Alaska

Comprehensive System of Student Assessment

Technical Report

Spring 2012
Grades 4, 8, and 10
Science
Standards Based Assessment (SBA)

DATA RECOGNITION
DRC
CORPORATION

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CHAPTER 1: BACKGROUND OF THE ALASKA SCIENCE ASSESSMENT

The Science Standards Based Assessment (SBA) is a criterion-based assessment, and is aligned to the Alaska academic science content standards, which include Grade Level Expectations (GLEs) for each grade. The science SBA was first administered operationally in April 2008 to students in grades 4, 8, and 10. Assessment items were extensively reviewed by Alaska educators and subsequently field-tested in three standalone field tests (i.e., grades 4, 8, and 10) administered in April 2007.

Alaska academic content standards for science were developed for each grade 3 through 11 and are aligned with the National Science Education Standards. The assessments in grades 4, 8, and 10 focus on standards designated for those grades (e.g., the grade 4 test is not cumulative for grades 3 and 4).

The No Child Left Behind Act (NCLB) required science standards be developed by the 2005–2006 school year and science be assessed in one grade span of 3–5, 6–9, and 10–12, by no later than the 2007–2008 school year. In response, Alaska's Commissioner of Education and Early Development (EED), after discussions with the Alaska State Board of Education, principals, teachers, superintendents, and other stakeholders, determined that plans should be developed to administer a standards-based assessment in science in grades 4, 8, and 10 (the Standards Based Assessment).

The Alaska science SBA is a coherent set of assessments aligned with Alaska GLEs developed for students in grades 4, 8, and 10. The core set of assessments consists of custom assessments in science in grades 4, 8, and 10, which are suitable for reporting student achievement in relation to state proficiency standards, and for inclusion in state and federal school/district accountability programs.

CHAPTER 2: TEST DESIGN AND ITEM DEVELOPMENT

SCIENCE ASSESSMENT MEASURES

The science component of the Standards Based Assessment (SBA) is composed of items that address GLEs in grades 4, 8, and 10. The assessable GLEs for each grade level are distributed among four reporting categories. Information about the reporting categories and the GLEs assessed in each reporting category, as well as the types and numbers of items used in each reporting category, can be found in the test blueprints (Appendix 1).

Multiple-choice (MC), short constructed-response (SCR), and extended constructed-response (ECR) items are used to assess the science GLEs. These item types are designed to measure students' knowledge at various cognitive levels and provide a variety of information about science achievement.

Multiple-Choice Items

MC items require students to select a correct answer from four response choices with a single correct answer. Each MC item is scored as right or wrong and has a value of 1 point. MC items are used to assess a variety of skill levels, from short-term recall of facts to problem solving. The selection of incorrect response choices, or distractors, by the student commonly results from misunderstood concepts, incorrect logic, or invalid application of a concept.

Constructed-Response Items

The science constructed-response (CR) items are designed to link science process with content. These items address comprehension of knowledge and skills at higher cognitive levels in ways that MC items cannot. They offer the opportunity for students to create a response to meaningful situations aligned to the assessable GLEs. Students must read the items carefully, analyze information, and, when required, offer explanations. These items provide insight into the students' science knowledge, abilities, and reasoning processes.

There are two types of SBA science assessment CR items: short constructed-response (SCR) and extended constructed-response (ECR). The student can earn 0–2 points on SCRs and 0–4 points on ECRs. Both types are scored using item-specific rubrics. The abbreviated tasks of SCRs and the more elaborate tasks of ECRs are carefully constructed to reflect the scoring rubrics. All item-specific scoring rubrics are based on generic rubrics, which are written by DRC test development specialists.

2012 OPERATIONAL PLAN

The 2012 grades 4, 8, and 10 SBAs in science were comprised of a single reconstructed operational core form at each grade level. One form of the single operational core form was available at each grade level. Each of the forms included the core set of operational items, plus a set of unique placeholder (PH) items embedded throughout each of the core operational forms. The placeholder items embedded in each form did not count toward a student's score. However, all placeholder items had been previously reviewed and approved by Alaska educators during item data review meetings.

Table 2–1 displays the design for the science test for each grade. The column entries for this table denote:

- the grade level
- number of core MC items
- number of placeholder (PH) MC items
- number of core SCR items
- number of core ECR items
- number of placeholder SCR and ECR
- total number of MC, CR (SCR and ECR) items
- total number of operational points

Table 2–1. Science Test Plan 2012 Operational Form

Grade	Multiple-Choice Items		Core SCR Items (2 pt.)	Core ECR Items (4 pt.)	PH CRs (2 pt. or 4 pt.)	Total Items MC/CR	Total Operational Points
	Core	PH					
4	46	4	2	0	1	50/3	50
8	52	4	3	1	1	56/5	62
10	52	4	2	2	1	56/5	64

An individual student's score is based solely on the core items. The total number of operational points is 50 points at grade 4, 62 points at grade 8, and 64 points at grade 10. The total raw score is obtained by combining the points from the core MC and core CR (SCR and ECR) portions of the test as follows:

Student's Score in Science = **Grade 4:** 46 MC items plus
two 2-point SCR items = 50 points

Grade 8: 52 MC items plus
three 2-point SCR items plus
one 4-point ECR item = 62 points

Grade 10: 52 MC items plus
two 2-point SCR items plus
two 4-point ECR items = 64 points

GRADE-LEVEL EXPECTATIONS SUBSUMED WITHIN REPORTING CATEGORIES

The science content area standard categories (or strands) are subdivided for specificity and eligible content or limits. The Alaska Science GLEs are organized into the seven standard categories shown in Table 2–2. The GLEs identified specifically for local assessment purposes are not included.

Table 2–2. Distribution of Science GLEs by Standard Category for Grades 4, 8, and 10

Distribution of Science GLEs		Grade Level		
		4	8	10
STANDARD CATEGORIES	A - Science as Inquiry and Process	2	2	2
	B - Concepts of Physical Science	2	4	7
	C - Concepts of Life Science	6	6	6
	D - Concepts of Earth Science	6	5	8
	E - Science and Technology	3	0	1
	F - Cultural, Social, Personal Perspectives, and Science	0	0	1
	G - History and Nature of Science	2	1	4
	TOTAL	21	18	29

As outlined in Table 2–3, the seven standard categories are organized into four reporting categories.

Table 2–3. Reporting Categories with Corresponding GLEs for Grades 4, 8, and 10

Grade Level Expectation Distribution by Reporting Category		Grade Level		
		4	8	10
		Number of GLEs per Reporting Category		
A, E–G*	**Nature of Science and Technology**	7	3	8
B	**Concepts of Physical Science**	2	4	7
C	**Concepts of Life Science**	6	6	6
D	**Concepts of Earth Science**	6	5	8
	TOTAL	**21**	**18**	**29**

*Title varies by grade level.

TEST DEVELOPMENT TIMELINE

Prior to spring 2012, three forms of the SBAs existed: Form A, Form B, and Form C. Form A was administered in spring 2008 and 2010. Form B was administered in spring 2009 while Form C was administered in spring 2011. The spring 2012 (Form D) is a rebuilt or reconstructed form composed of the following items: an anchor set of items from Form A, items from Form B, items from Form C, and remaining items in the pool of approved previously field-tested items. Form D also includes embedded placeholder items. A series of major test development activities took place from 2010–2012 which culminated in the administration of the operational spring 2012 SBA assessments. These key activities included the following:

- Development of items and tasks for the spring 2012 operational forms.
- Review of items previously field tested (item review with data) by external committees of educators (content review, bias/sensitivity review).
- Field testing of items.
- Update of the Alaska item bank.
- Preparation of the rebuilt or reconstructed spring 2012 operational form.

ITEM AND TEST DEVELOPMENT PROCESS

The most significant considerations in the item and test development process used in the previous years for the development of the spring 2012 operational Form D were as follows: Aligning the items to the GLEs; determining the grade-level appropriateness (reading level/interest level, etc.); item/task level of complexity; estimated difficulty level; relevancy of context for each item; providing rationales for distractors; and determining style, accuracy, and correct terminology were some of the major considerations in the item and test development process. The *Standards for Educational and Psychological Testing* (AERA, APA, NCME, 1999) and *Universal Design* (Thompson, Johnstone, & Thurlow, 2002) guided the following steps in the item and test development process:

- Analyze the GLEs and test blueprints.
- Analyze item specifications and style guides.
- Select qualified item writers.
- Develop item-writing workshop training materials.
- Train test development specialists and item writers to write items.
- Write items that match the standards, are free of bias, and address fairness and sensitivity concerns.
- Conduct and monitor internal item reviews and quality processes.
- Prepare items for review by committees of Alaska educators (content and bias/sensitivity).
- Select and assemble items.
- Test items, score items, and analyze data.
- Review items and associated statistics after testing, including bias statistics.
- Update item bank.

Item Writer Training

The test items used in the rebuilt or reconstructed form were written by internal DRC item writers who have experience writing items, and selected writers from across the country who are experienced writers, teachers, or former teachers who have specialized knowledge and skill in the subject area of their expertise (e.g., biology, physical science). All writers met the following qualifications:

- A bachelor's degree or higher in science, curriculum and instruction, and/or related field.
- In-depth understanding and knowledge of the special considerations involving the writing of standards-based items, including an understanding of cognitive levels, estimated difficulty levels, grade-level appropriateness, depth of knowledge, readability, and bias considerations.
- In-depth understanding and knowledge of the special considerations involving the writing of standards-based constructed-response (0–2 point and 0–4 point) items, including the writing of scoring rubrics for each item.

All item writers were provided with one-on-one writing sessions with DRC test development specialists and lead item writers. Prior to developing items for the SBA, the cadre of item writers was trained with regard to:

- Alaska content standards and GLEs.
- Cognitive levels, including depth of knowledge.
- Principles of universal design.
- Skill-specific and balanced test items for the grade level.
- Contextual relevance.
- Developmentally appropriate structure and content.
- Item-writing technical quality issues.
- Style considerations approved by the EED.

The DRC *Item Writer Orientation Manual*, *Fairness in Testing Manual*, *Depth of Knowledge Levels*, and the *Universally Designed Assessments* documents that were used during the training are provided in Appendices 2–5.

Item Writing

To ensure that all test items met the requirements of the approved target content test blueprint and item specifications and were adequately distributed across subcategories and levels of difficulty, item writers were asked to document the following specific information as each item was written.

Alignment to the Alaska Grade-level Expectations: There must be a high degree of match between a particular question and the GLE it is intended to measure. Item writers were asked to clearly indicate what GLE each item was measuring.

