fact, information, or procedure.

Level 2 Skill/Concept

Use information or conceptual knowledge, two or more steps, etc.

Level 3 Strategic Thinking

Requires reasoning, developing plan or a sequence of steps, some complexity, more than one possible answer.

Level 4 Extended Thinking

Requires an investigation, time to think and process multiple conditions of the problem.

EXAMPLE OF STANDARDS AND DEPTH-OF-KNOWLEDGE LEVELS CONTENT AREA: GEOMETRY

	Mathematics Standard	Depth-of-Knowledge Level
State D Grade 8	**VI. Geometric and Spatial Sense**	
VI.2	Explore transformations of geometric figures.	3
State B Grade 8	**II. Geometry**	
II.4	Graph on a coordinate plane similar figures, reflections, and translations.	2
State A Grade 6	**IV. Geometry and Spatial Sense**	
IV.D.	Investigate and predict the results of transformations of shapes, figures, and models including slides, flips, and turns.	
IV.D.1	Identify and describe the results of translations (slides), reflections (flips), rotations (turns), or glide reflections.	2

EXAMPLE OF STANDARDS AND DEPTH-OF-KNOWLEDGE LEVELS CONTENT AREA: PROBABILITY AND STATISTICS

	Mathematics Standard	Depth-of-Knowledge Level
State D Grade 8	VII. Data Analysis, Probability & Statistics	
VII.3	Formulate, predict, and defend positions taken that are based on data collected.	3
State B Grade 8	VI. Probability and Statistics	
VI.1	Collect data involving 2 variables and display on a scatter plot; interpret results.	3

Which of these means about the same as the word *gauge*?

a. balance

b. measure

c. select

d. warn

A car odometer registered 41,256.9 miles when a highway sign warned of a detour 1,200 feet ahead. What will the odometer read when the car reaches the detour? (5,280 feet = 1 mile)

(a) 42,456.9

(b) 41,279.9

(c) 41,261.3

(d) 41,259.2

(e) 41,257.1

Did you use the calculator on this question?

☐ Yes ☐ No

Which of these conclusions is best supported by information from the passage?

a. If a candidate meets the personal and educational qualifications and is in fair physical shape, his or her chances of becoming an agent are very good.
b. Compared with other law enforcement agencies in the country, the F.B.I. has a low success rate for tracking down and apprehending suspected offenders.
c. The job of an agent is not for everyone; it takes someone with special training who is not afraid of danger and doesn't mind being socially isolated at times.
d. The life of a federal investigator is not as interesting as most people think; agents spend most of their time working at desks.

13

It Is Still A Level 1

Marc Umile poses for a picture in front of a projection of the string of numbers knows as pi in Philadelphia, Friday, March, 2, 2006. Umile is among a group of people fascinated with pi, a number that has been computed to more than a trillion decimal places. He has recited pi to 12,887 digits, perhaps the U.S. record. (AP Photo/Matt Rourke)

Coding Process Tips

- One primary standard/objective/target and up to two secondary standards (if necessary)
- Source of Challenge (a correct/incorrect response for the wrong reason)
- Think of the typical grade 8 student
- Notes (any insights to share)
- Consider full range of standards
- Use generic standard sparingly

Notes

A good note provides sufficient information to decipher the activity:

- The item only targets a small part of the objective—make an ordinary inference using text features.
- Generic standard used because no computation of square root only estimation.

Notes

A poor note states the obvious or repeats what is recorded elsewhere:

- The activity does not have a standard. It matches 4.7.8 student expectation A.
- This activity connects to the standard, loosely.

Notes

- Brief and to the point
- What essential part of the standard does the activity match?
- How does activity relate to typical grade level student?
- Does the activity fit?

Debriefing Questions

A. What major topics or subtopics were only partially covered by assessment items or did not have any corresponding items?

B. In what ways did the performance (DOK levels) required by the assessment items meet or did not meet the full performance as expected by the standards?

C. Compared to other assessments being analyzed, how does this assessment align to the set of standards or expectations?

Edit View Favorites Tools Help

Back Search Favorites Media

dress http://www.wcer.wisc.edu/WAT/index.aspx Go Link

HOME | ABOUT | LOGIN | TUTORIAL | REVIEW | REPORTS | CONTACTS

WAT WEB ALIGNMENT TOOL

Disclaimer:
This material is based upon work supported by the National Science Foundation under contract number EHR 0233445 awarded to the University of Wisconsin-Madison and the Wisconsin Center for Education Research. Any opinions, findings, or conclusions are those of the creator(s) and developers and do not necessarily reflect the views of the supporting agencies.

LOG OUT

Welcome to Web Alignment Tool

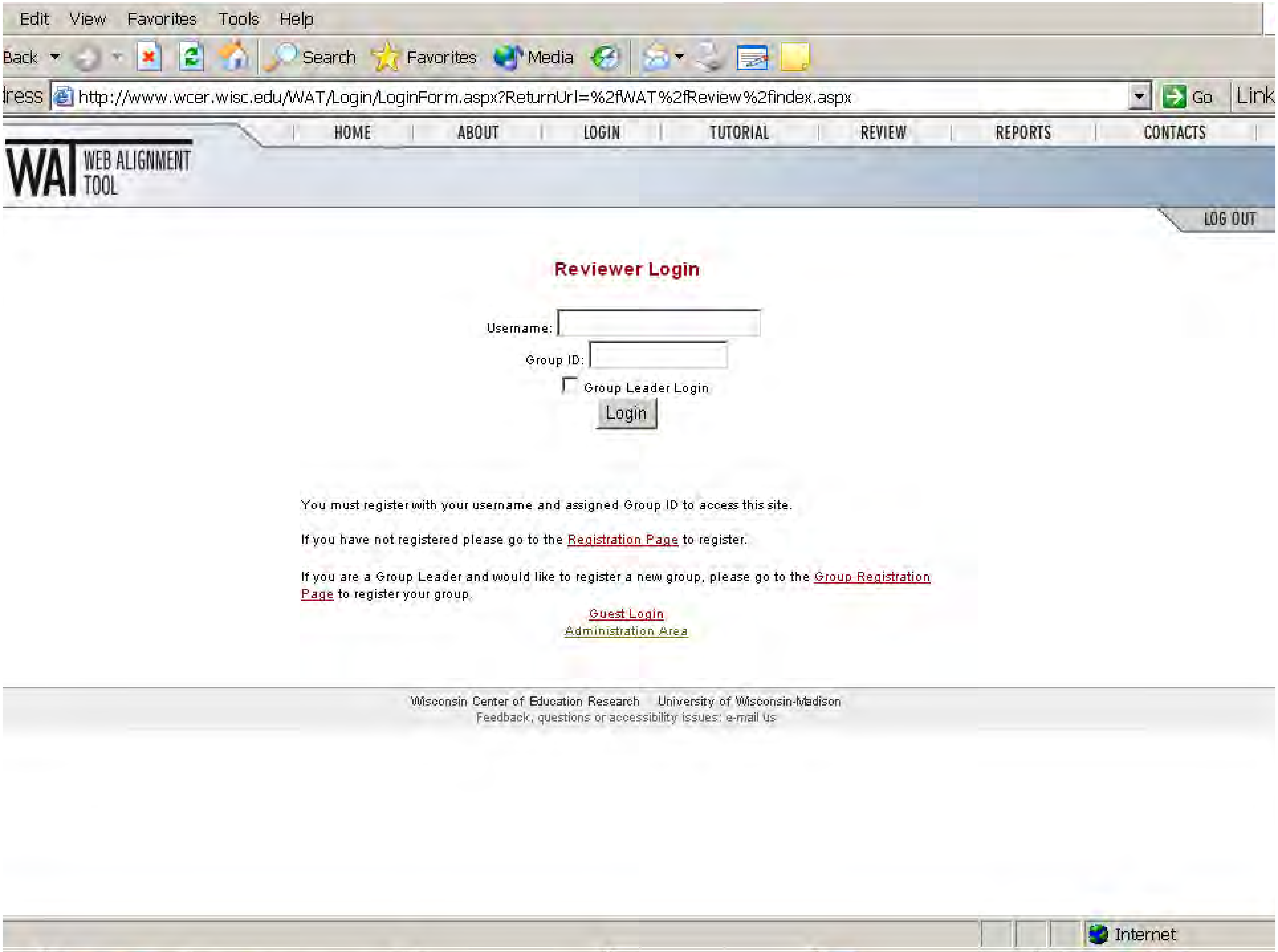
This tool is designed to produce reports on the alignment of curriculum standards and student assessments.

The process requires a group of reviewers first to assign depth-of-knowledge (DOK) levels to standards/objectives (Part I). Then reviewers are to code assessment items by identifying the depth-of-knowledge for each item and the corresponding standard/objective (Part II).

1. The steps in using this tool and the process include
2. Training on DOK levels for content area
3. Logging on
4. Selecting a state, content area, and grade
5. Individually coding DOK for each objective
6. Group reaching consensus on the DOK for each objective
7. Coding independently the DOK for each assessment item and corresponding objective(s)
8. Recording Source of Challenge and Notes

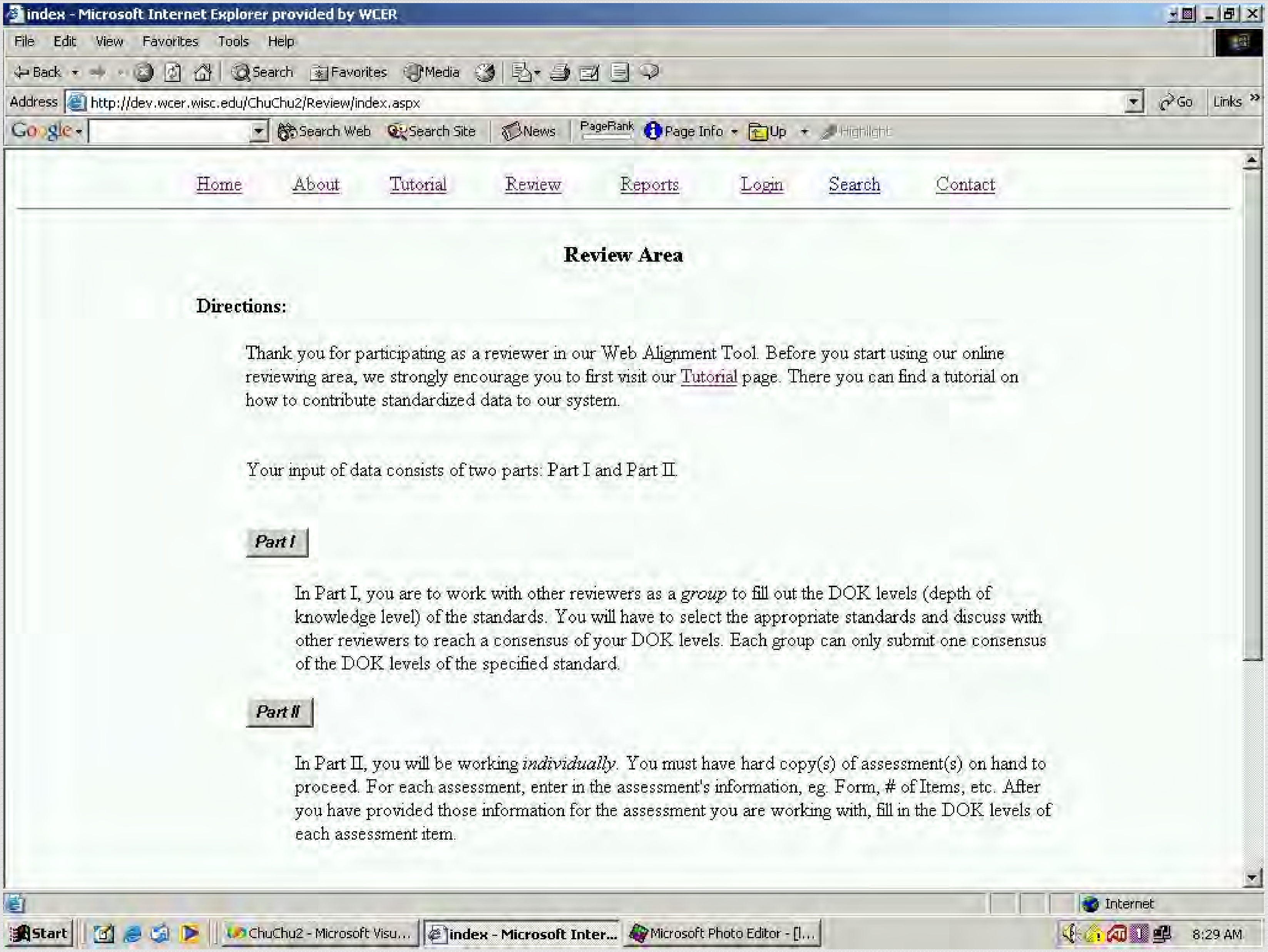
Wisconsin Center of Education Research University of Wisconsin-Madison
Feedback, questions or accessibility issues: e-mail us