Estimated Difficulty Level: Prior to field testing items, the item difficulties were not known, and writers could only make approximations as to how difficult an item might be. The estimated difficulty level was based upon the writer's own judgment as directly related to his or her classroom teaching and knowledge of the curriculum for a given grade level. The purpose for indicating estimated difficulty levels as items were written was to help ensure that the pool of items prepared for review by Alaska educators and EED and subsequent pilot testing and field testing would include a range of difficulty (low, medium, and high).

Appropriate Grade Level, Item Context, and Assumed Student Knowledge: Item writers were asked to consider the conceptual and cognitive level of each item. They were asked to review each item to determine whether or not the item was measuring something that was important and could be successfully taught and learned in the classroom.

Multiple-choice (MC) Item Options and Distractor Rationale/Analysis: Writers were instructed to make sure that each item had only one clearly correct answer. Item writers submitted the answer key with the item. All distractors were plausible choices that represented common errors and misconceptions in student reasoning.

Constructed-Response (CR): Each constructed-response item (SCR and ECR items) included specific scoring rubrics. Specific scoring rubrics were completed and explained why each score point would be assigned. The complete item-specific rubrics were also written to explain the strengths and weaknesses that were typically displayed for each score point.

Face Validity and Distribution of Complexity Levels: Writers were instructed to write items to reflect various levels of cognitive complexity using *Taxonomy of Educational Objectives* (Bloom et. al., 1956). As each item was written, the writer classified items into one of four of the six possible levels contained in Bloom's Taxonomy that are applicable to multiple-choice items cognition levels: recall or knowledge, application, analysis, or evaluation for each item. The writers were instructed to write items so that the pool of items would represent a distribution of items across cognitive levels, as required by the test and item specifications.

Face Validity and Distribution of Items Based Upon Depth of Knowledge: Writers were asked to classify the depth of knowledge of each item, using a model based on Norman Webb's work on depth of knowledge (Webb, 2002, 2006). Items were classified as one of four depth of knowledge categories: recall, skill/concept, strategic thinking, and extended thinking.

Readability: For science item development, writers were instructed to pay careful attention to the readability of each item to ensure that the focus was upon the concepts; not on reading comprehension. As a result, the goal for each writer was to write items that were, to the greatest degree possible, independent of the assessment of reading. Science contains many content-specific vocabulary terms. These terms make it impossible to use the standard methods available for determining the reading level of test questions. Wherever it was practical and reasonable, every effort was made to keep the vocabulary one grade level below the tested grade level. Resources writers used to verify the vocabulary level were the *EDL Core Vocabularies* (Taylor et.al., 1989) and the *Children's Writer's Word Book* (Mogilner, 1992). In addition, every test question was taken before committees comprised of Alaska grade-level experts in the field of science education. They reviewed each question from the perspective of the students they teach, and they determined the grade-level appropriateness of the vocabulary used.

Curriculum-specific Issues: All items were to be curriculum independent with respect to both science content and vocabulary. In other words, items were not developed to align with any one particular science textbook series. As items were written, writers were asked to document any specific curriculum issues.

Grammar and Structure for Item Stems and Item Options: All items were written to meet technical quality, including correct grammar, syntax, and usage in all items, as well as parallel construction and structure of text associated with each item.

Editorial Review of Items

After items were written, DRC test development specialists and editorial staff reviewed each item for item quality, making sure that the test items were in compliance with industry guidelines for clarity, style, accuracy, and appropriateness for Alaska students. While there are many published guidelines for reviewing assessment items, the list below serves to summarize some of the more major considerations DRC test development specialists and editors followed when reviewing items to make sure they conformed to standard item quality for good, reliable, fair test questions.

Guidelines for Reviewing Assessment Items

A good item should

- have only one clear correct answer and contain answer choices that are reasonably parallel in length and structure.
- have a correctly assigned content code (item map).
- measure one main idea or problem.
- measure the objective or curriculum content standard it is designed to measure.
- be at the appropriate level of difficulty.
- be simple, direct, and free of ambiguity.
- make use of vocabulary and sentence structure that is appropriate to the grade level of the student being tested.
- be based on content that is accurate and current.
- when appropriate, contain stimulus material that is clear and concise and provides all information that is needed.
- when appropriate, contain graphics that are clearly labeled.
- contain answer choices that are plausible and reasonable in terms of the requirements of the question, as well as the students' level of knowledge.
- contain distractors that relate to the question and can be supported by a rationale.
- reflect current teaching and learning practices in the field of science education.
- be free of gender, ethnic, cultural, socioeconomic, and regional stereotyping bias.

Item Content Review

Prior to placement of items within the 2012 operational forms, all newly developed test items were submitted to content committees for review. The content committees consisted of Alaska educators from school districts throughout Alaska. The primary responsibility of the content committees was to evaluate items with regard to quality and content classification, including grade-level appropriateness, estimated difficulty, depth of knowledge, and source of challenge. They also suggested revisions, if appropriate. The committee also reviewed the items for adherence to the principles of universal design, including language demand and issues of bias and sensitivity.

The content reviews for items placed on the spring 2012 Form D occurred in 2007 and 2010. Committee members were selected by EED, and EED-approved invitations were sent by DRC. The meeting commenced with an overview of the test development process. Training was provided by DRC senior staff members. Training included how to review items for technical quality and content quality, including depth of knowledge and adherence to principles of universal design. In addition, training included providing committee members with the procedures for item review, including the use of tracking review forms (Appendix 6) to be used during the item content review.

DRC test development specialists facilitated the review of items. Committee members, grouped by grade level, reviewed the items for quality and content, as well as for the following categories designated on the item review tracking form.

- GLE Alignment
- Difficulty Level (classified as Low, Medium, or High)
- Correct Answer
- Quality of Graphics
- Appropriate Language Demand
- Freedom from Bias (classified as Yes or No)
- Overall Judgment (classified as Approved, Accept with Revisions, or Rewrite)

Security was addressed by committee members and facilitators adhering to a strict set of procedures. Items in binders did not leave the meeting rooms and were accounted for at the end of each day before attendees were dismissed. All attendees, with the exception of EED staff, were required to sign a Confidentiality Agreement (Appendix 7). All materials not in use were kept in secure meeting rooms. During lunch and breaks, if meeting rooms were unused, they were locked or closely monitored by DRC personnel. While not in use by DRC, the meeting rooms were locked and unavailable to anyone other than one DRC person and the Chief of Security of the meeting facility. Rooms were attended to only under strict supervision by DRC personnel. Secure materials that did not need to be retained after the meeting were deposited in secure barrels, and their contents were shredded under supervision of a DRC employee.

The results of the spring 2010 item content review were reported in the *Spring 2010 Alaska Science Standards Based Assessment (SBA) Technical Report.* The results of earlier item content reviews were reported in their respective technical reports.

Bias and Sensitivity Review

Prior to field testing items within the forms, all newly developed test items were also submitted to Bias and Sensitivity Committees for review. The most recent review took place in Alaska in spring 2010. The committee's primary responsibility was to evaluate items as to acceptability with regard to bias and sensitivity issues. They also made recommendations for changes or deletion of items in order to remove the area of concern. The bias/sensitivity committee was composed of a panel of experts who represented the diversity of Alaska students. The committee was trained by a DRC test development lead to review items for bias and sensitivity issues using a *Fairness in Testing Manual* developed by DRC (Appendix 3). This manual was revised specifically for the Alaska program.

All items were read by all of the committee members. Each member noted bias and/or sensitivity comments on review forms (Appendix 8). All comments were then compiled and the actions taken on these items were recorded by DRC. Committee members were required to sign a Confidentiality Agreement (Appendix 7) and strict security measures were in place to ensure that secure materials did not leave the meeting rooms. All secure materials were kept in a locked room while not in use. Secure materials that did not need to be retained after the meeting were deposited in secure barrels and their contents were shredded under supervision of a DRC employee.

Item Field Test

All field-tested items were embedded in operational forms in previous administrations. Placeholder items were used for the spring 2012 forms.

Item Field Test Data Review

As stated previously, spring 2012 form D contained placeholder items. A review of field-test items with statistical data was held following the spring 2011 administration of form C. The following field test statistical analyses were completed at that time:

- Proportion selecting correct response (*p*-values)
- Average person logit for all choices
- Number of persons attempting the item
- Item-total correlations
- Fit statistics
- Differential item functioning (DIF)
- Logit difficulty of item

Item analysis results were reviewed by DRC psychometricians to identify any items that were not performing as expected. These items were flagged so DRC test development specialists were made aware of potential areas of concern. For example, in the case of multiple-choice items, DRC test development specialists checked to make sure that the key for each item was correct and that none of the other response options were plausible. In the case of items where large values of DIF occur, DRC test development specialists reviewed each item flagged to consider whether or not a feature of the item may have caused a problem and/or contributed to the DIF. Under the guidance of DRC psychometricians, DRC test development specialists determined which of the flagged items were to be reviewed by a group of Alaska educators to determine whether or not the item was appropriate for use. In many cases, items with extreme DIF were removed from the pool of items available for use in forms construction. Additional guidelines concerning the review of item analysis results for the item-selection process are provided on the following pages.

Items not identified for this review were those that had good statistical characteristics and, consequently, were regarded as statistically acceptable. Likewise, items of extremely poor statistical quality were regarded as unacceptable and needed no further review. However, there were some items that DRC deemed as needing further review by a committee of Alaska educators. The intent was to capture all items that needed a closer look; thus the criteria employed tended to over-identify rather than under-identify items.

The most recent review of science items with data was conducted on August 2 and 3, 2011 and included items that appeared on spring 2011, Form C. Items accepted at this review were then eligible to be placed on the spring 2012, Form D. The committees were composed of Alaska educators. EED also selected internal staff members to attend. Committee members were selected by EED, and EED-approved invitations were sent to them by DRC. In this session committee members were first trained by a DRC senior psychometrician with regard to the

statistical indices used in item evaluation. This was followed by a discussion with examples concerning potential reasons why an item might be retained regardless of the statistics. The committee review process involved a brief exploration of possible reasons for the statistical profile of an item (such as possible bias, grade appropriateness, and instructional issues) and a decision regarding acceptance (Appendix 6). DRC test development specialists facilitated the statistical review of the items.

Security was addressed by adhering to a strict set of procedures. Test items did not leave the meeting rooms and were accounted for at the end of each day before attendees were dismissed. All attendees, with the exception of EED staff, were required to sign a Confidentiality Agreement (Appendix 7). All materials not in use were kept in secure meeting rooms. During lunch and breaks, if meeting rooms were unused, they were locked or closely monitored by DRC personnel. While not in use by DRC, the meeting rooms were locked and unavailable to anyone other than one DRC person and the Chief of Security of the meeting facility. Rooms were attended to only under strict supervision by DRC personnel. Secure materials that did not need to be retained after the meeting were deposited in secure barrels, and their contents were shredded under supervision of a DRC employee.

The results of the August 2011 data review were reported in the *Spring 2011 Alaska Science Standards Based Assessment (SBA) Technical Report*.

PSYCHOMETRIC GUIDELINES FOR SELECTING ITEMS

Proportion Correct

The proportion correct, or *p*-value, is the proportion of the total group of test takers answering the MC item correctly. The proportion for an item will show how difficult the item was for the students who took that field-test form. In general, MC items with a proportion correct somewhat higher than half the difference between the chance level and 1.00 should be recommended for selection first, and the range for selection should be between 0.40 and 0.90. When necessary to meet the test blueprint or other test specifications, items that fall outside this range may be used, albeit sparingly. The overall form was constructed to a mean *p*-value target range of 0.63 to 0.67, with special care taken to select items that were at or near the cutpoints.

Average Person Logit

The average person logit for an item is the average measure of the persons attempting that item, which can vary from field-test form to field-test form. The average person logit for a response option is the average measure for the persons selecting that response. The average person logit for the correct response should be greater than the average logit for every other response. The difference between the average person logit for the correct response and the incorrect responses is an indication of the discrimination of the item. The larger the difference, the more discriminating the item. Item discrimination is also estimated by the item-total correlation.

Item-Total Correlation

The item-total correlation is the relationship between a student's performance on the item and the student's performance on the content-area test as a whole. If the item has a high item-total correlation, it generally means that the students who answered the item correctly achieved higher

scores on the operational test than those who did not answer the item correctly. Item discrimination is an important statistic in the forms construction process because the higher the average value for the test, the more reliable the test. Items with item-total correlations of 0.35 or greater were given primary consideration in the item selection phase of the test development process. The use of 0.35 is a rule of thumb that meets best practices. This value is higher for field-test items because the item-total correlation for Alaska field-test items generally decreases from field test to operational test. However, items with item-total correlation values between 0.20 and 0.35 were included if such items were necessary to satisfy specific content cells of the detailed test blueprint.

Fit Statistic

A goodness-of-fit statistic is computed as part of the calibration of all items in the field test. Essentially, a chi-square statistic that quantifies the sum of the squared standardized distances of the observed item performance from the expected performance for all persons, based on the Rasch model, is computed for each item. This statistic evaluates how well each item fits the psychometric model. Poor fit could be a result of an item not functioning as expected or because the item measures a different construct than the remaining items. Typically, items with values greater than +5 would be considered suspect.

Differential Item Functioning (DIF) Analyses

DIF analysis is conducted on all field-test items to determine whether an item potentially favors one group of students over another. DIF procedures examine the possibility that an item's characteristics may negatively affect the performance of select groups of students. Evidence of DIF is usually considered as a signal to test developers to examine an item more closely to consider whether or not it is measuring the same underlying construct for various subpopulations.

DRC utilizes the Mantel-Haenszel (MH) or the Standardized Mean Difference (SMD) statistic for detecting DIF, depending on the item type. The MH statistic is the most commonly used technique for MC items in large-scale, educational assessment. It does not depend on the application or the fit of any specific measurement model. The SMD statistic is used for CR items with more than two score categories.

Essentially, these methods quantify the average amount more or less difficult that a member of the reference group found the studied item than did comparable members of the focal group. From this value, one of three severity classification categories is assigned (A, B, or C). The A category represents negligible potential DIF. The B category indicates moderate potential DIF; that is to say, that one group outperformed the other group once differences in skill levels between the two groups have been accounted for. The C category indicates that there is large potential DIF. Items assigned an A are given primary consideration in test construction. C items are considered only if the inclusion of such items is necessary to satisfy specific content cells of the detailed test blueprint or other test specifications. Items with C DIF must pass committee review before they are placed on an operational form.

ITEM BANK

Overview

The DRC item bank is a secure, searchable database. The item bank stores items along with associated graphic images, item characteristics (e.g., item ID, standard, answer key, subject, grade), administration information (e.g., form, sequence, year of administration), as well as item level statistics (e.g., *p*-values (proportion correct), item-total correlations, and omits (proportion leaving an item blank). Items are maintained throughout an item's lifecycle from development through the form construction phase. Information about each item is accessible using the item bank's searching and reporting capabilities in the following situations: determining item development needs, constructing field test and operational test forms, locating released or rejected items, as well as verifying or researching information from committee review sessions.

Functionality

A unique, sequential item ID is assigned to items when they enter the bank. This ensures that each item is uniquely identified throughout its lifecycle with one item ID. Another client-specific item ID may also be assigned.

Current and historic information about item status and characteristics are easily accessible in the item bank. Item characteristics (e.g., standard, key, passage type, calculator status, etc.) are searchable and viewable in the item bank. The item image and associated graphics are also stored in the item bank. The items and graphics can be viewed and versioned based upon suggested modifications by committees and internal edits. Versioning allows changes to be made and archived for reference.

Item status information from committee review sessions is stored in the database. Items accepted by committees are available for form construction. Conversely, items rejected by committees remain in the database for reference and are flagged so they are not available for future test forms.

Item Cards and Reporting Options

Common outputs of the item bank include item cards and user-defined reports. DRC's item cards contain item text and associated graphics, unique item identifiers, as well as applicable administration and statistical information. Item cards are used for committee reviews, client reviews, and form construction purposes.

Information is queried in the item bank to generate reports. For example, a list of items with their associated statistics can be printed for a specific administration or a list of rejected or released items can be printed for reference.

Security

While the viewing options in the item bank are read-only, only approved DRC employees are allowed to make modifications or changes to items and their associated item level administration information.

Quality Assurance

The item bank is the central repository of all item-level information at DRC. All changes to an item, its graphic, and associated item-specific information are made in this database. This allows our test development specialists to access the most current, reliable information available at any time in the item and form development processes.

The integrity of the item bank is maintained by tracking changes to items, graphics, and associated information during all stages of development. Similarly, item status codes reflect the availability of an item so that only the most recent version of an item image is placed on a test form. Items which have been released or rejected are flagged so that they are not available for form construction purposes.

During the form construction process, information is extracted from the item bank: DRC relies on the accuracy of the information stored in the item bank. DRC strives to make updates to items and all item related information in a timely manner to ensure the accuracy and reliability of the bank.

Item Bank Summary

The spring 2012 (Form D) is a rebuilt or reconstructed form composed of the following items: operational items from Form A, Form B, and Form C, embedded field-test items from Form C and remaining items in the pool of approved previously field-tested items. The numbers of items eligible at each grade 4, 8, and 10 remaining in the item bank from the initial field test in spring 2007 and 2011 field tested items available to be used on the rebuilt or reconstructed form are presented in Table 2–4.

Table 2–4. SBA Science Items

Grade 4

Standard	MC	CR
Science as Inquiry and Process	11	0
Concepts of Physical Science	11	0
Concepts of Life Science	16	0
Concepts of Earth Science	14	0
Science and Technology	12	0
Cultural, Social, Personal Perspectives, and Science	NA*	NA*
History and Nature of Science	5	0

Table 2–4 (continued). SBA Science Items

Grade 8

Standard	MC	CR
Science as Inquiry and Process	14	1
Concepts of Physical Science	18	1
Concepts of Life Science	24	0
Concepts of Earth Science	19	0
Science and Technology	NA*	NA*
Cultural, Social, Personal Perspectives, and Science	NA*	NA*
History and Nature of Science	8	0

Grade 10

Standard	MC	CR
Science as Inquiry and Process	15	3
Concepts of Physical Science	12	0
Concepts of Life Science	25	0
Concepts of Earth Science	14	0
Science and Technology	1	0
Cultural, Social, Personal Perspectives, and Science	4	0
History and Nature of Science	8	0

*NA—these standards are locally assessed

SPRING 2012 SCIENCE SBA OPERATIONAL FORMS CONSTRUCTION

The spring 2012 (Form D) is a rebuilt or reconstructed form composed of the following items: items from Form A, items from Form B, items from Form C, and remaining items in the pool of approved previously field-tested items. The form was rebuilt or reconstructed to meet the target range of the content specifications set forth in the target test blueprints, as well as to meet psychometric standards for excellence. It also reflected a range of valid content at the appropriate level of difficulty.

The following information documents the steps DRC's test development specialists took in the construction process to ensure that the Science SBAs (Form D) are of high quality, legally defensible, and meet the requirements as outlined by the Alaska testing program.

Steps in the Forms Construction Process

1. DRC test development specialists reviewed the content standards and test blueprints, including the number of items per domain or reporting category for each content-area test.
2. DRC psychometricians provided DRC test development specialists with the psychometric guidelines for operational forms construction.
3. DRC psychometricians analyzed item statistics for the field tested items and provided DRC test development specialists with characteristics for each item.
4. DRC test development specialists received all item cards and verified that each item image had its correct item characteristics and psychometric data.
5. DRC test development specialists reviewed all items in the operational pool and made an initial selection of items according to test blueprint guidelines and psychometric guidelines.
6. DRC test development specialists created item-mapping charts for the test.
7. Final recommendations for items selected for the operational forms were prepared for review by senior test development staff.
8. Based upon senior review, suggested replacements were made by DRC test development specialists, if necessary.
9. Operational forms were prepared for psychometric review and approval.
10. Based upon psychometric review, suggested replacements were made by DRC test development specialists, if necessary.
11. Operational forms were prepared for EED review and approval.

The spring 2012 forms were reviewed and approved by EED. Feedback was provided and a complete review done to ensure the reconstructed operational forms remained consistent to their original administration and met the parameters of the blueprints.

DRC Internal Review of the Items and Forms

At every stage of the test development process the match of the item to the content standard was reviewed and verified since establishing content validity is one of the most important aspects in the legal defensibility of a test. As a result, it is essential that an item selected for a form link directly to the content curriculum standard and performance standard to which it is measuring. DRC test development specialists verified all items against their classification codes and item maps, both to evaluate the correctness of the classification and to ensure that the given task measures what it purports to measure.

CHAPTER 3: TEST ADMINISTRATION PROCEDURES

OVERVIEW

The 2012 science SBA was administered to students in grades 4, 8, and 10 during the spring of 2012. The test administration window was April 2 through April 16, 2012. However, districts could apply for permission from EED to begin testing the Thursday prior to the start of the window. Specific statewide testing days were not designated.

A District Test Coordinator (DTC) was assigned at every school district. Associate (Building) Test Coordinators were assigned at each school and reported to the DTC. Associate (Building) Test Coordinators oversaw the Test Administrators (district staff who administered the assessment) in their building. DRC distributed the testing materials to DTCs, who disseminated them to the schools.