Internet



Edit View Favorites Tools Help
Back Search Favorites Media
http://www.wcer.wisc.edu/WAT/Login/LoginForm.aspx?ReturnUrl=%2fWAT%2fReview%2findex.aspx
Go Link
HOME ABOUT LOGIN TUTORIAL REVIEW REPORTS CONTACTS
WAT WEB ALIGNMENT TOOL
LOG OUT
Reviewer Login
Username:
Group ID:
Group Leader Login
Login
You must register with your username and assigned Group ID to access this site.
If you have not registered please go to the Registration Page to register.
If you are a Group Leader and would like to register a new group, please go to the Group Registration Page to register your group.
Guest Login
Administration Area
Wisconsin Center of Education Research University of Wisconsin-Madison
Feedback, questions or accessibility issues: e-mail us
Internet


LoginDetails - Microsoft Internet Explorer provided by WCER
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://dev.wcer.wisc.edu/ChuChu2/Registration/LoginDetails.aspx?User=jdoe
Go Links
Search Web Search Site News PageRank Page Info Up Highlight
site at a later date.
Username: jdoe
Group ID: 9038
Group Title: Wisconsin Science 8th Grade
Group Leaders: You should also have a password associated with the information above.
You can enter a different e-mail address and click the 'Send Email' button below to send yourself a reminder of your login information. This e-mail will only be used this one time only and discarded afterwards.
jdoe@wisc.edu
Group Leaders: You are then to enter the details of the assessments, such as the number of items on the assessment(s) and the form number, that your group will be completing. However if you are unsure of these details at this point, you can later login as a Group Leader and go to the 'Review' tab to perform this part. Please click the 'Continue' button below.
Reviewers: Your registration process is completed. You can now move on to the 'Review' section by clicking 'Continue' below.
Send Email
Continue
Wisconsin Center of Education Research
University of Wisconsin-Madison
Feedback, questions or accessibility issues: e-mail us
Internet
Start
ChuChu2 - Microsoft Visu...
LoginDetails - Microso...
Microsoft Photo Editor - [...
8:27 AM



Review Area

Directions:

Thank you for participating as a reviewer in our Web Alignment Tool. Before you start using our online reviewing area, we strongly encourage you to first visit our Tutorial page. There you can find a tutorial on how to contribute standardized data to our system.

Your input of data consists of two parts: Part I and Part II.

Part I

In Part I, you are to work with other reviewers as a *group* to fill out the DOK levels (depth of knowledge level) of the standards. You will have to select the appropriate standards and discuss with other reviewers to reach a consensus of your DOK levels. Each group can only submit one consensus of the DOK levels of the specified standard.

Part II

In Part II, you will be working *individually*. You must have hard copy(s) of assessment(s) on hand to proceed. For each assessment, enter in the assessment's information, eg. Form, # of Items, etc. After you have provided those information for the assessment you are working with, fill in the DOK levels of each assessment item.

Web Sites

Alignment Tool

http://watv2.wceruw.org

Questions?

Appendix H: Training Materials and Participant Information Packet

Appendix H.1: NAEP CAI Participant Information Packet

Dear Content Alignment Institute (CAI) Participants and Guests,

Welcome!

In order to ensure that the Content Alignment Institute runs smooth and orderly, we have included some information, directions, and maps, along with a few simple instructions that all guests of NORC offices will need to follow. Please review this material prior to your arrival in Bethesda, MD. **If you have any questions, don't hesitate to contact us directly at:**

ContentAlignmentInstitute@norc.org or by phone at **1-866-315-7124**

Hotel and NORC Offices

Panelists and Facilitators will have accommodations for **FIVE NIGHTS** at:

Hilton Garden Inn
7301 Waverly Street
Bethesda, Maryland, 20814
301-654-8111

You are free to use your HHonors rewards number. If you provided this to NORC prior to your travels, we were able to give the number to the Hilton Garden Inn, however we recommend that you confirm upon check-in.

Your hotel room has been pre-paid, however you will be required to provide a credit card for incidentals. Please refer to the reimbursement section of this document for information on what is an allowable expense.

Walking from the Hilton Garden Inn to Bethesda Towers (NORC Office) (10–15 minute walk):

- Coming out of the hotel, take a right heading north on Waverly St. You will cross Montgomery Ave.

- At the intersection of Waverly and East-West Highway, take a right onto East-West Highway and continue walking for a few blocks (you will pass a Starbucks and a construction site).
- 4350 East-West Highway will be on your right, directly across from the Chevy Chase High School.
- **Please note that Facilitators and Panelists can take a reimbursable taxi from the Hilton Garden Inn to the NORC office. If you choose to take a taxi, please keep your receipt for reimbursement.**

Parking at Bethesda Towers (NORC Office) or at the Hilton Garden Inn:

Hotel guests are encouraged to park at the Hilton Garden Inn and walk or take a taxi to the Bethesda Towers (location of the NORC offices). If you are not staying at the hotel and choose to drive to NORC's office, you can park at the Bethesda Towers building.

Driving Directions to 4350 East-West Highway, Bethesda Towers building:

From Northern VA:

- Take I-495 N/ CAPITAL BELTWAY toward ROCKVILLE/ BALTIMORE (Crossing into MARYLAND).
- Take EXIT 33, MD-185 S/CONNECTICUT AVE toward CHEVY CHASE & bear right on ramp.
- At approx. the 4th Traffic Light, Turn RIGHT onto MD-410 W/ EAST-WEST HWY

(The 3 bulleted instructions below are consistent from all routes listed here.)

- Stay in the LEFT lane. East-West Highway (MD-410) becomes One-Way just before the Traffic Light at Chelton Road.
- Go through the Chelton Road intersection and immediately look to the left for the access road. Merge LEFT onto access road.
- The entrance to Bethesda Towers and the Parking Garage will be on your left. (See detailed instructions on next page for Parking at Bethesda Towers and Accessing NORC Offices.")

From Maryland:

- Take I-95 S via the exit on the LEFT toward WASHINGTON,
- Merge onto I-495 W/ CAPITAL BELTWAY via EXIT 27 toward SILVER SPRING
- Merge onto MD-185 S/ CONNECTICUT AVE via EXIT 33,
- Turn RIGHT onto MD-410 W/ EAST-WEST HWY,
- **Follow last 3 bulleted instructions above.**

From Washington DC:

- Start out going west on Constitution Ave. NW/ US-50 toward 16th St. NW
- Turn RIGHT onto 17th St. NW
- 17th St. NW becomes Connecticut Ave NW, Turn slight left to stay on Connecticut Ave.
- Enter next roundabout and take 3rd exit to continue on Connecticut Ave. (Crossing into Maryland)
- Turn LEFT onto MD-410 W/ EAST-WEST HWY.
- **Follow last 3 bulleted instructions above.**

The parking rate at Bethesda Towers (4350 East-West Highway) is approximately $15/day and is payable only by credit card. If you are a CAI participant (Panelists and Facilitators) and you choose to park at Bethesda Towers, **please bring your parking ticket to the meeting for validation: your parking is of no charge to you.**

To access the parking garage (map below):

- Coming from Connecticut Avenue, turn onto East-West Hwy (MD410-West). Stay in the left lane.
- As you approach the one-way section of East-West Hwy you should be able to view the white Bethesda Towers buildings ahead on the left. (We are across the street from Bethesda Chevy-Chase High School).
- As you approach the traffic light at Chelton Rd, drive slowly beyond the light and take the first small access road on the left. You must left-merge onto this road in order access the parking garage for Bethesda Towers. This is easy to miss so stay alert!
    - If you miss the access road, go around the block and try again. Make the next left on Pearl St, then the next left on Montgomery Ave, then the next left back onto East-West Hwy and finally the first left onto the access road.
- Once on the access road, pass the grassy island, turn left and you will see the entrance into the parking garage on the right. Once inside the garage, park your car near the 4350 building entrance.

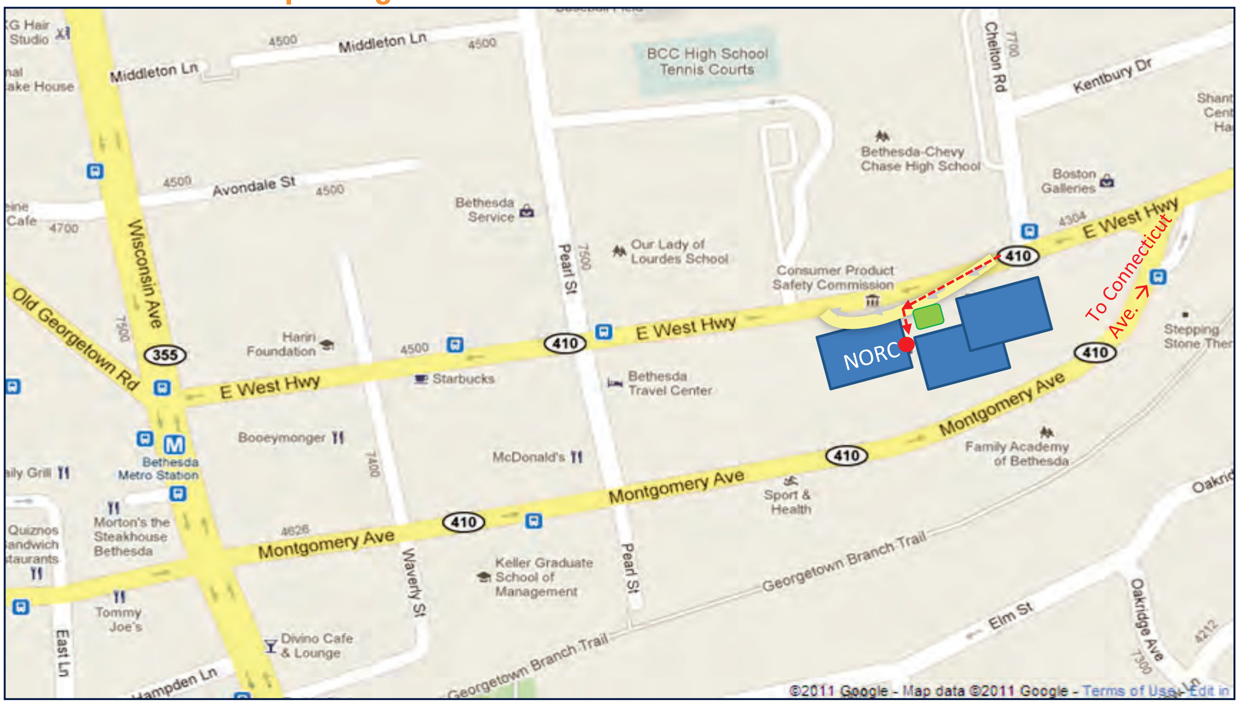
Additionally, please be aware that there are municipal garages with coin operated meters about 2 blocks away that offer hourly/daily parking. The closest garage is Waverly Garage.

Please see the following link for a map of nearby municipal garages and their location:

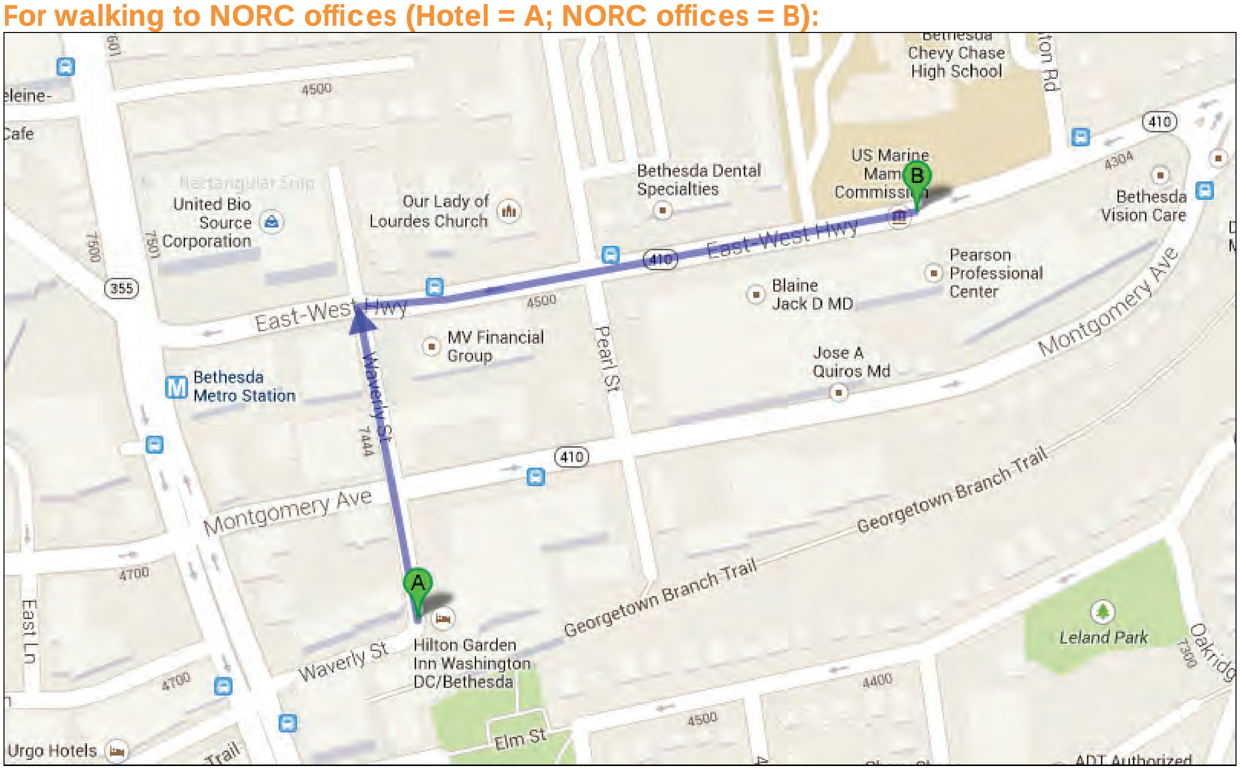
http://www.downtownbethesda.com/guide/community.php?md=98

Maps:

For Bethesda Tower parking:



For walking to NORC offices (Hotel = A; NORC offices = B):



Arrival at NORC Offices

On Monday, February 9, we will begin at 8:00 AM with registration. At 8:30 AM we will start the Institute, so please arrive by 8:00am to ensure timely checking with security.

NORC takes security very seriously. Upon arrival at NORC's office, you will take the elevator to the **8th floor.**

You will be greeted by an NORC staff person, and required to sign in at the reception area. You will then be escorted to **NORC's CAI Check-in room.** This room will serve as your **FIRST** and **LAST** stop during each day of the Institute.

You will be required to show a photo ID each day, and you will sign in and out. You will be provided with a VISITOR'S badge that you MUST wear throughout the entire time you are at NORC's offices.

For security purposes, all guests of NORC must be escorted when not in their respective meeting and break-out rooms. We will have staff available to assist in keying you in and out of areas so that you may visit the rest room, etc.

NORC will be providing an area for you in the event that you need to make or receive personal cell phone calls. Alert a member of the project staff and s/he will escort you to that area.

Securing Your Work Materials and Personal Items

All guests that will be either participating or observing the Institute will be required to sign two Confidentiality Forms upon arrival: One for ACT and one for NAEP. These signed forms will be collected and archived by the project.

At the point of check-in/check-out, NORC will also require that Panelists and Facilitators sign in/out the NORC-provided laptop and other confidential materials that will be used during the Institute. Panelists and Facilitators will be responsible for these items each day. These items will then be locked in a secure location overnight. NORC will also have space for all those attending the CAI to securely store your personal effects (coats, bags, etc.).

Meals

BREAKFAST AND DINNER WILL NOT BE PROVIDED AT THE CAI.
Please ensure that you have eaten prior to arriving at NORC facilities.

Coffee:
Coffee will be served at 8:30 am upon check-in at the NORC's office.

Lunch:

Lunch and a light afternoon snack will be provided.

Instructions for Participants to Submit Request for Honorarium and Reimbursement of Travel Expenses

Honorarium:

NORC will reimburse all expenses related to travel for the *NAEP Content Alignment Institute* in accordance with Federal guidelines. In order to submit for reimbursement you must complete the honorarium payment form requesting your honorarium and for reimbursement of travel-related expenses not already covered by NORC. Please fill out the personal information section only, and enter the total amount of your expenses in the “Expenses” line. In addition, please fill out the IRS Form W-9, which is included in your folder on check-in.

Note that the Honorarium Request form will specify a payment amount for your participation in the meeting. A separate Travel & Expense Reimbursement Form that itemizes and calculates your travel expenses is provided for your convenience

Expense Reimbursement:

Panelist and Facilitator meals may be claimed at full allowable per diems based on the maximum amount allowed per day as listed below. You may also choose to itemize expenses based on actual expenses incurred during travel. If you itemize travel expenses, original receipts documenting actual charges are required to be submitted with your reimbursement request. Note that Lunch ONLY will be served at the Institute.

According to federal regulations, the per diem for daily meals and incidental expenses is $71 for the DC metro area. However, the first and last calendar day of travel is calculated at 75 percent of this total ($53.25). Amounts for any meals provided to you (lunch each day) during your travel should be deducted from your full per diem payment. Please review the chart below for further detail:

Maximum Allowable Per Diem				
M&IE	**Regular Per Diem**	**First Day of Travel**	**Meeting Days Feb 9–12**	**Last Day of Meeting & Travel Feb 13**
Breakfast	$12.00	$9.00	$12.00	$9.00
Lunch	$18.00	$13.50	Provided	Provided
Dinner	$36.00	$27.00	$36.00	$27.00
Incidentals	$5.00	$3.75	$5.00	$3.75
Total	**$71.00**	**$53.25**	**$53.00**	**$39.75**

Ground Transportation and Parking:

Panelists and Facilitators will be reimbursed for their Metro fare or cab fare to and from the airport, as well as parking expenses**. Please keep your transportation receipts**. If participants choose to park onsite at the building housing the NORC offices, please bring your ticket with you and we will validate it during the meeting. (Meeting guests will need to pay for parking using a credit card). If you choose to park at the Hilton Garden Inn, please submit the parking receipt with your travel reimbursement form. Overnight parking at the Hilton is $15.

Mileage Rate:

Effective January 1, 2015, the U.S. GSA mileage reimbursement rate for privately owned vehicles (POVs), non-government automobiles is $ .575 per mile.

Further Travel and Expense Reimbursement Information:

Travel costs for the *NAEP Content Alignment Institute* in Bethesda, MD to be documented include: any transportation costs (airplane, train, taxi, etc.) and additional meals not covered by NORC. The hotel is direct-billed to NORC, but this does not include incidentals. Any receipts provided as supporting documentation of your expenses should specify method of payment (i.e., cash, credit card, etc.)

In accordance with IRS regulations, we will need to receive reimbursement requests within 30 days of the meeting dates. We will provide a stamped envelope for you to submit your completed reimbursement form, but you may alternatively send your reimbursement materials to:

Attention: Irma Wirawan
NORC at the University of Chicago
1155 E. 60th St.
Chicago IL 60637

Please contact Isabel Guzman-Barron at guzman-isabel@norc.org or 312-759-4268 with questions about the reimbursement process.

Substitute Reimbursement

If your school district or agency is requesting reimbursement for the cost of a substitute for the five days when you are at the Institute, please have your district or agency send an invoice or reimbursement request for the total amount of substitute costs along with a completed IRS Form W-9 to:

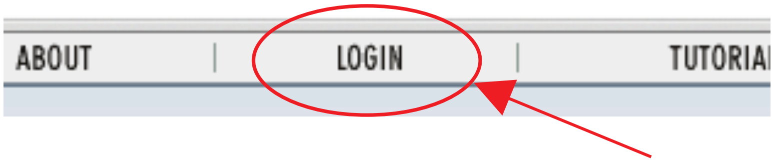
Rolf Blank, Project Director
Via email: blank-rolf@norc.org
Or mail: NORC at the University of Chicago
4350 East-West Highway, Suite 800
Bethesda, MD 20814-4499
301-634-9325

Appendix H.2: Instructions for Logging Into the WATv2 Tool

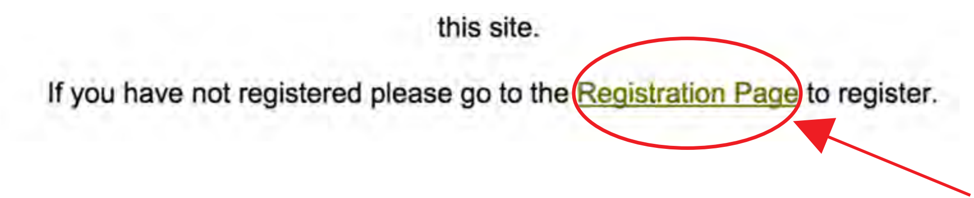
Logging in to the WATv2

1. Go to http://watv2.wceruw.org/

2. Click on the "LOGIN" button on the top navigation bar.



3. To register, click on the Registration Page link near the middle of the page.



4. Enter your **group ID**. The ID numbers for each group are listed below:

		Group Leader*	Group ID
Mathematics	Group 1	[redacted]	86
	Group 2	[redacted]	87
Reading	Group 1	[redacted]	88
	Group 2	[redacted]	89

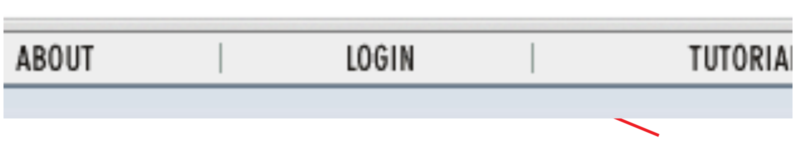
5. Click Submit

6. Confirm that you are in the correct group. Then click Continue

7. Complete the questions as best you can. Your password will be sent to the email you enter. If this feature doesn't work, be sure to write down your username and just click to continue.

YOUR USERNAME:

8. Return to the login page, using the login button at the top of the screen, if needed.



9. Enter your username and group ID. Click Login .

*Some areas of this document have been redacted for confidentiality requirements.