STUDENT POPULATION TESTED

Districts submitted their enrollment and accommodated materials counts via DRC's eDIRECT Enrollment System, November 7 through December 6, 2011. Districts also submitted their precode files via DRC's eDIRECT Precode system, January 3 through January 17, 2012. Districts with 30 or more schools and 9,000 or more students were given the option to submit their enrollment files directly to DRC by December 6, 2011. Anchorage and Fairbanks took advantage of the opportunity to submit a file and then use DRC's eDIRECT Enrollment System for review and verification of their data. In addition, these larger districts were allowed to submit their precode files via DRC's eDIRECT Precode system by February 17, 2012, with precode and district/school labels arriving in these districts by March 15, 2012.

The enrollment and documents processed counts were as follows:

Table 3–1. Project Counts

District Count	School Count
54	490
Enrollment Count	**Processed Count**
Grade 4: 10,339	**Grade 4:** 9,555
Grade 8: 10,092	**Grade 8:** 9,324
Grade 10: 10,000	**Grade 10:** 9,110

ACCOMMODATIONS

Appropriate accommodations were available for students with disabilities to use while taking the assessments. These accommodations were required to be documented in an Individualized Education Program (IEP) or in a 504 plan. Students with documented transitory impairments and students identified as Limited English Proficient were also permitted to use accommodations.

Acceptable accommodations are documented in the Participation Guidelines for Alaska Students in State Assessments.

Accommodations actually used at testing were required to be marked in the science test book. Districts were instructed to assign test administrators (never the student himself or herself) to mark the inside cover (page 2) of the test book with the student's IEP, 504, and LEP status, as well as accommodations actually used at testing. (As an alternative to marking accommodations in the booklet, districts were permitted to submit a file of accommodations used to EED. Anchorage was the only district to submit such a file.) Accommodations information was reported back to districts in the Reading, Writing, Math, and Science Student Data File and in final Data Interaction for Alaska Student Assessments (DIASA). The results of this data collection are also shown on Table 9–1 of this Technical Report.

TEST ADMINISTRATOR TRAINING

DTCs were trained February 28–29, 2012 by EED and DRC. The training focused on test materials receipt, distribution and return procedures, and general testing information. DTCs scheduled training sessions with test administrators during March and April 2012.

TEST SECURITY

The science SBA materials are considered secure materials. According to Alaska test security regulation 4 AAC 06.765, all test materials must be kept secure. No portion of test materials may be photocopied or duplicated at any time. Except for the person testing, no person, including test administrators, is permitted to read test items on the science SBA prior to, during (except for the student testing), or after administration. Teachers, proctors, test administrators, or any testing personnel may not read test items aloud, silently, to themselves, or to another individual, unless specifically required to provide a documented accommodation to an individual or student group. Parents/guardians may not read test items under any circumstances.

The DTC designated the school and district personnel who had access to secure test materials, and thus needed to sign the Test Security Agreements. All signed test security forms were returned to the DTC and kept on file in the district.

Prior to the first test administration of the school year, DTCs signed and sent their District Test Coordinator Test Security Agreements to EED.

MATERIALS

The following materials were produced for this administration:

- *District Test Coordinator's Manual*
- *Test Administration Directions*
- Form D Science Test Books – Grade 4
- Form D Science Test Books – Grade 8
- Form D Science Test Books – Grade 10
- Large Print Test Books
- Braille Test Books
- Ancillary materials—Periodic table for grade 10 only, precode labels, district/school labels, "Do Not Score" labels, return shipping labels, security checklists, school box range sheets, shipping rosters, and packing lists

Samples of the *District Test Coordinator's Manual* and *Test Administration Directions* are provided in Appendix 9.

Packaging and Shipping Materials

All materials were packaged by school and shipped to the districts in one shipment. All test materials arrived in the districts by March 5, 2012, as scheduled.

District ancillary materials were packed in the last box, which was labeled, "District Materials Enclosed." Boxes were filled 75-percent full to allow districts space to return their materials after they had expanded due to being removed from shrink-wrap and used by students.

All standard format test books were barcoded, packaged by range sheet, and shrink-wrapped in groups of 10. DRC standard format test book overage was shrink-wrapped in groups of three. DRC barcoded all accommodated materials and shrink-wrapped Large Print and Braille test books.

DRC entered, packed, and shipped requests for additional materials March 5–21, 2012. DRC processed 9 additional materials requests for this administration.

Materials Return

Districts returned all materials via Assessment Distribution Services on April 19, 2012, and most materials arrived at DRC's warehouse on April 23, 2012. All districts affixed district-specific, lilac DRC return shipping labels to all of their return boxes.

Box Receipt

As materials arrived, DRC's Materials Processing team (MAT) checked the bill of lading to ensure that the number of boxes received matched the number signed for by the DTC and Assessment Distribution Services. The Materials Processing team scanned each box using the DRC's Operations Materials Management System (OpsMMS) box receipt system. This automated system provided immediate information regarding materials return, including identifying the date and time each box was checked in, where the box originated, and any districts and schools that did not return materials. As soon as box receipt was complete, MAT notified EPM of any schools that did not return a box.

CHAPTER 4: SCORING & STUDENT PERFORMANCE REPORTING

DOCUMENT PROCESSING

All secure materials were scanned in by district through DRC's OpsMMS system to ensure accurate counts. Through an automated precount system, DRC counted the books before check-in and again at scanning to ensure counts matched. If a count did not match, the books were reconciled to ensure accurate numbers. Accommodated testing materials were also checked in securely using the security barcodes on documents.

The Materials Processing team produced a preliminary Missing Materials Report and performed quality checks based on this report. The report was then forwarded to EPM, who checked for documentation regarding missing materials on the security checklists and in recorded correspondence from the districts. If sufficient documentation regarding a material was found, the item was removed from the Missing Materials Report.

DRC used its Image Scanning System to scan the science SBA test books. Scanning of test books was completed on May 2, 2012. All predefined editing and validating rules were followed.

HANDSCORING OF CONSTRUCTED RESPONSES

For the Alaska SBAs, DRC employed a variety of score-point scales for scoring SCR (short constructed-responses) and ECR (extended constructed-response) items.

Preliminary rubrics for field-test items were written during the item development stage, and these rubrics were refined once live student responses were available for review. DRC staff used the rubrics and live student responses to build anchor sets and training materials for each item assessed.

READERS

The scorers for the Alaska SBAs were selected from DRC's larger pool of available professional test scorers. All of our readers for the Alaska SBAs had an undergraduate degree and background in the content areas being assessed.

DRC selects readers who are articulate, concerned with the task at hand, and, most importantly, flexible. Our readers must have strong content-specific backgrounds: they are educators, writers, editors, accountants, and other professionals. They are valued for their experience but, at the same time, are required to set aside their own biases about student performance and accept the scoring standards of the client's program. Candidates must demonstrate proficiency in the content areas they will be scoring.

Rangefinding and Developing Training Material

DRC's Scoring Directors and Content Specialists consensus scored "live" field test responses to create training materials for our scorers. During this process, student responses were selected and the rubric and scoring guidelines were applied. DRC staff moved from item to item until a sufficient number of scored responses were compiled to construct training materials. Responses that were particularly relevant (in terms of the scoring concepts they illustrate) were annotated for use in the scoring guide. The scoring guide for each item served as the readers' constant reference. An anchor set and a training set were created for each field-test item. For operational items, these materials would be enhanced with the addition of further training sets and qualifying sets.

Training the Readers

The fundamental objective of any handscoring activity is that results be accurate and consistent. Therefore, it is important that high-quality methods of training and monitoring readers be employed.

Training for readers in each content area began with a room-wide presentation and discussion of the scoring guide by the Scoring Director and/or Team Leader. The scoring guide for each item contained the scoring rubric and anchor papers that were selected and annotated to define and articulate the score scale. Next, the readers "practiced" by scoring the responses in the training sets. The Scoring Director and/or Team Leaders then led a thorough discussion of each set.

After the scoring guide and all training sets were discussed, readers of operational items demonstrated their ability to apply the scoring criteria by qualifying (i.e., scoring with acceptable agreement with "true" scores) on at least one of the qualifying sets. Any readers who did not qualify by the end of the qualifying process were not allowed to score any Alaska "live" responses.

IMAGING

DRC used its Image Scanning and Scoring system for the handscoring of the responses to constructed-response items.

DRC's hardware environment to support the image handscoring system consists of a server-based solution, with hundreds of handscoring workstations (PCs). Each DRC scoring site has a server, a local area network (LAN), and workstations for readers, Team Leaders, and Scoring Directors. There is locally resident software to view the students' constructed-responses and to recall images of any student document upon demand. Each handscoring site is connected to the DRC main operation facility with multiple T1 transmission lines. The operation facility has multiple application and secure database servers that support the scanning, editing, scoring, and handscoring processes. The database backups and archived images are also housed on the secure servers.

The student responses were separated for readers by item for each subject, and only qualified readers had access to student response images. The readers read each response and keyed in the correct score. After the score is entered, a new response image appeared. Images of specific sets of items (unit-specific) were sent to designated groups of readers qualified to score those items.

This process of routing and scoring sets of imaged items continued until all responses to items or prompts received the prescribed number of independent readings. Non-adjacent scores that required resolving were routed to Scoring Directors or Team Leaders for electronic review and resolution.

Quality Control of Handscoring

DRC's quality control procedures helped to ensure that constructed-response items for the Alaska assessment were scored in an objective and accurate manner using the following approach.

Ten percent of all operational (common) items were independently scored by two readers for the purposes of monitoring inter-rater reliability. The imaging system re-directed every tenth item to a second scorer for another independent reading.

In order to monitor reader reliability and to ensure that an acceptable agreement rate was maintained, DRC monitored the daily statistics provided by the reliability reports, which documented individual reader data, including reader number and team designation, number of responses scored, individual score point distributions, and exact agreement rates. A ratio of one Team Leader for every 10–12 readers was maintained to ensure adequate monitoring of the readers. In addition to this information, Team Leaders conducted routine "read behinds" for all readers. The inter-rater reliability statistics are included in Appendix 10.

Another tool that was used to ensure that accuracy and consistency were maintained in handscoring was the use of validity papers. For this process, Content Specialists and Scoring Directors selected scored papers from a previous administration that were then inserted into the imaging system and dispersed intermittently to the readers. Readers were unaware that they were being dealt pre-scored responses along with live responses. Validity papers were carefully chosen to model the range of each score point. The results of these papers were used as another monitoring tool for all readers.

DATA PROCESSING

The original scanned multiple-choice data was converted into a master student file. Record counts were verified against the counts from the Document Processing staff to ensure all students were accounted for in the file.

DRC provided EED with a demographic correction file so that edits and updates could be applied to student data. After the demographic information was updated, the student file was scored against the appropriate answer key, indicating correct and incorrect responses. Correct responses were designated by converting the numeric value into an alpha value (e.g., 1 becomes A, 2 becomes B). Incorrect responses remained numeric. In addition, the original response string was stored for data verification and auditing purposes.

Scores for a student's constructed responses were systematically matched to the student's multiple-choice responses by a unique document ID (lithocode). This process allowed DRC to score and create a student record for each test book returned for processing, while providing accurate and reliable data. Student scale scores and proficiency levels were determined prior to production of final data files and reports.

Once the scored master student file was deemed 100-percent accurate, DRC's Psychometric Services staff performed additional detailed analysis on the data files prior to EED's review and approval process.

REPORTING

DRC worked with EED to determine appropriate student data file layouts. The layouts included field names, field descriptions, and field values. DRC posted district-level data files and layouts to its eDIRECT online system and placed state-level data files and layouts on an FTP site that EED can access.

DRC created report mockups of the production reports that were produced and delivered for this administration. The mockups comprised simulated, but realistic, data elements and were in the required report layout, displayed the approximate fonts and font sizes, and demonstrated paper size and printing elements.

DRC followed a review process that allowed EED to review, change, and approve all mockups prior to report development. The mockups were reviewed by DRC's Business Analysts and Software Quality Assurance Analysts for accuracy and consistency. EED reviewed the mock-ups as part of the Functional Specifications Document for Reporting review. During the review process, EED was able to evaluate the static content and layout of each report to make certain it reflected the format, verbiage, and design required. DRC worked closely with EED throughout the review process to incorporate any changes or modifications.

EED identified Kenai as the sample district for quality verification, and so DRC prioritized the scoring and reporting of the district's student documents.

During all phases of reporting, DRC performed a thorough quality assurance review prior to releasing of reports. A cycle of sample reports was reviewed by EED prior to producing live reports for districts and schools.

DRC provided the district and state reports and data files as outlined under the "District Reports" and "State Reports" headings that follow. DRC also produced Parent/Student and Teacher/Staff versions of the *Guide to Test Interpretation*. Samples of these guides are provided in Appendix 11 and are also available on EED's Web site.

Final Grades 4, 8, and 10 science SBA reports were provided electronically via eDIRECT as scheduled on May 16, 2012. Paper copies of the final grades 4, 8, and 10 science SBA reports were delivered to the districts as scheduled on or before May 29, 2012.

District Reports

- Student Reports
- School Student Rosters
- School Summary Reports
- School Subpopulation Summary Reports
- District School Rosters

- District Subpopulation Summary Reports
- Student Data File
- Abbreviated Student Data File

State Reports

- Student Data File
- Abbreviated Student Data File
- State Subpopulation Summary Reports
- DVDs

CHAPTER 5: FORM ANALYSIS & ITEM CALIBRATION

RASCH MEASUREMENT MODELS

Scale scores for the science SBAs were developed using the family of Rasch (1960) measurement models for scaling and equating. The advantage of using Rasch models in scaling is that all of the items measuring performance in a particular grade level can be placed on a common difficulty scale, allowing the Rasch difficulty values for the individual items to be used in computing a Rasch logit for any raw score point on any test constructed from scaled items.

Rather than percent correct, the Rasch model expresses item difficulty (and student proficiency) in units commonly referred to as logits. In the simplest case, a logit is a transformed *p*-value with the average *p*-value represented by a logit of zero. The logit metric has several mathematical advantages over *p*-values. It is an interval scale, meaning two items with logits of 0 and +1 are the same distance apart as items with logits of +3 and +4. Logits are independent of the ability distribution of the students taking a particular test. A specific form will have a mean logit of zero, whether the average *p*-value of the test is 0.8 or 0.3. The Rasch model also allows person measures and item measures to be placed on a common scale. This allows the comparison of person ability and item difficulty to determine the probability that a person will respond correctly to any given test item. This comparison is not possible in the percent correct metric used in the true-score model. It is impossible to predict how well a person who answered 80% of the items correctly will perform on an item answered correctly by 80% of the persons.

The standard Rasch calibration procedure sets the mean difficulty of the items on any unanchored calibration at zero. Any item with a *p*-value lower than the mean receives a positive logit and any item with a *p*-value higher than the mean receives a negative logit. Consequently, the logits for any calibration, whether it is a fourth-grade science test or a high-school mathematics test, relate to an arbitrary origin defined by the average of item difficulties for that form. The average fourth-grade science item will have a logit of zero; the average high-school mathematics item will have a logit of zero in unanchored calibrations. This common logit scale describes both item difficulties and student abilities.

Because both dichotomous and polytomous items were part of the science SBAs, DRC utilized a mixed-model item calibration approach that placed both item types onto a common scale. Multiple-choice (MC) items, scored either right or wrong, were calibrated using the familiar form of the dichotomous Rasch model. Constructed-response (CR) items were calibrated using another model in the Rasch family, Master's partial-credit model (Wright & Masters, 1982). The latter model parameterizes each threshold needed to obtain the maximum score on the task. Consequently, there is one item difficulty parameter for each of the $n - 1$ score transitions (0/1, 1/2, etc.), or thresholds. While the partial-credit model is a non-trivial extension of the simple logistic Rasch model, an MC item may be thought of as a partial-credit task with only one threshold.

With the partial-credit model, π_{nix} is the probability that person *n* scores *x* on item *i*. The conditional probability of a score of 1, given a score of 0 or 1 is:

$$\Phi_{ni1} = \frac{\pi_{ni1}}{\pi_{ni0} + \pi_{ni1}} = \frac{\exp(\beta_n - \delta_{i1})}{1 + \exp(\beta_n - \delta_{i1})},$$

where β_n is the ability of person *n* and δ_{i1} is the difficulty of the first threshold for item *i*.

The preceding equation can be expanded to obtain one general expression for the probability of person *n* scoring *x* on item *i*:

$$\pi_{nix} = \frac{\exp\sum_{j=0}^{x}(\beta_n - \delta_{ij})}{\sum_{k=0}^{m_i}\exp\sum_{j=0}^{k}(\beta_n - \delta_{ij})}, \quad x = 0, 1, \ldots, m_i,$$

where m_i is the number of thresholds and for notational convenience,

$$\exp\sum_{j=0}^{0}(\beta_n - \delta_{ij}) = 1.$$

This equation expresses the probability of person *n* scoring *x* on the m_i threshold of item *i* as a function of the person's measure (β_n) and the threshold difficulties (δ_{ij}) of the m_i thresholds for item *i*. The observation *x* is a count of the successfully completed item thresholds.

The unconditional, joint maximum likelihood (UCON) estimation procedure estimates the person parameters (i.e., ability) simultaneously with the item parameters (i.e., difficulty). The UCON procedure was accomplished using WINSTEPS Version 3.74.0 (Linacre, 2012). This calibration software is commercially available and widely used in the testing industry and is considered the industry standard for Rasch calibration.

ITEM STATISTICS

Appendix 12 provides item-level statistics by grade level for the spring 2012 science SBA operational assessments. These statistics (i.e., logit, standard error, fit, *p*-value, item-total correlation, and percent of omits) represent the item characteristics most commonly used to determine whether an item functioned in an appropriate manner. Table 5–1 presents the mean or median of these statistics within each grade level.

The logit column in the table and appendix provides the item difficulty. The standard error (*SE*) column gives the asymptotic standard error associated with these values.

The Rasch fit statistics are used to determine how well items conform to the requirements of the Rasch measurement model. The items were analyzed for scale comparability by examining the residuals between observed and expected scores for the persons and items (Smith, 2000; Mead, 1978). This process investigated the underlying construct measured by a test by analyzing the

patterns of item covariation within the scale. For example, when local dependence is exhibited, it may indicate violations of unidimensionality, thus introducing sources of variability that are unrelated to the construct being measured. Even if some minor item dependence existed in the CR item formats, they were likely to have minor influence on scores (Stout, 1987). A standardized weighted total fit (OUTFIT *z*-std) statistic was computed for each item. This fit statistic quantifies the sum of the squared difference of the observed item performance from the expected performance for all persons. Items may not fit the Rasch model for several reasons, all of which relate to students responding to items in an unexpected way. In many cases, the reason behind why students respond in unexpected ways to a particular item is unclear. However, it is possible to determine possible causes of an item's misfit by re-examining the item and its distractors. Content specialists examined items with large fit statistics and confirmed that each item had only one correct answer and was properly written.

The *p*-value for an MC item is the percent (or proportion) of all students that responded to an item correctly. The *p*-value for a CR item represents the average score earned divided by the maximum number of points for that item. For the spring 2012 science SBA forms, the range of CR item scores is from 0–2 or 0–4 points.

The item-total correlation (PtBis or Corr.) provides a measure of internal consistency of the responses. It assesses how well each item measures the trait defined by the set of items as a whole. Typically, students with high proficiency (i.e., those that perform well on the science SBA overall) would be expected to answer items correctly, and students with low proficiency (i.e., those that perform poorly on the science SBA overall) to answer items incorrectly. If these expectations are met, the item-total correlation between the item and the total test score will be high and positive, indicating that the item is a good discriminator between high-ability and low-ability students. An item-total correlation value above 0.30 is usually considered acceptable. An item-total correlation value below 0.30 indicates that an item may not be measuring what it was intended to measure, and should be reviewed. DRC content specialists reviewed all items with item-total correlations below 0.30 and verified that each item was acceptable as written and scored. As seen in Table 5–1, the median item-total correlations for MC and CR items exceeded the 0.30 criterion.

The omits column represents the proportion of persons leaving the item blank for MC items and the proportion of persons with blanks or other condition codes for CR items. The non-scorable codes are recoded as 0 points during item calibration.

Table 5–1. Summary of Operational Item Analysis

Grade	Item Type	Mean Logit	Mean *SE*	Mean Fit	Mean *p*-value	Median PtBis or Corr	Mean Omits
4	MC	0.04	0.03	-1.68	0.66	0.43	0.01
	CR	0.22	0.02	-1.80	0.66	0.45	0.01
8	MC	0.12	0.03	-1.09	0.64	0.40	0.00
	CR	0.66	0.02	-1.03	0.57	0.56	0.04
10	MC	0.35	0.03	-0.01	0.61	0.37	0.00
	CR	0.95	0.02	1.70	0.49	0.57	0.09

FORM STATISTICS

Tables 5–2 through 5–7 contain summary descriptive statistics for student performance and item difficulty, including mean score, standard deviation, and minimum and maximum scores by grade level. These statistics were generated using WINSTEPS 3.74.0 (Linacre, 2012) and illustrate student and item performance. The top halves of the student summary tables provide descriptive statistics for persons (i.e., students) measured. The column labeled "Measure" provides the mean and standard deviation of the estimated student proficiency measures. The "Model Error" column presents similar information for the asymptotic standard errors.