Appendix H.3: ACT College Readiness Standards Mathematics 2008 Coding Sheets

ACT College Readiness Standards Mathematics 2008 Coding Sheets

ACT College Readiness Standards Mathematics 2008

Level	*Description*	*DOK*
BOA	Basic Operations & Applications	
BOA 201	Perform one-operation computation with whole numbers and decimals	
BOA 202	Solve problems in one or two steps using whole numbers	
BOA 203	Perform common conversions (e.g., inches to feet or hours to minutes)	
BOA 301	Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent	
BOA 302	Solve some routine two-step arithmetic problems	
BOA 401	Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportions, tax added, percentage off, computing with a given average	
BOA 501	Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour)	
PSD	PSD Probability, Statistics, & Data Analysis	
PSD 201	Calculate the average of a list of positive whole numbers	
PSD 202	Perform a single computation using information from a table or chart	
PSD 301	Calculate the average of a list of numbers	
PSD 302	Calculate the average, given the number of data values and the sum of the data values	
PSD 303	Read tables and graphs	
PSD 304	Perform computations on data from tables and graphs	
PSD 305	Use the relationship between the probability of an event and the probability of its complement	
PSD 401	Calculate the missing data value, given the average and all data values but one	
PSD 402	Translate from one representation of data to another (e.g., a bar graph to a circle graph)	
PSD 403	Determine the probability of a simple event	
PSD 501	Calculate the average, given the frequency counts of all the data values	
PSD 502	Manipulate data from tables and graphs	
PSD 503	Compute straightforward probabilities for common situations	

Level	***Description***	***DOK***
NCP	NCP Numbers: Concepts & Properties	
NCP 201	Recognize equivalent fractions and fractions in lowest terms	
NCP 301	Recognize one-digit factors of a number	
NCP 302	Identify a digit's place value	
NCP 401	Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor	
NCP 501	Find and use the least common multiple	
NCP 502	Order fractions	
NCP 503	Work with numerical factors	
NCP 504	Work with scientific notation	
NCP 505	Work with squares and square roots of numbers	
XEI	Expressions, Equations, & Inequalities	
XEI 201	Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g)	
XEI 202	Solve equations in the form x + a = b, where a and b are whole numbers or decimals	
XEI 301	Substitute whole numbers for unknown quantities to evaluate expressions	
XEI 302	Solve one-step equations having integer or decimal answers	
XEI 303	Combine like terms (e.g., 2x + 5x)	
XEI 401	Evaluate algebraic expressions by substituting integers for unknown quantities	
XEI 402	Add and subtract simple algebraic expressions	
XEI 403	Solve routine first-degree equations	
XEI 404	Perform straightforward word-to-symbol translations	
XEI 501	Solve real-world problems using first-degree equations	
XEI 502	Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions)	
XEI 503	Identify solutions to simple quadratic equations	
GRE	Graphical Representation	
GRE 201	Identify the location of a point with a positive coordinate on the number line	
GRE 301	Locate points on the number line and in the first quadrant	
GRE 401	Locate points in the coordinate plane	

Level	***Description***	***DOK***
PPF 301	Exhibit some knowledge of the angles associated with parallel lines	
PPF 401	Find the measure of an angle using properties of parallel lines	
PPF 402	Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°)	
PPF 501	Use several angle properties to find an unknown angle measure	
MEA	Measurement	
MEA 201	Estimate or calculate the length of a line segment based on other lengths given on a geometric figure	
MEA 301	Compute the perimeter of polygons when all side lengths are given	
MEA 302	Compute the area of rectangles when whole number dimensions are given	
MEA 401	Compute the area and perimeter of triangles and rectangles in simple problems	
MEA 402	Use geometric formulas when all necessary information is given	
MEA 501	Compute the area of triangles and rectangles when one or more additional simple steps are required	
MEA 502	Compute the area and circumference of circles after identifying necessary information	

Appendix H.4: NAEP 2013 Grade 8 Mathematics Coding Sheets

NAEP 2013 Grade 8 Mathematics Coding Sheets

Date: __________ Group Number: ____________ Panelist Name: ________________________________

NAEP 2013 Grade 8 Mathematics

Level	*Description*	*DOK*
I.	Number Properties & Operations	
I.1	Number Sense	
I.1.a	Use place value to model and describe integers and decimals.	
I.1.b	Model or describe rational numbers or numerical relationships using number lines and diagrams.	
I.1.d	Write or rename rational numbers.	
I.1.e	Recognize, translate or apply multiple representations of rational numbers (fractions, decimals, and percents) in meaningful contexts.	
I.1.f	Express or interpret numbers using scientific notation from real-life contexts.	
I.1.g	Find or model absolute value or apply to problem situations.	
I.1.h	Order or compare rational numbers (fractions, decimals, percents, or integers) using various models and representations (e.g., number line).	
I.1.i	Order or compare rational numbers including very large and small integers, and decimals and fractions close to zero.	
I.2	Estimation	
I.2.a	Establish or apply benchmarks for rational numbers and common irrational numbers (e.g., π) in contexts.	
I.2.b	Make estimates appropriate to a given situation by: a) Identifying when estimation is appropriate; b) determining the level of accuracy needed; c) Selecting the appropriate method of estimation; or d) Analyzing the effect of an estimation method on the accuracy of results.	
I.2.c	Verify solutions or determine the reasonableness of results in a variety of situations, including calculator and computer results.	
I.2.d	Estimate square or cube roots of numbers less than 1,000 between two whole numbers.	

Level	Description	DOK
I.3	Number operations	
I.3.a	Perform computations with rational numbers.	
1.3.d	Describe the effect of multiplying and dividing by numbers including the effect of multiplying or dividing a rational number by: a) Zero; or b) A number less than zero; or c) A number between zero and one; or d) One; or e) A number greater than one.	
I.3.e	Interpret rational number operations and the relationships between them.	
I.3.f	Solve application problems involving rational numbers and operations using exact answers or estimates as appropriate.	
I.4	Ratios and proportional reasoning	
I.4.a	Use ratios to describe problem situations.	
I.4.b	Use fractions to represent and express ratios and proportions.	
I.4.c	Use proportional reasoning to model and solve problems (including rates and scaling).	
I.4.d	Solve problems involving percentages (including percent increase and decrease, interest rates, tax, discount, tips, or part/whole relationships).	
I.5	Properties of number and operations	
I.5.a	Describe odd and even integers and how they behave under different operations.	
I.5.b	Recognize, find, or use factors, multiples, or prime factorization.	
I.5.c	Recognize or use prime and composite numbers to solve problems.	
I.5.d	Use divisibility or remainders in problem settings.	
I.5.e	Apply basic properties of operations.	
I.6	Mathematical reasoning using numbers	
I.6.a	Explain or justify a mathematical concept or relationship (e.g., explain why 17 is prime).	
I.6.b	Provide a mathematical argument to explain operations with two or more fractions.	

Level	***Description***	***DOK***
II	Measurement	
II.1	Measuring physical attributes	
II.1.b	Compare objects with respect to length, area, volume, angle measurement, weight, or mass.	
II.1.c	Estimate the size of an object with respect to a given measurement attribute (e.g., area).	
II.1.e	Select or use appropriate measurement instrument to determine or create a given length, area, volume, angle, weight, or mass.	
II.1.f	Solve mathematical or real-world problems involving perimeter or area of plane figures such as triangles, rectangles, circles, or composite figures.	
II.1.h	Solve problems involving volume or surface area of rectangular solids, cylinders, prisms, or composite shapes.	
II.1.i	Solve problems involving rates such as speed or population density.	
II.2	Systems of measurement	
II.2.a	Select or use an appropriate type of unit for the attribute being measured such as length, area, angle, time, or volume.	
II.2.b	Solve problems involving conversions within the same measurement system such as conversions involving square inches and square feet.	
II.2.c	Estimate the measure of an object in one system given the measure of that object in another system and the approximate conversion factor. For example: Distance conversion: 1 kilometer is approximately 5/8 of a mile; Money conversion: U.S. dollars to Canadian dollars; Temperature conversion: Fahrenheit to Celsius.	
II.2.d	Determine appropriate size of unit of measurement in problem situation involving such attributes as length, area, or volume.	
II.2.e	Determine appropriate accuracy of measurement in problem situations (e.g., the accuracy of each of several lengths needed to obtain a specified accuracy of a total length) and find the measure to that degree of accuracy.	
II.2.f	Construct or solve problems (e.g., floor area of a room) involving scale drawings.	
II.3	Measurement of triangles	
II.3.a	Solve problems involving indirect measurement such as finding the height of a building by comparing its shadow with the height and shadow of a known object.	

Level	***Description***	***DOK***
III	Geometry	
III.1	Dimension and shapes	
III.1.a	Draw or describe a path of shortest length between points to solve problems in context.	
III.1.b	Identify a geometric object given a written description of its properties.	
III.1.c	Identify, define, or describe geometric shapes in the plane and in three-dimensional space given a visual representation.	
III.1.d	Draw or sketch from a written description polygons, circles, or semicircles.	
III.1.e	Represent or describe a three-dimensional situation in a two-dimensional drawing from different views.	
III.1.f	Demonstrate an understanding about the two- and three-dimensional shapes in our world through identifying, drawing, modeling, building, or taking apart.	
III.2	Transformation of shapes and preservation of properties	
III.2.a	Identify lines of symmetry in plane figures or recognize and classify types of symmetries of plane figures.	
III.2.c	Recognize or informally describe the effect of a transformation on two-dimensional geometric shapes (reflections across lines of symmetry, rotations, translations, magnifications, and contractions).	
III.2.d	Predict results of combining, subdividing, and changing shapes of plane figures and solids (e.g., paper folding, tiling, cutting up and rearranging pieces).	
III.2.e	Justify relationships of congruence and similarity and apply these relationships using scaling and proportional reasoning.	
III.2.f	For similar figures, identify and use the relationships of conservation of angle and of proportionality of side length and perimeter.	

Level	***Description***	***DOK***
III.3	Relationships between geometric figures	
III.3.b	Apply geometric properties and relationships in solving simple problems in two and three dimensions.	
III.3.c	Represent problem situations with simple geometric models to solve mathematical or real-world problems.	
III.3.d	Use the Pythagorean theorem to solve problems.	
III.3.f	Describe or analyze simple properties of, or relationships between, triangles, quadrilaterals, and other polygonal plane figures.	
III.3.g	Describe or analyze properties and relationships of parallel or intersecting lines.	
III.4	Position, direction, and coordinate geometry	
III.4.a	Describe relative positions of points and lines using the geometric ideas of midpoint, points on common line through a common point, parallelism, or perpendicularity.	
III.4.b	Describe the intersection of two or more geometric figures in the plane (e.g., intersection of a circle and a line).	
III.4.c	Visualize or describe the cross section of a solid.	
III.4.d	Represent geometric figures using rectangular coordinates on a plane.	
III.5	Mathematical reasoning in geometry	
III.5.a	Make and test a geometric conjecture about regular polygons.	
IV	Data analysis, statistics, and probability	
IV.1	Data representation The following representations of data are indicated for each grade level. Objectives in which only a subset of these representations is applicable are indicated in the parenthesis associated with the objective. Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.	
IV.1.a	Read or interpret data, including interpolating or extrapolating from data.	
IV.1.b	For a given set of data, complete a graph and then solve a problem using the data in the graph (histograms, line graphs, scatterplots, circle graphs, and bar graphs).	
IV.1.c	Solve problems by estimating and computing with data from a single set or across sets of data.	
IV.1.d	Given a graph or a set of data, determine whether information is represented effectively and appropriately (histograms, line graphs, scatterplots, circle graphs, and bar graphs).	
IV.1.e	Compare and contrast the effectiveness of different representations of the same data.	

Level	***Description***	***DOK***
IV.2	Characteristics of data sets	
IV.2.a	Calculate, use, or interpret mean, median, mode, or range.	
IV.2.b	Describe how mean, median, mode, range, or interquartile ranges relate to distribution shape.	
IV.2.c	Identify outliers and determine their effect on mean, median, mode, or range.	
IV.2.d	Using appropriate statistical measures, compare two or more data sets describing the same characteristic for two different populations or subsets of the same population.	
IV.2.e	Visually choose the line that best fits given a scatterplot and informally explain the meaning of the line. Use the line to make predictions.	
IV.3	Experiments and samples	
IV.3.a	Given a sample, identify possible sources of bias in sampling.	
IV.3.b	Distinguish between a random and nonrandom sample.	
IV.3.d	Evaluate the design of an experiment.	
IV.4	Probability	
IV.4.a	Analyze a situation that involves probability of an independent event.	
IV.4.b	Determine the theoretical probability of simple and compound events in familiar contexts.	
IV.4.c	Estimate the probability of simple and compound events through experimentation or simulation.	
IV.4.d	Use theoretical probability to evaluate or predict experimental outcomes.	
IV.4.e	Determine the sample space for a given situation.	
IV.4.f	Use a sample space to determine the probability of possible outcomes for an event.	
IV.4.g	Represent the probability of a given outcome using fractions, decimals, and percents.	
IV.4.h	Determine the probability of independent and dependent events. (Dependent events should be limited to a small sample size.)	
IV.4.J	Interpret probabilities within a given context.	