The top half of the item summary tables provide the same descriptive statistics outlined above, with the exception that items are the unit of analysis rather than students. In this table, "Measure" refers to estimated item difficulty, so that the average measure refers to the average difficulty of the items on the test. Again, "Model Error" is the descriptive statistics for the asymptotic standard errors.

The bottom half of the tables contain the Root Mean Square Error (RMSE). The Real RMSE corresponds to a worst-case error estimate, and Model RMSE corresponds to a best-case estimate. The adjusted standard deviation is an estimate of the "true" standard deviation, which adjusts for potential measurement error by removing it from the standard deviation estimate (Wright & Masters, 1982, see pages 92 and 113):

$$SA_I^2 = SD_I^2 - MSE_I \ ,$$

where SA_I is the adjusted standard deviation, SD_I is the observed standard deviation, and MSE_I is the mean square error, which is calculated using the following equation:

$$MSE_I = \frac{\sum_{i=1}^{L} s_i^2}{L},$$

where L is the number of items and s_i is the standard error of item i.

The RMSE is computed by taking the square root of the MSE value:

$$RMSE_I = \sqrt{MSE_I} \ .$$

The item separation value then provides the adjusted standard deviation in RMSE units. It is calculated by finding the ratio of the adjusted standard deviation to the RMSE:

$$G_I = SA_I / RMSE_I \ .$$

The test reliability estimate is called the index of "item separation reliability." This is a refined measure of internal consistency reliability, which provides the proportion of observed item variance that is not due to estimation error. The item separation reliability estimate is computed using:

$$R_I = \frac{SA_I^2}{SD_I^2}.$$

It can also be calculated using only the separation value:

$$R_I = \frac{G_I^2}{1 + G_I^2}.$$

The processes for obtaining person separation and person separation reliability values are analogous to those for calculating item separation and item separation reliability values. The previous equations should be used, substituting a "*P*" for each "*I*."

Below the tables, the standard error of the mean for the persons and items tested, respectively, are provided. This value is an estimate of the average amount of error associated with the sample person and item means. Two additional statistics, the student raw score-to-measure correlation and Coefficient Alpha student raw score reliability, are also reported below the Student Summary tables.

Table 5–2. Grade 4—Summary of 9272 Measured Students

	Raw Score	Count	Measure	Model Error
Mean	33.1	48.0	1.01	0.38
SD	9.7	0.0	1.21	0.13
Max.	50	48	5.68	1.84
Min.	2	48	-3.50	0.31
	RMSE	**True *SD***	**Person Separation**	**Person Separation Reliability**
Real	0.41	1.14	2.78	0.89
Model	0.40	1.15	2.86	0.89

SE of Student Measure Mean = 0.01
Student Raw Score-to-Measure Correlation = 0.97
Coefficient Alpha Student Raw Score Reliability = 0.91

Table 5–3. Grade 4—Summary of 48 Measured Items

	Raw Score	Count	Measure	Model Error
Mean	6386.3	9272.0	0.05	0.03
SD	1976.5	0.0	0.87	0.00
Max.	15370	9272	1.54	0.04
Min.	3306	9272	-1.70	0.02
	RMSE	**True *SD***	**Item Separation**	**Item Separation Reliability**
Real	0.03	0.87	32.28	1.00
Model	0.03	0.87	32.85	1.00

SE of Item Measure Mean = 0.13

Table 5–4. Grade 8—Summary of 8,927 Measured Students

	Raw Score	Count	Measure	Model Error
Mean	39.2	56.0	0.91	0.31
SD	11.9	0.0	1.04	0.08
Max.	62	56	5.75	1.83
Min.	3	56	-3.01	0.26
	RMSE	**True *SD***	**Person Separation**	**Person Separation Reliability**
Real	0.33	0.99	3.00	0.90
Model	0.32	0.99	3.09	0.90

SE of Student Measure Mean = 0.01
Student Raw Score-to-Measure Correlation = 0.98
Coefficient Alpha Student Raw Score Reliability = 0.91

Table 5–5. Grade 8—Summary of 56 Measured Items

	Raw Score	Count	Measure	Model Error
Mean	6249.1	8927.0	0.16	0.02
SD	2662.9	0.0	0.76	0.00
Max.	22307	8927	1.93	0.04
Min.	2918	8927	-1.86	0.01
	RMSE	**True *SD***	**Item Separation**	**Item Separation Reliability**
Real	0.03	0.76	29.53	1.00
Model	0.03	0.76	30.15	1.00

SE of Item Measure Mean = 0.10

Table 5–6. Grade 10—Summary of 8,420 Measured Students

	Raw Score	Count	Measure	Model Error
Mean	38.0	56.0	0.94	0.30
SD	11.7	0.0	0.99	0.05
Max.	64	56	6.16	1.83
Min.	2	56	-3.30	0.27
	RMSE	**True *SD***	**Person Separation**	**Person Separation Reliability**
Real	0.32	0.94	2.98	0.90
Model	0.30	0.94	3.10	0.91

SE of Student Measure Mean = 0.01
Student Raw Score-to-Measure Correlation = 0.99
Coefficient Alpha Student Raw Score Reliability = 0.90

Table 5–7. Grade 10—Summary of 56 Measured Items

	Raw Score	Count	Measure	Model Error
Mean	5710.0	8420.0	0.40	0.03
SD	3051.4	0.0	0.88	0.00
Max.	24440	8420	2.50	0.04
Min.	2105	8420	-1.54	0.01
	RMSE	**True *SD***	**Item Separation**	**Item Separation Reliability**
Real	0.03	0.88	33.42	1.00
Model	0.03	0.88	34.07	1.00

SE of Item Measure Mean = 0.12

FREQUENCY DISTRIBUTIONS

Items

Appendix 13 provides frequency distributions of all science SBA item difficulties, including the thresholds for CR items. Each item sequence number is shown to the right of its corresponding logit, which represents the lowest possible value for that row. When more than one item falls in the logit range, the items are arranged from lowest to highest logit value. For instance, as seen in Figure 13–1 of the appendix, the logit value for grade 4 Item 36 is between 0.7 and 0.9, and it is also lower than the logit value for Item 13, which is located on the same line. In addition, each CR item sequence number is displayed to the right of its corresponding logit for each possible threshold.

Persons

Appendix 14 provides frequency distributions of raw scores and scale scores by grade for the spring 2012 science SBA administration. The columns in these tables present each raw score, scale score, scale score asymptotic standard error, frequency count, frequency percent, cumulative frequency, and cumulative percent. The range of reported scale scores for the science SBAs is 100 through 600.

CAUTIONS FOR SCORE USE

As with any assessment, student scores at the minimum or maximum ends of the score range will have large standard errors of measurement and should be viewed cautiously. For instance, if the maximum score for the grade 8 science SBA is 600 and a student achieves this score, it cannot be determined whether the student would have achieved a higher scale score if that score were possible. All that is known is that the student's scale score, as revealed by this test, is at least 600. In this manner, extreme scale scores may vary from one administration to the next even if the number of items tested does not, making comparisons of students that score at the extreme ends of the score distribution difficult. To minimize confusion and the potential for misinterpretation, the maximum scale scores possible on the SBAs have been fixed so they do not change across administrations.

CHAPTER 6: SCALING & EQUATING

INTRODUCTION

To maintain the same passing standard across different administrations, EED, in association with testing vendors, constructs all tests to be of similar difficulty. This similarity is maintained from administration to administration at the total test level and, as much as possible, at the reporting standard level.

The spring 2012 operational science SBA tests were new forms developed for this administration. Because these forms were new forms, pre-equating based field-test item difficulties (when possible) was employed.

In addition to the operational items, DRC embedded unscored placeholder items in order to allow for field-test items to be placed in the same sequence in future tests. These items do not count toward an individual student's score.

Because the operational forms used in 2012 were new forms, post-test common-item equating was used to place the scale scores on the same metric as the 2008 science standard setting forms.

ITEM CALIBRATION

The stability (invariance) of the item difficulties for the spring 2012 administration was determined by anchoring the operational item difficulty values to those obtained from the items' previous administrations. This anchored calibration method produced results such that the items and thresholds were on the same scale as the original (spring 2008) operational test form. The WINSTEPS (Linacre, 2012) program was used to anchor (hold the item difficulty constant) the Rasch item difficulty estimates and the constructed-response (CR) threshold estimates for the items from the previous administrations, as well as estimate the change in item difficulty (displacement) between the field test and operational administrations.

The calibrated item and threshold difficulties were used in conjunction with actual student performance to obtain Rasch ability estimates for each possible raw score value for the overall test, as well as each subscale/reporting standard. The generation of this raw score-to-Rasch ability was accomplished through fundamental formulas in the Rasch measurement model (Wright and Masters, 1982).

SCALING

The combination of both dichotomously scored MC items as well as polytomously scored CR tasks required the use of a partial-credit model. The Newton-Raphson iterative procedure was used to obtain precise ability estimates:

$$b_r^{(t+1)} = b_r^t - \frac{r - \sum_i^L \sum_{k=1}^{m_i} kP_{rik}^{(t)}}{-\sum_i^L \left[\sum_{k=1}^{m_i} k^2 P_{rik}^{(t)} - \left(\sum_{k=1}^{m_i} kP_{rik}^{(t)} \right)^2 \right]}, \quad r = 1,\ldots, M-1,$$

where b_r^t is the estimated ability of the student with score r after t iterations, k is the number of thresholds, L is the number of items, $M = \sum_i^L m_i$, and $P_{rik}^{(t)}$ is the probability π_{nix} defined earlier in Chapter 5:

$$\pi_{nix} = \frac{\exp \sum_{j=0}^{x} (\beta_n - \delta_{ij})}{\sum_{k=0}^{m_i} \exp \sum_{j=0}^{x} (\beta_n - \delta_{ij})}, \quad x = 0, 1, \ldots, m_i.$$

The asymptotic standard error was estimated from the denominator of the final iteration:

$$SE(b_r) = \left[\sum_i^L \left[\sum_{k=1}^{m} k^2 P_{rik}^{(t)} - \left(\sum_{k=1}^{m} k P_{rik}^{(t)} \right)^2 \right] \right]^{-1/2}.$$

The iteration was terminated using the WINSTEPS convergence criteria of 0.01 maximum logit change.