Level	***Description***	***DOK***
V	Algebra	
V.1	Patterns, relations, and functions	
V.1.a	Recognize, describe, or extend numerical and geometric patterns using tables, graphs, words, or symbols.	
V.1.b	Generalize a pattern appearing in a numerical sequence, table, or graph using words or symbols.	
V.1.c	Analyze or create patterns, sequences, or linear functions given a rule.	
V.1.e	Identify functions as linear or nonlinear or contrast distinguishing properties of functions from tables, graphs, or equations.	
V.1.f	Interpret the meaning of slope or intercepts in linear functions.	
V.2	Algebraic representations	
V.2.a	Translate between different representations of linear expressions using symbols, graphs, tables, diagrams, or written descriptions.	
V.2.b	Analyze or interpret linear relationships expressed in symbols, graphs, tables, diagrams, or written descriptions.	
V.2.c	Graph or interpret points represented by ordered pairs of numbers on a rectangular coordinate system.	
V.2.d	Solve problems involving coordinate pairs on the rectangular coordinate system.	
V.2.f	Identify or represent functional relationships in meaningful contexts including proportional, linear, and common nonlinear (e.g., compound interest, bacterial growth) in tables, graphs, words, or symbols.	
V.3	Variables, expressions, and operations	
V.3.b	Write algebraic expressions, equations, or inequalities to represent a situation.	
V.3.c	Perform basic operations, using appropriate tools, on linear algebraic expressions (including grouping and order of multiple operations involving basic operations, exponents, roots, simplifying, and expanding).	

Level	***Description***	***DOK***
V.4	Equations and inequalities	
V.4.a	Solve linear equations or inequalities (e.g., ax + b = c or ax + b = cx + d or ax + b > c).	
V.4.b	Interpret “=” as an equivalence between two expressions and use this interpretation to solve problems.	
V.4.c	Analyze situations or solve problems using linear equations and inequalities with rational coefficients symbolically or graphically (e.g., ax + b = c or ax + b = cx + d).	
V.4.d	Interpret relationships between symbolic linear expressions and graphs of lines by identifying and computing slope and intercepts (e.g., know in y = ax + b, that a is the rate of change and b is the vertical intercept of the graph).	
V.4.e	Use and evaluate common formulas (e.g., relationship between a circle’s circumference and diameter [C = pi d], distance and time under constant speed).	
V.5	Mathematical reasoning in algebra	
V.5.a	Make, validate, and justify conclusions and generalizations about linear relationships.	

Appendix H.5: Mathematics Decision Rules

Mathematics Decision Rules

NAEP 2013 Grade 8 and ACT EXPLORE Study

February 9-13, 2015

1. When multiple performance levels are listed, base the DOK assignment on the most central performance.
2. If the standard/framework states the performance is described as "routine" or "straightforward" in most instances it will be at a DOK level one.
3. Assign the DOK based on what is explicitly stated in the standard/framework and not on what might or could be included.
4. When coding assessment items, read all distractors as they may affect the DOK of the item; and read the rubrics for open-ended items as they may affect the DOK of the item.
5. When coding assessment items and a specific topic and/or performance is not included in a set of standards, code it one level up to the topic heading (the generic standard) and add a note. For example, when coding NAEP assessment items on coordinate geometry to ACT standards, code them to the generic GRE—Graphical Representation with a note saying the items assess coordinate geometry.
6. When coding ACT Standards to assessment items, follow these guidelines:

Probability, Statistics, & Data Analysis

- Use PSD 201 if there is a list given and it includes only positive whole numbers.
- Use PSD 301 if there is a list given and it includes decimals.
- Use PSD 302 if the number of values and the sum of the values are given but there is not a list of values.
- Use PSD 202 if there is only one computation required.
- Use PSD 304 if multiple computations are required.

Expressions, Equations, & Inequalities

- Use XEI 202 when the equation is given and is in the form stated in the standard and there is no context.
- Use XEI 403 when the equation involved is beyond the form X + A = B [e.g., AX + B = CX + D; or AX + BX = C]; uses integers or decimals or fractions; or when solving literal equations.
- Use XEI 303 when the expressions are limited to one variable.
- Use XEI 402 when the expressions include multiple variables.

Measurement

- Use MEA 401 when there is a context or problem situation, not just a picture.

Appendix H.6: Mathematics Depth of Knowledge (DOK) Definitions

Mathematics Depth of Knowledge (DOK) Definitions

DOK 1 (Recall)

DOK 1 is defined by the rote recall of information or performance of a simple, routine procedure. For example, repeating a memorized fact, definition, or term, performing a simple algorithm, rounding a number, or applying a formula are DOK 1 performances.

Performing a one-step computation or operation, executing a well-defined multi-step procedure or a direct computational algorithm are also included in this category. Examples of well-defined multi-step procedures include finding the mean or median or performing long division. Reading information directly from a graph, plugging data into an electronic device to derive an answer, or simple paraphrasing are all tasks that are considered a level of complexity comparable to recall. A student answering a DOK 1 item either knows the answer or does not: that is, the item does not need to be "figured out" or "solved."

At a DOK 1, problems in context are straightforward and the solution path is obvious. For example, the problem may contain a keyword that indicates the operation needed. Other DOK 1 examples include plotting points on a coordinate system, using coordinates with the distance formula, or drawing lines of symmetry of geometric figures.

At more advanced levels of mathematics, symbol manipulation and solving a quadratic equation or a system of two linear equations with two unknowns are considered comparable to recall assuming students are expected or likely to use well-known procedures (e.g. factoring, completing the square, substitution, or elimination) to derive a solution. Operating on polynomials or radicals, using the laws of exponents, or simplifying rational expressions are considered rote procedures.

Verbs should not be classified as any level without considering what the verb is acting upon or the verb's direct object. "*Identify* attributes of a polygon" is recall, but "*identify* the rate of change for an exponential function" requires a more complex analysis. To *describe* by listing the steps used to solve a problem is recall (i.e, *Show your work*) whereas to *describe* by providing a mathematical argument or rationale for a solution is more complex.

Webb, N. L. *Alignment study in language arts, mathematics, science, and social studies of state standards and assessments for four states*. A study of the State Collaborative on Assessment & Student Standards (SCASS) Technical Issues in Large-Scale Assessment (TILSA). Washington, D. C.: Council of Chief State School Officers, December 2002. Revised in 2014 by Norman Webb, Sara Christopherson with the help of Lynn Raith.

DOK 2 (Skill/Concept)

DOK 2 involves engaging in some mental processing beyond a habitual response as well as decision-making about how to approach the problem or activity. This category can require conceptual understanding and/or demonstrating conceptual knowledge by explaining thinking in terms of concepts.

DOK 2 tasks includes distinguishing among mathematical ideas, processing information about the underlying structure, drawing relationships among ideas, deciding among and performing appropriate skills, applying properties or conventions within a relevant and necessary context, transforming among different representations, interpreting and solving problems and/or graphs. When given a problem statement, formulating an equation or inequality, deriving a solution, and reporting the solution in the context of the problem fit within DOK 2. Processes such as classifying, organizing, and estimating that involve attending to multiple attributes, features, or properties also fall into this level.

Verifying that the number of objects in one set is larger or fewer than the number of objects in a second set by matching pairs or forming equivalent groups is a DOK 2 activity for a kindergartener. A first grader modeling a joining or separating situation pictorially or physically also is at this level.

Skills and concepts include constructing a graph and interpreting the meaning of critical features of a function, beyond just identifying or finding such features as well as describing the effects of parameter changes. Note, however, that using a well-defined procedure to find features of a standard function, such as the slope of a linear function with one variable or a quadratic, is a DOK 1. Graphing higher order or irregular functions is a DOK 2. Basic computation, as well as converting between different units of measurement, are generally a DOK 1, but illustrating a computation by different representations (e.g. equations and a base-ten model) to explain the results is a DOK 2. Computing measures of central tendency (applying set procedures) is a DOK 1, but interpreting such measures for a data set within its context or using measures to compare multiple data sets is a DOK 2. Performing original formal proofs is beyond DOK 2, but explaining in one’s own words the reasons for an action or application of a property is comparable to a DOK 2. Activities at a DOK 2 are not limited only to number skills, but may involve visualization skills (e.g. mentally rotating a 3D figure or transforming a figure) and probability skills requiring more than simple counting (e.g. determining a sample space or probability of a compound event). Other activities at this category include detecting or describing non-trivial patterns, explaining the purpose and use of experimental procedures, and carrying out experimental procedures.

DOK 3 (Strategic Thinking)

DOK 3 requires reasoning and analyzing using mathematical principles, ideas, structure, and practices. DOK 3 includes solving involved problems; conjecturing; creating novel solutions and forms of representation; devising original proofs, mathematical arguments, and critiques of arguments; constructing mathematical models; and forming robust inferences and predictions. Although DOK 2 also involves some problem solving, DOK 3 includes situations that are non-routine, more demanding, more abstract, and more complex than DOK 2. Such activities are characterized by producing sound and valid mathematical arguments when solving problems, verifying answers, developing a proof, or drawing inferences. Note that the sophistication of a mathematical argument that would be considered DOK 3 depends on the prior knowledge and experiences of the person. For example, primary school student arguments for number problems can be a DOK 3 activity (e.g. counting number of combinations, finding shortest route from home to school, computing with large numbers) as can abstract reasoning in developing a logical argument by students in higher grades. DOK 3 problems are those for which it is not evident from the first reading what is needed to derive a solution and so require demanding reasoning to work through. Such problems usually can be solved in different ways and may even have more than one correct solution based on different stated assumptions. Paraphrasing in one's own words or reproducing a proof that was previously demonstrated is a DOK 2. Applying properties and producing arguments in proving a theorem or identity not previously seen is a DOK 3. Also in the DOK 3 category is making sense of the mathematics in a situation, creating a mathematical model of a situation considering contextual constraints, deriving a new formula, designing and conducting an experiment, and interpreting findings.

DOK 4 (Extended Thinking)

DOK 4 demands are at least as complex as those of DOK 3, but a main factor that distinguishes the two categories is the need to perform activities over days and weeks (DOK 4) rather than in one sitting (DOK 3). The extended time that accompanies this type of activity allows for creation of original work and requires metacognitive awareness that typically increases the complexity of a DOK 4 task overall, in comparison with DOK 3 activities. Category 4 activities require complex reasoning, planning, research, and verification of work. Conducting a research project, performance activity, an experiment, and a design project as well as creating a new theorem and proof fit under Category 4. The extended time period is not a distinguishing factor if the required work is only repetitive and does not require applying significant conceptual understanding and higher-order thinking. For example, collecting water temperature from a river each day for a month and then reporting the findings by constructing a graph is a DOK 2 activity. Developing a mathematical model of the flow of water in a river for all four seasons using a number of variables would be a DOK 4 activity. It is likely that a DOK 4 activity will require making connections among a number of ideas or variables within the area of mathematics or among a number of content areas. Category 4 activities require selecting an appropriate approach among many alternatives to produce a product, conclusion, or finding, such as critiquing a body of work, synthesizing ideas in a new way, or creating an original model.

Appendix H.7: Mathematics DOK Definitions Level

Mathematics DOK Definitions Level

Subject	Depth of Knowledge			
	Level 1	**Level 2**	**Level 3**	**Level 4**
Mathematics	Requires students to recall or observe facts, definitions, or terms. Involves simple one-step procedures. Involves computing simple algorithms (e.g., sum, quotient). Examples: ■ Recall or recognize a fact, term or property ■ Represent in words, pictures or symbols in a math object or relationship ■ Perform routine procedure like measuring	Requires students to make decisions of how to approach a problem. Requires students to compare, classify, organize, estimate or order data. Typically involves two-step procedures. Examples: ■ Specify and explain relationships between facts, terms, properties or operations ■ Select procedure according to criteria and perform it ■ Solve routine multiple-step problems	Requires reasoning, planning or use of evidence to solve problem or algorithm. May involve activity with more than one possible answer. Requires conjecture or restructuring of problems. Involves drawing conclusions from observations, citing evidence and developing logical arguments for concepts. Uses concepts to solve non-routine problems. Examples: ■ Analyze similarities and differences between procedures ■ Formulate original problem given situation ■ Formulate mathematical model for complex situation	Requires complex reasoning, planning, developing and thinking. Typically requires extended time to complete problem, but time spent not on repetitive tasks. Requires students to make several connections and apply one approach among many to solve the problem. Involves complex restructuring of data, establishing and evaluating criteria to solve problems. Examples: ■ Apply mathematical model to illuminate a problem, situation ■ Conduct a project that specifies a problem, identifies solution paths, solves the problem, and reports results ■ Design a mathematical model to inform and solve a practical or abstract situation

Appendix H.8: Facilitator Instructions

Facilitator Instructions*

NAEP and ACT EXPLORE Content Alignment Study

February 9-13, 2015 | By Norman Webb

The NAEP-ACT EXPLORE study is a little different from the typical content alignment study. In analyzing the 2013 grade 8 NAEP assessments and the ACT EXPLORE, we will be doing an assessment to an assessment study as compared to analyzing curriculum standards with an assessment. In order to make a comparison between the two assessments, the design requires mapping each assessment to the standards or expectations used by NAEP and used by ACT. The degree of alignment between the two assessments will be determined by inferring from the data how the two assessments compare to the NAEP grade 8 standards and objectives and how the two assessments compare to the ACT College Readiness Standards (CRS).

Another difference with the design of this study is there will be two groups for each content area. The groups are to code the data independently so there will be a measure of consistency in coding. This will assure the findings are more reliable. In order for this to work, it is important that the process followed by each group be consistent. That is, one facilitator should not make arbitrary decisions or come up with decision rules for his or her group during the coding process. The design does allow for adjudication of the data within and between groups. The two facilitators for a content area should review the two frameworks prior to the study and come to agreement on how to code statements with possible ambiguity. This has to be done before the institute so these decisions can be incorporated in the training.

A third difference in this study is your role which is to facilitate the group process and not to code the data yourself. You need to monitor the progress of each panelists and help to be sure the panelists are keeping pace with the others. You should also look at data on the WATv2 to identify when and what adjudication will be needed. I will also be doing this and will keep in communication with all of you during the institute. The five of us will meet at the end of each day to review the progress made and to address any issues that may arise.

Pre-institute

1. I will send each of you a framework comparison paper that was done for the study. In this paper Raven McCrory (Michigan State) for mathematics and Karen Wixson (Univ of NC Charlotte) for reading conducted the analysis. In each report there is a side-by-side chart that compares and contrasts the NAEP framework with the ACT College Readiness Standards. I will also send you the coding sheets that will be used, one listing the NAEP expectations and one listing the ACT CRS expectations. You should read this report to understand some of the background of each of the frameworks. You should also look for issues that may arise because a standard or expectation in one framework uses different

wording that in the other framework or does not explicitly include a topic, or any other issue that made cause panelists to code an item to one standard rather than another.

2. At least one week before the institute and after reading the framework paper, talk with your partner facilitator and decide between the two of you how specific issues should be addressed by reviewers and what should be included in the training of the panelists. For example, the ACT CRS does not include standards addressing coordinate geometry. You should be clear with each other that a coordinate geometry item on the NAEP assessment would be coded to the generic standard of "Graphical Representation" (GRE). In reading, NAEP has expectations that students make complex inferences across texts whereas the ACT CRS only includes a single text. A NAEP item that requires students to make inferences from more than one text then would need to be coded under the ACT CRS as a standard under "Generalization and Conclusions" (GEN) with a note that the item included two passages.

3. [redacted] will lead the training for reading and [redacted] will lead the training for mathematics. Please be aware of the time limits we have for training. You will need to set a priority of what is the most important part of the process to include in the training. Panelists should be well versed in the DOK definitions and have an understanding of certain decision rules. You will be able to discuss in more detail specific decision rules when the panelists assign DOK levels to the frameworks.

4. You also will be sent a copy of the agenda. Please make note of the time schedule and what needs to be completed by a specific day and time. We need to keep to the schedule in order to get the planned steps completed in the five days.

5. You need to read the DOK definitions. These have been revised from our last alignment study and hopefully will help clarify points of differences in the past. You need to be well versed in the new version of the definitions.

During the Institute

6. I will provide a general training on the process (about 30 minutes). I will just cover the general design of the study and a basic description of the DOK levels.

7. You will have from 10:45 to 12:45 on Monday morning to train the panelists on the DOK levels, general decision rules you have prepared, and the use/login of the WATv2. This will be one of the few times that the two groups for a content area will work together. You need to work with your partner to determine how you will divide the work between the two facilitators for the training. The purpose of this training with the combined groups is to have a common understanding of the DOK definitions and decision rules by all of the panelists for a content area.

There will be enough time for panelists to have a workable knowledge of DOK levels. As noted in 3 above, you need to prepare your training to fit the time available and to use the time efficiently. This does not mean you should read the DOK definitions to the panelists. You need to have the panelists read the definitions and then you need to quiz them on major points and differences among the levels.

8. By 1:30 PM on Monday, every panelists should have a general understanding of the DOK levels and the process. They should also be logged on to the WATv2.

9. For assigning DOK levels to the NAEP framework, the two groups will work independently. Have each panelist log on to the WATv2 and Part I to enter a DOK level for each of the objectives listed in the NAEP grade 8 framework. You can check on their progress and identify objectives with any variation among the eight panelists. If only one or two panelists differ from the others, then ask for a reason for each and without a compelling difference take the majority value and move on. Only discuss in great detail (within reason) when three or more levels have been assigned to one objective or when the panelists are split between two DOK levels (4-4 or 5-3). You should let the opinion of the eight panelists determine the DOK level even if their opinion differs from your own. If panelists cannot come to agreement, then you can work to negotiated the panelists to a consensus level and then more on.

   Remember, the phase for assigning a DOK to the NAEP framework should be considered additional training on the DOK level definitions. Be sure to have people justify their arguments for a DOK assignment by going back to the definitions. Be sensitive and on the lookout for panelists who do not fully understand the DOK levels as appropriate. Offer these panelists additional explanation either in the group or on the side to increase their understanding.

10. The two reading groups should be done coding the NAEP framework by 3:15 PM on Monday. The two mathematics groups should be done coding the NAEP framework by 4:00 PM. Give your groups a brief break at this time while the two group leaders meet with me to determine what differences in the codings of the DOK to the NAEP framework between the two groups need to be discussed. These differences then will be discussed by the content area group as a whole (16 panelists) facilitated by the lead facilitator. Again, this should be considered an important part of being sure all of the panelists have a common understanding of the DOK levels for the content area.

11. At the end of the day on Monday, I will meet with all four of the facilitators to review the day and discuss any adjustments that need to be made in pacing, extra training for individual panelists, or any other issues.

12. On Tuesday I will conduct a brief process check with all 32 panelists and the four facilitators. Then the panelists will divide into two groups by content area. The lead facilitator is to go over the process for coding assessment items to the NAEP framework (Part II). Panelists need to be told that if they cannot find a good match between an item and any of the objectives or specific expectations, they should code the item to the more general expectation or "generic standard." They also need to be told for open-ended items to consult the scoring rubric to decide on the DOK level of the item. They should be told to write a brief, but complete thought, as a Note to clarify their coding if needed. For example, if the assessment item only targets a small part of an expectation, then this should be noted. Panelists should also be told about source-of-challenge and this should be used if they find an item where there is an error so that a student may answer the item correctly without having the knowledge being targeted or answer the item incorrectly even though they have the knowledge.

    The groups then should be separated into two groups for each content area. Then the panelists should code five items and then discuss their codings with each other to be sure they understand the process. Again, this needs to be done efficiently without taking too much time. Then have the panelists code the NAEP assessment items to the NAEP framework. Panelists should write the DOK for each item on the printed page. Because they will need to enter the DOK level again when they code the NAEP items to the ACT CRS. This coding should go until 3:00 PM on Tuesday. During this time you should monitor the coding of the panelists and respond to any questions. If a panelist asks about what is a correct answer for an item, asked me to look at the NAEP answer key.

    After all of the panelists have finished coding, then review the data on the WATv2 to see what codings need to be adjudicated. Any item without a majority (N=5) of the reviewers in agreement on the assignment of an objective or standard should be discussed among the panelists within a group. If any item was assigned three or more different DOK levels, then these items should be discussed to resolve the differences. The desired Intraclass correlation for the coding of DOK levels across the items is 0.70 or higher. If the Intraclass correlation is below 0.70 look for one or two panelists that consistently coded differently from the rest of the group and indicate to these panelists that they are coding consistently lower or higher than the group and point this out with a couple of items. The desired pairwise agreement for an objective is 0.80 and for a standard is 0.90. If the initial statistics are way below these values, then try to find items where panelists varied in their coding by objective or standard. The NAEP framework could have some overlapping expectations that would result in a variation among coding. If this is the case then the desired levels above may not be reached.

    After you discuss with your group the variation in coding, the panelists should be given the opportunity to return to the WATv2 and change their codings. It is not necessary for any panelist to change their coding if they do not think the discussion produced a compelling reason to do so.

13. The test items for both the NAEP and the ACT are secured documents. NORC will distribute confidentiality statements to be signed by all panelists and facilitators. Panelists will need to sign out and sign in a test form from NORC staff. Test forms will be numbered so each reviewer should be assigned a number and receive the test with the same number for each assessment analysis.

14. Once the within-group adjudication has been completed and panelists have made changes to their coding, then I will look at the results from each of the groups for a content area. I will note significant differences in the results between the two groups that need to be justified. Then I will discuss with the two facilitators if some adjudication needs to be done with all 16 panelists for the content area.

15. The group would continue with the next step, coding the ACT EXPLORE assessment items to NAEP standards and objectives after the within-group adjudication. Do not wait for the between-group adjudication.

16. At the end of day on Tuesday, panelists will be ask to complete a feedback survey to provide information on training and their opinion on the process being used.

17. Before coding the ACT EXPLORE to the NAEP standards and objectives, have the panelist within a group code five items individually and then discuss the results as a group to be sure each panelist understands the process.

18. Repeat the process for coding the ACT EXPLORE items to the NAEP expectations. This should begin at least at the beginning of Wednesday morning. ACT staff will be available at the institute to answer questions and provide the answer key to any item if needed. There will be two ACT EXPLORE test forms that will need to be coded. Use the same process for adjudication as discussed above.

19. The coding of the ACT EXPLORE items to the NAEP expectations should be completed by noon on Wednesday. Each form only has 30 items.

20. After lunch on Wednesday, have reviewers code the DOK levels to the ACT College Readiness standards. Repeat the same steps as described in number 9 and 10 above for the NAEP standards and objectives.

21. You should finish coding the DOK levels to the ACT CRS and adjudicate by the end of the day on Wednesday.

22. On Thursday, begin by coding the NAEP assessment items to the ACT CRS. This part of the coding should be done with adjudication by the end of Thursday and follow the same procedures as discussed in number 12 above. Panelists will be asked to complete another feedback survey at the end of the day on Thursday.

23. On Friday morning, the panelist should code the two ACT EXPLORE assessments to the ACT CRS following the same procedures as discussed in number 12 above.

24. Panelists should not be dismissed until all of the tests have been turned in and accounted for and you have checked with me.

*Some areas of this document have been redacted for confidentiality requirements.