ITEM BANK MAINTENANCE

The item bank was then updated with the operational item statistics from this administration.

CHAPTER 7: FIELD-TEST ITEM DATA SUMMARY

There were no field-test items for this test administration; therefore, no field-test item data summary is provided.

CHAPTER 8: SCALE SCORES & PERFORMANCE LEVELS

OVERVIEW

To ensure that student proficiency results for each grade are reported on a common standard score scale, EED provides a unique scale score conversion system for each SBA assessment. In this system, raw scores are converted to a logistic metric. Logit measures are then transformed into scale scores. Scale scores are intended to make scores more meaningful by defining a scale of measurement that is not tied to a particular test form. The scales across all grades have a theoretical maximum of 600, a minimum of 100, with the proficient cut score fixed to 300.

DESCRIPTION OF SCORES

Raw Score

The basic summary statistic on all SBA assessments is the raw score. A raw score is reported for each examinee taking the science SBA. The raw score is the number of multiple-choice (MC) items answered correctly plus the number of points earned on constructed-response (CR) items. By itself, the raw score has limited utility; it can only be interpreted in reference to the total number of items on an assessment, and raw scores should not be compared across reporting categories or administrations.

Scale Score

Since a given raw score may not represent the same skill level on every test form, all statewide assessment score reports include scale scores. Scale scores are statistical conversions of raw scores that adjust for slight shifts in item difficulties and permit valid comparison across all test administrations within a particular grade and content area.

When new test forms are developed, the new set of items may require slightly different levels of content-area skill to answer correctly. This depends on the difficulty of the specific questions used on each form. To be fair to students and to permit valid comparison of test scores across administrations, the skills represented by each scale score point must remain consistent from year to year.

As noted previously, scale scores adjust for slight shifts in underlying difficulty levels at each score point and provide valid points of comparison across all test administrations within a particular grade and content area. With scale scores, schools can reasonably compare the demonstrated knowledge and performance of groups of students across years.

Comparability of Scale Scores Across Grades

Through the process described in the previous section, the standards for Proficient were established to have consistent interpretation from grade tested to grade tested. The logit measures that defined the Proficient cut score for each grade were thus defined to be a scale score of 300. As a result, a student who receives a scale score of 300 at each grade is making progress that is the same as the growth defined by the Proficient standards across the grades tested.

Further, the relationship between the logit measures and the scale scores was established so that the standard deviation of scale scores would be 75 on average across all the grades in the baseline year. As seen in the science SBAs, the standard deviation of the logit measures varies from grade to grade. Therefore the standard deviation of student scale scores is higher than 75 at some grades and less than that amount at others.

As a result, the interpretation of scale scores is the same for all grades in the following context: a scale score of 225, for example, means that the student scored approximately one standard deviation below the standard for Proficient. If that same student had a scale score of 250 in that subject at the next grade tested (meaning the student now is approximately 0.67 standard deviations below the standard for Proficient), the student is now closer to the standard of Proficient at this grade than he/she was the year previously to the standard for Proficient at the lower grade. Restated, a higher scale score at one grade than another means that the student is achieving at a higher level relative to the standard for Proficient at the higher grade.

TRANSFORMATIONS

As previously mentioned, raw scores were transformed into logits in the initial calibration. Logits in turn were mathematically transformed into scale scores to provide a more convenient metric for reporting. To maintain consistency from administration to administration, the minimum scale score necessary for proficiency was set at 300 for each grade. The minimum scale scores necessary for each proficiency level are provided in Table 8–1. Table 8–2 provides the equations and minimum logits used for each transformation. These equations were applied to the overall test as well as to each reporting subscale. Refer to Appendix 13 to locate the logit cut scores compared to item difficulties for each grade.

Table 8–1. Science Raw and Scale Score Cut Scores for Each Proficiency Level

	Raw Score Cut Score			Below Proficient		Proficient		Advanced	
Grade	Below Proficient	Proficient	Advanced	SS Cut	SS *SE*	SS Cut	SS *SE*	SS Cut	SS *SE*
4	24	35	43	233	18	300	19	357	24
8	30	39	50	258	17	300	18	359	21
10	24	35	47	245	19	300	19	369	21

Table 8–2. Transformation Equations

		Logit Cutpoint		
Grade	Transformation Equation	FBP/BP	BP/P	P/A
4	Scale Score = (57.6923 x Logit) + 241.0692	-0.1375	1.0128	2.0086
8	Scale Score = (65.7895 x Logit) + 249.5526	0.1338	0.7592	1.6675
10	Scale Score = (69.4444 x Logit) + 257.9306	-0.1807	0.5986	1.5922

Complete raw-to-scale score tables are provided in Appendix 14.

SCALE SCORE SUMMARY STATISTICS

Table 8–3 includes scale score descriptive information for each overall grade level. Subscale descriptive statistics can be found in Appendix 15. Histograms of the overall test scale scores are also provided in Figures 8–1 to 8–3.

Table 8–3. Content Area Scale Score Information

	Grade 4 (*n*=9281)	Grade 8 (*n*=8939)	Grade 10 (*n*=8435)
Mean	299.23	309.21	323.49
Standard Error of Mean	0.73	0.73	0.75
Median	295.00	311.00	324.00
Mode	366	357	351
Standard Deviation	70.00	68.68	68.63

Figure 8–1. Grade 4 Scale Score Frequencies

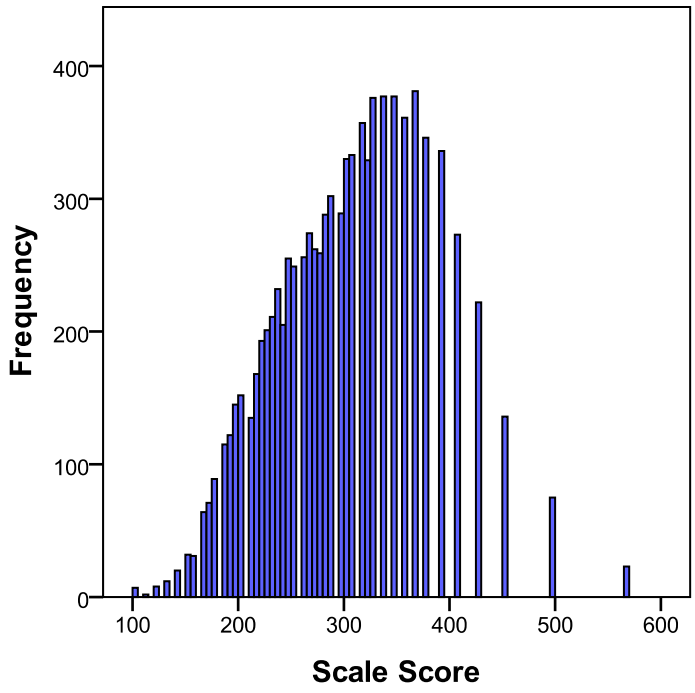


Figure 8–2. Grade 8 Scale Score Frequencies

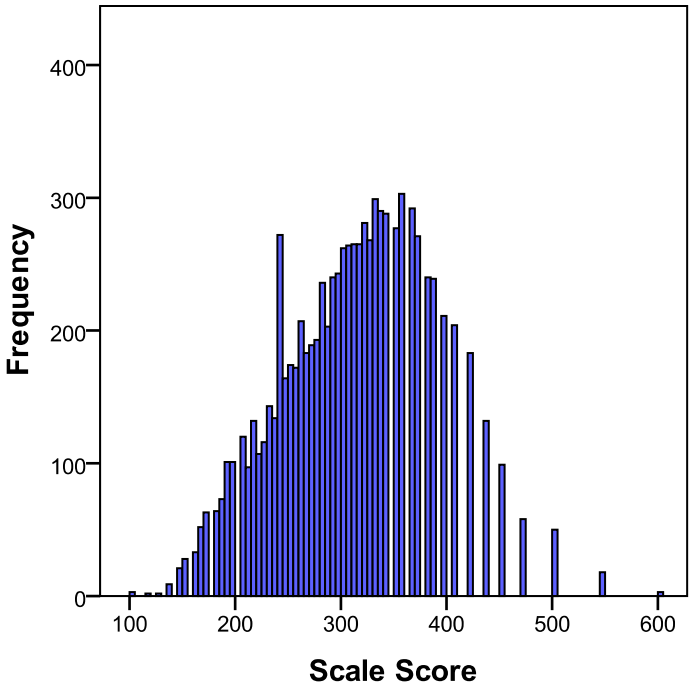
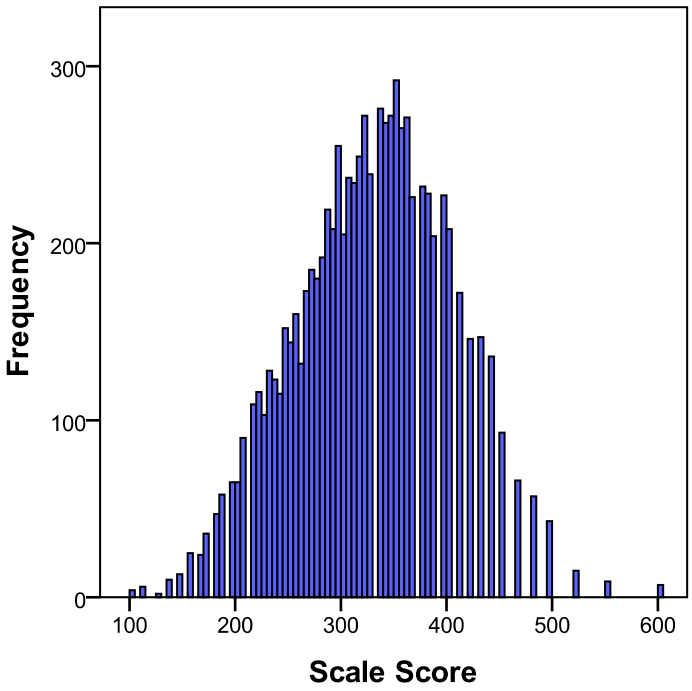


Figure 8–3. Grade 10 Scale Score Frequencies



PROFICIENCY LEVELS

Alaska has four levels of achievement on the SBA tests: Far Below Proficient (FBP), Below Proficient (BP), Proficient (P), and Advanced (A).

Scale score cutpoints at each level of proficiency are the same each year. Appendix 16 provides detailed information about the proficiency level as well as the Proficiency Level Definitions and Descriptors in each grade tested.

Table 8–4 provides the distribution of students in each of the proficiency levels for all grades.