Appendix I: Group Consensus DOK Values by Framework

Appendix I.1: Group Consensus DOK Values for the 2013 NAEP Grade 8 Mathematics Framework: Panels 1 and 2

Appendix I.1

Group Consensus DOK Values for the 2013 NAEP Grade 8 Mathematics Framework: Panels 1 and 2

Group Consensus
NAEP 2013 Grade 8 Mathematics, Mathematics, Grade 8

Level	Description	DOK
I.	Number Properties & Operations	1
I.1	Number Sense	1
I.1.a	Use place value to model and describe integers and decimals.	1
I.1.b	Model or describe rational numbers or numerical relationships using number lines and diagrams.	1
I.1.d	Write or rename rational numbers.	1
I.1.e	Recognize, translate or apply multiple representations of rational numbers (fractions, decimals, and percents) in meaningful contexts.	2
I.1.f	Express or interpret numbers using scientific notation from real-life contexts.	1
I.1.g	Find or model absolute value or apply to problem situations.	1
I.1.h	Order or compare rational numbers (fractions, decimals, percents, or integers) using various models and representations (e.g., number line).	1
I.1.i	Order or compare rational numbers including very large and small integers, and decimals and fractions close to zero.	1
I.2	Estimation	2
I.2.a	Establish or apply benchmarks for rational numbers and common irrational numbers (e.g., ?) in contexts.	1
I.2.b	Make estimates appropriate to a given situation by: a) Identifying when estimation is appropriate; b) determining the level of accuracy needed; c) Selecting the appropriate method of estimation; or d) Analyzing the effect of an estimation method on the accuracy of results.	2
I.2.c	Verify solutions or determine the reasonableness of results in a variety of situations, including calculator and computer results.	2
I.2.d	Estimate square or cube roots of numbers less than 1,000 between two whole numbers.	2
I.3	Number operations	2
I.3.a	Perform computations with rational numbers.	1
1.3.d	Describe the effect of multiplying and dividing by numbers including the effect of multiplying or dividing a rational number by: a) Zero; or b) A number less than zero; or c) A number between zero and one; or d) One; or e) A number greater than one.	2
I.3.e	Interpret rational number operations and the relationships between them.	2
I.3.f	Solve application problems involving rational numbers and operations using exact answers or estimates as appropriate.	2
I.4	Ratios and proportional reasoning	2
I.4.a	Use ratios to describe problem situations.	1
I.4.b	Use fractions to represent and express ratios and proportions.	1

I.4.c	Use proportional reasoning to model and solve problems (including rates and scaling).	2
I.4.d	Solve problems involving percentages (including percent increase and decrease, interest rates, tax, discount, tips, or part/whole relationships).	2
I.5	Properties of number and operations	1
I.5.a	Describe odd and even integers and how they behave under different operations.	2
I.5.b	Recognize, find, or use factors, multiples, or prime factorization.	1
I.5.c	Recognize or use prime and composite numbers to solve problems.	1
I.5.d	Use divisibility or remainders in problem settings.	2
I.5.e	Apply basic properties of operations.	1
I.6	Mathematical reasoning using numbers	3
I.6.a	Explain or justify a mathematical concept or relationship (e.g., explain why 17 is prime).	2
I.6.b	Provide a mathematical argument to explain operations with two or more fractions.	3
II	Measurement	2
II.1	Measuring physical attributes	2
II.1.b	Compare objects with respect to length, area, volume, angle measurement, weight, or mass.	1
II.1.c	Estimate the size of an object with respect to a given measurement attribute (e.g., area).	2
II.1.e	Select or use appropriate measurement instrument to determine or create a given length, area, volume, angle, weight, or mass.	1
II.1.f	Solve mathematical or real-world problems involving perimeter or area of plane figures such as triangles, rectangles, circles, or composite figures.	2
II.1.h	Solve problems involving volume or surface area of rectangular solids, cylinders, prisms, or composite shapes.	2
II.1.i	Solve problems involving rates such as speed or population density.	2
II.2	Systems of measurement	1
II.2.a	Select or use an appropriate type of unit for the attribute being measured such as length, area, angle, time, or volume.	1
II.2.b	Solve problems involving conversions within the same measurement system such as conversions involving square inches and square feet.	1
II.2.c	Estimate the measure of an object in one system given the measure of that object in another system and the approximate conversion factor. For example: Distance conversion: 1 kilometer is approximately 5/8 of a mile; Money conversion: U.S. dollars to Canadian dollars; Temperature conversion: Fahrenheit to Celsius.	1
II.2.d	Determine appropriate size of unit of measurement in problem situation involving such attributes as length, area, or volume.	1
II.2.e	Determine appropriate accuracy of measurement in problem situations (e.g., the accuracy of each of several lengths needed to obtain a specified accuracy of a total length) and find the measure to that degree of accuracy.	2

II.2.f	Construct or solve problems (e.g., floor area of a room) involving scale drawings.	2
II.3	Measurement of triangles	2
II.3.a	Solve problems involving indirect measurement such as finding the height of a building by comparing its shadow with the height and shadow of a known object.	2
III	Geometry	2
III.1	Dimension and shapes	2
III.1.a	Draw or describe a path of shortest length between points to solve problems in context.	2
III.1.b	Identify a geometric object given a written description of its properties.	1
III.1.c	Identify, define, or describe geometric shapes in the plane and in three-dimensional space given a visual representation.	1
III.1.d	Draw or sketch from a written description polygons, circles, or semicircles.	1
III.1.e	Represent or describe a three-dimensional situation in a two-dimensional drawing from different views.	2
III.1.f	Demonstrate an understanding about the two- and three-dimensional shapes in our world through identifying, drawing, modeling, building, or taking apart.	2
III.2	Transformation of shapes and preservation of properties	2
III.2.a	Identify lines of symmetry in plane figures or recognize and classify types of symmetries of plane figures.	1
III.2.c	Recognize or informally describe the effect of a transformation on two-dimensional geometric shapes (reflections across lines of symmetry, rotations, translations, magnifications, and contractions).	2
III.2.d	Predict results of combining, subdividing, and changing shapes of plane figures and solids (e.g., paper folding, tiling, cutting up and rearranging pieces).	2
III.2.e	Justify relationships of congruence and similarity and apply these relationships using scaling and proportional reasoning.	2
III.2.f	For similar figures, identify and use the relationships of conservation of angle and of proportionality of side length and perimeter.	2
III.3	Relationships between geometric figures	2
III.3.b	Apply geometric properties and relationships in solving simple problems in two and three dimensions.	1
III.3.c	Represent problem situations with simple geometric models to solve mathematical or real-world problems.	2
III.3.d	Use the Pythagorean theorem to solve problems.	1
III.3.f	Describe or analyze simple properties of, or relationships between, triangles, quadrilaterals, and other polygonal plane figures.	2
III.3.g	Describe or analyze properties and relationships of parallel or intersecting lines.	2
III.4	Position, direction, and coordinate geometry	2

III.4.a	Describe relative positions of points and lines using the geometric ideas of midpoint, points on common line through a common point, parallelism, or perpendicularity.	1
III.4.b	Describe the intersection of two or more geometric figures in the plane (e.g., intersection of a circle and a line).	2
III.4.c	Visualize or describe the cross section of a solid.	2
III.4.d	Represent geometric figures using rectangular coordinates on a plane.	1
III.5	Mathematical reasoning in geometry	3
III.5.a	Make and test a geometric conjecture about regular polygons.	3
IV	Data analysis, statistics, and probability	2
IV.1	Data representation The following representations of data are indicated for each grade level. Objectives in which only a subset of these representations is applicable are indicated in the parenthesis associated with the objective. Histograms, line graphs, scatterplots, box plots, bar graphs, circle graphs, stem and leaf plots, frequency distributions, and tables.	2
IV.1.a	Read or interpret data, including interpolating or extrapolating from data.	2
IV.1.b	For a given set of data, complete a graph and then solve a problem using the data in the graph (histograms, line graphs, scatterplots, circle graphs, and bar graphs).	2
IV.1.c	Solve problems by estimating and computing with data from a single set or across sets of data.	2
IV.1.d	Given a graph or a set of data, determine whether information is represented effectively and appropriately (histograms, line graphs, scatterplots, circle graphs, and bar graphs).	2
IV.1.e	Compare and contrast the effectiveness of different representations of the same data.	3
IV.2	Characteristics of data sets	2
IV.2.a	Calculate, use, or interpret mean, median, mode, or range.	1
IV.2.b	Describe how mean, median, mode, range, or interquartile ranges relate to distribution shape.	2
IV.2.c	Identify outliers and determine their effect on mean, median, mode, or range.	2
IV.2.d	Using appropriate statistical measures, compare two or more data sets describing the same characteristic for two different populations or subsets of the same population.	2
IV.2.e	Visually choose the line that best fits given a scatterplot and informally explain the meaning of the line. Use the line to make predictions.	2
IV.3	Experiments and samples	3
IV.3.a	Given a sample, identify possible sources of bias in sampling.	2
IV.3.b	Distinguish between a random and nonrandom sample.	1
IV.3.d	Evaluate the design of an experiment.	3
IV.4	Probability	2
IV.4.a	Analyze a situation that involves probability of an independent event.	2
IV.4.b	Determine the theoretical probability of simple and compound events in familiar contexts.	2

IV.4.c	Estimate the probability of simple and compound events through experimentation or simulation.	2
IV.4.d	Use theoretical probability to evaluate or predict experimental outcomes.	2
IV.4.e	Determine the sample space for a given situation.	2
IV.4.f	Use a sample space to determine the probability of possible outcomes for an event.	1
IV.4.g	Represent the probability of a given outcome using fractions, decimals, and percents.	1
IV.4.h	Determine the probability of independent and dependent events. (Dependent events should be limited to a small sample size.)	1
IV.4.J	Interpret probabilities within a given context.	2
V	Algebra	2
V.1	Patterns, relations, and functions	2
V.1.a	Recognize, describe, or extend numerical and geometric patterns using tables, graphs, words, or symbols.	1
V.1.b	Generalize a pattern appearing in a numerical sequence, table, or graph using words or symbols.	2
V.1.c	Analyze or create patterns, sequences, or linear functions given a rule.	2
V.1.e	Identify functions as linear or nonlinear or contrast distinguishing properties of functions from tables, graphs, or equations.	2
V.1.f	Interpret the meaning of slope or intercepts in linear functions.	2
V.2	Algebraic representations	2
V.2.a	Translate between different representations of linear expressions using symbols, graphs, tables, diagrams, or written descriptions.	2
V.2.b	Analyze or interpret linear relationships expressed in symbols, graphs, tables, diagrams, or written descriptions.	2
V.2.c	Graph or interpret points represented by ordered pairs of numbers on a rectangular coordinate system.	1
V.2.d	Solve problems involving coordinate pairs on the rectangular coordinate system.	1
V.2.f	Identify or represent functional relationships in meaningful contexts including proportional, linear, and common nonlinear (e.g., compound interest, bacterial growth) in tables, graphs, words, or symbols.	2
V.3	Variables, expressions, and operations	2
V.3.b	Write algebraic expressions, equations, or inequalities to represent a situation.	2
V.3.c	Perform basic operations, using appropriate tools, on linear algebraic expressions (including grouping and order of multiple operations involving basic operations, exponents, roots, simplifying, and expanding).	1
V.4	Equations and inequalities	1
V.4.a	Solve linear equations or inequalities (e.g., $ax + b = c$ or $ax + b = cx + d$ or $ax + b > c$).	1
V.4.b	Interpret ?=? as an equivalence between two expressions and use this interpretation to solve problems.	1

V.4.c	Analyze situations or solve problems using linear equations and inequalities with rational coefficients symbolically or graphically (e.g., ax + b = c or ax + b = cx + d).	2
V.4.d	Interpret relationships between symbolic linear expressions and graphs of lines by identifying and computing slope and intercepts (e.g., know in y = ax + b, that a is the rate of change and b is the vertical intercept of the graph).	2
V.4.e	Use and evaluate common formulas (e.g., relationship between a circle's circumference and diameter [C = pi d], distance and time under constant speed).	1
V.5	Mathematical reasoning in algebra	3
V.5.a	Make, validate, and justify conclusions and generalizations about linear relationships.	3

Appendix I.2: Group Consensus DOK Values for the ACT College Readiness Standards for the 2013 ACT EXPLORE Mathematics: Panels 1 and 2

Appendix I.2

Group Consensus DOK Values for the ACT College Readiness Standards for the 2013 ACT EXPLORE Mathematics: Panels 1 and 2

Table 14

Group Consensus

ACT College Readiness Standards Mathematics 2008, Mathematics, Grade 8

Level	Description	DOK
BOA	Basic Operations & Applications	1
BOA 201	Perform one-operation computation with whole numbers and decimals	1
BOA 202	Solve problems in one or two steps using whole numbers	1
BOA 203	Perform common conversions (e.g., inches to feet or hours to minutes)	1
BOA 301	Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent	1
BOA 302	Solve some routine two-step arithmetic problems	1
BOA 401	Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, computing with a given average	1
BOA 501	Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour)	2
PSD	PSD Probability, Statistics, & Data Analysis	1
PSD 201	Calculate the average of a list of positive whole numbers	1
PSD 202	Perform a single computation using information from a table or chart	1
PSD 301	Calculate the average of a list of numbers	1
PSD 302	Calculate the average, given the number of data values and the sum of the data values	1
PSD 303	Read tables and graphs	1
PSD 304	Perform computations on data from tables and graphs	1
PSD 305	Use the relationship between the probability of an event and the probability of its complement	2
PSD 401	Calculate the missing data value, given the average and all data values but one	2
PSD 402	Translate from one representation of data to another (e.g., a bar graph to a circle graph)	2
PSD 403	Determine the probability of a simple event	1
PSD 501	Calculate the average, given the frequency counts of all the data values	1
PSD 502	Manipulate data from tables and graphs	2
PSD 503	Compute straightforward probabilities for common situations	1
NCP	NCP Numbers: Concepts & Properties	1
NCP 201	Recognize equivalent fractions and fractions in lowest terms	1
NCP 301	Recognize one-digit factors of a number	1
NCP 302	Identify a digit’s place value	1

NCP 401	Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor	1
NCP 501	Find and use the least common multiple	1
NCP 502	Order fractions	1
NCP 503	Work with numerical factors	1
NCP 504	Work with scientific notation	1
NCP 505	Work with squares and square roots of numbers	1
XEI	Expressions, Equations, & Inequalities	1
XEI 201	Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g)	1
XEI 202	Solve equations in the form x + a = b, where a and b are whole numbers or decimals	1
XEI 301	Substitute whole numbers for unknown quantities to evaluate expressions	1
XEI 302	Solve one-step equations having integer or decimal answers	1
XEI 303	Combine like terms (e.g., 2x + 5x)	1
XEI 401	Evaluate algebraic expressions by substituting integers for unknown quantities	1
XEI 402	Add and subtract simple algebraic expressions	1
XEI 403	Solve routine first-degree equations	1
XEI 404	Perform straightforward word-to-symbol translations	1
XEI 501	Solve real-world problems using first-degree equations	2
XEI 502	Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions)	2
XEI 503	Identify solutions to simple quadratic equations	1
GRE	Graphical Representations	1
GRE 201	Identify the location of a point with a positive coordinate on the number line	1
GRE 301	Locate points on the number line and in the first quadrant	1
GRE 401	Locate points in the coordinate plane	1
PPF	Properties of Plane Figures	1
PPF 301	Exhibit some knowledge of the angles associated with parallel lines	1
PPF 401	Find the measure of an angle using properties of parallel lines	1
PPF 402	Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°)	1
PPF 501	Use several angle properties to find an unknown angle measure	2
MEA	Measurement	1
MEA 201	Estimate or calculate the length of a line segment based on other lengths given on a geometric figure	2
MEA 301	Compute the perimeter of polygons when all side lengths are given	1
MEA 302	Compute the area of rectangles when whole number dimensions are given	1
MEA 401	Compute the area and perimeter of triangles and rectangles in simple problems	1
MEA 402	Use geometric formulas when all necessary information is given	1
MEA 501	Compute the area of triangles and rectangles when one or more additional simple steps are required	2

MEA 502	Compute the area and circumference of circles after identifying necessary information	2
FUN	Functions	2

Appendix J: Panelist Evaluation Surveys and Results

Appendix J.1: Survey I Form

NAEP-Explore Content Alignment Institute - Survey I

NAEP-Explore Content Alignment Institute: February 9-13, 2015

Panelist Feedback Survey
We are interested in your feedback about this institute. Below, please respond to each statement indicating the extent to which you agree or disagree. Your responses will be kept confidential.

A.Training

	Strongly disagree	Disagree somewhat	Neither disagree nor agree	Agree somewhat	Strongly agree
1. The training materials were easy to understand.	○	○	○	○	○
2. The facilitator was effective in explaining the coding process.	○	○	○	○	○
3. I understood the criteria used to code the standards and items.	○	○	○	○	○
4. There were a sufficient number of examples to practice.	○	○	○	○	○
5. I had adequate time to practice coding.	○	○	○	○	○
6. There were ample opportunities to discuss and resolve coding discrepancies.	○	○	○	○	○
7. The rules for resolving coding discrepancies were clear.	○	○	○	○	○
8. The training sessions were well organized and well placed.	○	○	○	○	○

B. Process Evaluation

	Strongly disagree	Disagree somewhat	Neither disagree nor agree	Agree somewhat	Strongly agree
1. The training session adequately prepared me for the coding.	○	○	○	○	○
2. The facilitator was effective in assisting the panel with the coding process.	○	○	○	○	○
3. I felt at ease applying the criteria to the standards and items.	○	○	○	○	○
4. I had an adequate amount of time to code the standards and items.	○	○	○	○	○

Done

Appendix J.2: Survey II Form

NAEP-Explore Content Alignment Institute - Survey II

NAEP-Explore Content Alignment Institute: February 9-13, 2015

Panelist Feedback Survey
We are interested in your feedback about this institute. Below, please respond to each statement indicating the extent to which you agree or disagree. Your responses will be kept confidential.

A. Process Evaluation

	Strongly disagree	Disagree somewhat	Neither disagree nor agree	Agree somewhat	Strongly agree
1. The facilitator was effective in assisting the panel with the coding process.	○	○	○	○	○
2. I felt at ease applying the criteria to the standards and items.	○	○	○	○	○
3. I had an adequate amount of time to code the standards and items.	○	○	○	○	○
4. My final codes were often influenced by other panelists.	○	○	○	○	○
5. The coding results of my team accurately reflected the alignment between the assessments and the frameworks.	○	○	○	○	○

B. Your Views

1. Which aspects of the coding process did you find most difficult? Why?

2. In what ways could the training or the coding process be improved?

Done

Appendix J.3: Process Evaluation Survey I Table Results

Process Evaluation Survey I Table Results

NAEP-ACT Content Alignment Institute: February 9-13, 2015

Panelist Feedback Survey I (conducted Day 2 at 5 p.m.)

A. Training

We are interested in your feedback about this institute. Below, please respond to each statement indicating the extent to which you agree or disagree. Your responses will be kept confidential.

	Strongly disagree	Disagree somewhat	Neither disagree/agree	Agree somewhat	Strongly agree
1. The training materials were easy to understand.	0	0	2 (6%)	10 (30%)	**21**(64%)
2. The facilitator was effective in explaining the coding process.	0	1 (3%)	2 (6)	8 (24)	**22** (67)
3. I understood the criteria used to code the standards and items.	0	1 (3)	1 (3)	11 (20)	**20** (61)
4. There were a sufficient number of examples to practice.	1 (3%)	5 (15)	3 (9)	**12** (36)	**12** (36)
5. I had adequate time to practice coding.	1 (3)	6 (18)	5 (15)	10 (30)	**11** (33)
6. There were ample opportunities to discuss and resolve coding discrepancies.	1 (3)	6 (18)	4 (12)	**11** (33)	**11** (33)
7. The rules for resolving coding discrepancies were clear.	1 (3)	6 (18)	3 (9)	9 (14)	**14** (42)
8. The training sessions were well organized and well placed.	0	4 (12)	3 (9)	8 (24)	**18** (55)

B. Process evaluation

	Strongly disagree	Disagree somewhat	Neither disagree/agree	Agree somewhat	Strongly agree
1. The training session adequately prepared me for the coding.	0	3 (9%)	1 (3%)	**16** (48%)	13 (39%)
2. The facilitator was effective in assisting the panel with the coding process.	0	1 (3)	4 (12)	10 (30)	**18** (55)
3. I felt at ease applying the criteria to the standards and items.	0	3 (9)	2 (6)	**14** (42)	**14** (42)
4. I had an adequate amount of time to code the standards and items.	1 (3%)	10 (30)	1 (3)	10 (30)	**11** (33)

Panelist Feedback Survey II (conducted Day 4 at 5 p.m.)

A. Process Evaluation

We are interested in your feedback about this institute. Below, please respond to each statement indicating the extent to which you agree or disagree. Your responses will be kept confidential.

	Strongly disagree	Disagree somewhat	Neither disagree/agree	Agree somewhat	Strongly agree
1. The facilitator was effective in explaining the coding process.	0	1 (3%)	0	8 (23%)	**26** (74%)
2. I felt at ease applying the criteria to the standards and items.	0	1 (3)	1 (3)	11 (20)	**20** (61)
3. I had adequate amount of time to code the standards and items.	1 (3)	3 (9)	4 (11)	**15** (43)	12 (34)
4. My final codes were often influenced by other panelists.	2 (6)	4 (11)	**14** (40)	11 (31)	4 (11)
5. The coding results of my team accurately reflected the alignment between the assessments and the frameworks.	0	0	2 (6)	14 (40)	**19** (54)

Appendix J.4: Survey Results Description

Survey Results Description

Participant feedback was requested through a short survey given to all panelists. The first survey was administered at the end of the second day of the five-day CAI. This survey was comprised of two types of structured-response items that asked about: (a) training they had received for the content analysis process, and (b) their evaluation of the process of review and coding of standards and assessments. The second survey given at the end of day four of the Institute was comprised of structured questions regarding the panelists' evaluation of the process toward the end of their experience, and open-ended questions asking for specific issues they identified about the content analysis process.

The responses to items on Survey I are displayed in Appendix J.3 (Survey I, Tables A and B) and the data show highly positive views of the training and the process of content analysis by the panelists. Regarding the training, over 90 percent of panelists responded that the training materials were easy to understand (64 percent strongly agree, 30 percent agree), 90 percent of panelists found the facilitator was effective in explaining the coding process (22 percent strongly agree, 24 percent agree), and over 90 percent understood the criteria used in coding (61 percent strongly agree, 33 percent agree). While the data do show overall positive responses to the training process, the data also show room for improvement. Over two-thirds of respondents indicated there were a sufficient number of examples to practice (72 percent), a majority (63 percent) of panelists said they had adequate time to practice coding (21 percent wanted more time), and 66 percent indicated they had ample opportunities to discuss and resolve discrepancies (with 21 percent wanting more time for discussion/resolution). Regarding the organization of the training, responses were overall positive-- with 69 percent of panelists indicating the rules resolving discrepancies were clear, and 79 percent indicating the training sessions were well organized and well placed.

The questions for panelists regarding the process of content analysis showed very positive responses, and the panelists' views of the process did improve as the Institute proceeded (Appendix J.3, Survey II Table A, Process Evaluation). In the survey on day two, 88 percent of panelists indicated they were adequately prepared for the coding, and 84 percent reported on day two that the facilitator was effective in assisting panelists and the coding process. The change in responses on several evaluation items indicate improved attitudes by the end of the week. On day four of the Institute, a total of 97 percent of panelists thought their facilitator was effective, 97 percent felt at ease in applying the analysis criteria (improving from 84 percent on day two), and 78 percent felt they had adequate time to do the coding work (improving from 63 percent on day two). Thus about one-fourth of panelists did feel they could have used more time to do their analysis. Two questions were given to panelists on day four to report on their views of the work of their panel. A total of 94 percent of panelists felt the results of their coding team accurately reflected the alignment between assessments and frameworks (i.e., outcomes validity). Panelists were split on whether their codes were influenced by others in the group (44 percent indicated they were influenced by other while 40 percent were neutral–neither disagree or agree). The design of the content analysis is structured to move toward a consensus in the analysis and codes among the panel members, and thus panelists work is very likely to be influenced by the views of others.

The open-ended questions in the day four survey asked about aspects of the coding process that were difficult for the panelists and what suggestions they would have for improvement of the process. The primary difficulty identified by respondents was being able to comprehend the standards and framework well enough to provide a good match to content of assessment items, although a number of panelists indicated this step improved with greater familiarity and knowledge by the end of the Institute. The differences in structure of the ACT standards (broad) and NAEP framework objectives (specific) were listed as a difficulty, and for some matching the NAEP assessment items to the ACT standards was hard to accomplish. Third, the limited amount of time available was an issue and for some the number of NAEP items to be coded in one day was difficult. Several panelists wrote that they would have liked more time in training with the standards and more time in team discussion of DOK levels and others suggested that work at home prior to the Institute could have provided background on understanding the standards and objectives.