Table 8–4. Student Distribution of the Four Proficiency Levels

	Grade 4		Grade 8		Grade 10	
	n	**%**	***n***	**%**	***n***	**%**
Far Below Proficient	1778	19.16	2011	22.50	1139	13.50
Below Proficient	2871	30.93	1866	20.87	2000	23.71
Proficient	2840	30.60	3062	34.25	3080	36.51
Advanced	1792	19.31	2000	22.37	2216	26.27

CHAPTER 9: TEST VALIDITY & RELIABILITY

INTRODUCTION

Validity is the process of collecting evidence to support inferences from the use of the scores derived from the assessment process. Evidence on content validity of the spring 2012 science SBA is presented in terms of how the assessments were assembled to reflect the EED-prescribed blueprints that in turn reflect state content standards in each grade.

Reliability is defined as the consistency of measures. The ability to measure consistently is a necessary, but not sufficient, condition for making valid interpretations of the results.

VALIDITY

Content/Curricular Validity

The science SBA is a criterion-referenced assessment. This assessment is based on an extensive definition of the content it assesses. Therefore, the science SBA is content-based and aligned directly to the Alaska statewide content standards and should demonstrate good content validity. Content validity addresses whether the test adequately samples the relevant material it purports to cover.

Relation to Statewide Content Standards

From the inception of the science SBA, a committee of educators, item development experts, assessment experts, and EED staff have met to review new and field-tested items. A sequential review process has been put in place by EED. This provides many opportunities for these professionals to offer suggestions for improving or eliminating items as well as offer insights into the interpretation of the statewide content standards for the science SBA. These review committees participate in this process to ensure test content validity of the science SBA.

In addition to providing information on the difficulty, appropriateness, and fairness of these items, committee members provide a needed check on the alignment between the items and the content standards they are intended to measure. When items are judged relevant, that is, representative of the content defined by the standards, this judgment provides evidence to support the validity of inferences made (regarding knowledge of this content) with science SBA results. When items are judged to be unacceptable for any reason, the committee can either suggest revisions (e.g., reclassification, rewording) or elect to eliminate the item from the field-test item pool. Items that are approved by the review committee can later be embedded in operational science SBA forms to allow for the collection of performance data. In essence, these committees review and verify the alignment of the test items with the objectives and measurement specifications to ensure that the items measure appropriate content. The nature and specificity of these review procedures provide strong evidence for the content validity of the science SBAs.

Educator Input

For the spring 2012 science SBAs, Alaska educators provided valuable input on the alignment of the items and the statewide content standards during item development. Items were written specifically to measure the objectives and specifications of the content standards for the science SBA. Because many different people with different backgrounds wrote the items, the process included a built-in system of checks-and-balances for item development and review that reduced single-source bias. This direct input from educators offers evidence regarding the content validity of the science SBA. See Chapter 2 for details regarding the content review process.

Developer Input

EED and DRC staff have a history of test building experience, including content-related expertise, that they contributed to the development of the spring 2012 forms. The input and review by these assessment professionals provided further support of the item being an accurate measure of the intended objective. Thus, these reviews offer additional evidence for the content validity of the science SBAs.

Item to Content Area Match

Expert judgments from educators, test developers, and assessment specialists provide support for the alignment of the science SBAs with the statewide content standards. In addition, because expert teachers in the science content area were involved in establishing the content standards, the judgments of these same expert teachers in the review process provide a measure of content validity. A match between the content standards and the components of the science SBAs provides evidence that the assessment measures the content standards. A table showing the number of assessment components, tasks, or items matching each content standard is often used to provide documentation of the content validity of an assessment. The science SBA test blueprint provides this documentation. The blueprints for science are presented in Appendix 1.

Construct Validity

The term construct validity refers to the degree to which the test score is a measure of the educational domain (i.e., construct) of interest. A construct is an individual characteristic that is assumed to exist in order to explain some aspect of behavior (Linn & Gronlund, 1995). When a particular individual characteristic from the assessment results is inferred, a generalization or interpretation of some construct is made. For example, problem solving is a construct. An inference that students who master the mathematical reasoning portion of an assessment are “good problem-solvers” implies an interpretation of the results of the assessment in terms of a construct. To make such an inference, it is important to demonstrate that this is a reasonable and valid use of the results.

Construct-related validity evidence can come from many sources. *The Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 1999) provides the following list of possible sources:

- High intercorrelations among assessment items or tasks attest that the items are measuring the same trait, such as a content objective, sub-domain, or construct.
- Substantial relationships between the assessment results and other measures of the same defined construct.
- Little or no relationship between the assessment results and other measures that are clearly not of the defined construct.
- Substantial relationships between different methods of measurement regarding the same defined construct.
- Relationships to non-assessment measures of the same defined construct.

Evidence of Construct Validity

The collection of construct-related evidence is a continuous and ongoing process. Four indicators of construct validity for the spring 2012 science SBAs are item-total correlations, Rasch item fit statistics, intercorrelations, and test dimensionality.

Item-Total Correlations

An item-total correlation is the correlation between an item and the total test score, excluding that item score. Conceptually, if an item has a high item-total correlation (i.e., 0.40 or above), it indicates that students who performed well on the test overall usually answered the item correctly and students who performed poorly on the test overall usually answered the item incorrectly. That is, the item did a good job discriminating between high performing and low performing students. Assuming that the total test score represents the extent to which a student possesses the construct being measured by the test, high item-total correlations indicate that the items on the test require knowledge of this construct in order to be answered correctly. Item-total correlations for items on the spring 2012 science SBAs can be found in Appendix 12. The majority of items have item-total correlations of at least 0.30 (84% of items). These high item-total correlations provide evidence for construct validity.

Fit Statistics

In addition to item-total correlations, Rasch fit statistics also provide good evidence of construct validity. The Rasch model requires unidimensional data. Therefore, statistics showing that the items fit the measurement model also provide evidence of construct validity. Fit statistics for the spring 2012 SBAs can be found in Appendix 12. In this administration, 75% of item fit statistics are below +5.00, indicating good construct validity.

Intercorrelations

A third indicator of construct validity is the intercorrelations between the grade-level total scale scores and the subscale reporting category scale scores. This information is contained in Appendix 17.

Test Dimensionality

Further evidence of construct validity can be obtained from the principal component analysis of the Rasch residuals that is available through the WINSTEPS software. The residual is the difference between the observed and expected score for every item/person interaction included in the calibration. Information on the results of the principal component analysis of the residuals is found in Appendix 18.

The information in each table is divided into four parts. The first part presents the total standardized residual variance in eigenvalue units and plots those eigenvalue units in a scree plot. The second part repeats the eigenvalue unit information and provides a plot of the contrast loadings for the first contrast. The third part provides a numerical table of the values plotted in the second part along with some additional item information, such as item measure, fit statistics, item position and item ID and item type (M = multiple choice and 0 = constructed response). The fourth part lists the largest standardized residual correlations for item pairs. This information is provided for the three science SBA tests.

Validity Evidence for Different Student Populations

The primary evidence for the validity of the science SBAs lies in the content and construct being measured. Because the test assesses the statewide content standards required to be taught to all students, the test is not more or less valid for use with one subpopulation of students over another subpopulation. In other words, because the science SBA is measuring what is required to be taught to all students and is given under the same standardized conditions to all students, the validity of score interpretations should apply to all students. Tables 9–1 through 9–3 present the student demographic, disability, and accommodation information for the science SBAs.

Table 9–1. Summary of Student Demographics

Demographics	Grade 4		Grade 8		Grade 10	
	N	%	*N*	%	*N*	%
ALL STUDENTS	9281	100.00	8939	100.00	8435	100.00
ETHNICITY						
White (Caucasian)	4575	49.29	4585	51.29	4494	53.28
African American	372	4.01	338	3.78	291	3.45
Hispanic	619	6.67	564	6.31	541	6.41
Asian/Pacific Islander/Native Hawaiian	781	8.42	802	8.97	751	8.90
Alaska Native and American Indian	2121	22.85	2054	22.98	1831	21.71
Two or more races	813	8.76	596	6.67	527	6.25
Unknown						
SOCIOECONOMIC STATUS						
Not Low Income	4587	49.42	4828	54.01	5057	59.95
Low Income	4694	50.58	4111	45.99	3378	40.05
ENGLISH PROFICIENCY STATUS						
English Proficient	8236	88.74	8060	90.17	7683	91.08
Limited English Proficient	1045	11.26	879	9.83	752	8.92
MIGRANT STATUS						
Non-Migrant	8610	92.77	8240	92.18	7806	92.54
Migrant	671	7.23	699	7.82	629	7.46
SPECIAL EDUCATION STATUS						
Regular Education	7928	85.42	7826	87.55	7530	89.27
Individualized Education Plan	1353	14.58	1113	12.45	905	10.73
GENDER						
Female	4543	48.95	4406	49.29	4090	48.49
Male	4738	51.05	4533	50.71	4345	51.51
ACCOMMODATIONS						
Total	11	100.00	8	100.00	4	100.00
Braille	1	9.09	1	12.50	2	50.00
Large Print	10	90.91	7	87.50	2	50.00

Table 9–2. Summary of Primary Disability (Students with an IEP only)

Primary Disability	Grade 4		Grade 8		Grade 10	
	N	%	*N*	%	*N*	%
IEP STUDENTS	955	100.00	888	100.00	717	100.00
Cognitively Impaired	14	1.47	15	1.69	8	1.12
Hearing Impairment, includes Deaf	4	0.42	12	1.35	8	1.12
Speech or Language Impairment	53	5.55	16	1.80	19	2.65
Visual Impairment	3	0.31	4	0.45	3	0.42
Emotional Disturbance	40	4.19	52	5.86	48	6.69
Orthopedic Impairment	5	0.52	1	0.11	2	0.28
Other Health Impairment	176	18.43	163	18.36	127	17.71
Specific Learning Disability	598	62.62	571	64.30	463	64.57
Deaf-Blindness	1	0.10	1	0.11	0	0.00
Multiple Disabilities	8	0.84	6	0.68	6	0.84
Autism	52	5.45	44	4.95	28	3.91
Traumatic Brain Injury	1	0.10	3	0.34	5	0.70
Developmentally Delayed	0	0.00	0	0.00	0	0.00
STUDENTS WITH PREVIOUS SPECIAL EDUCATION SERVICES						
Received special education services at time of SBA last year but no longer qualifies for special education services at time of testing this year	109		58		33	
Reported as "Received special education services at time of SBA last year but no longer qualifies for special education services at time of testing this year" last year	104		59		31	

Table 9–3. Summary of Student Accommodations

Accommodations	Grade 4		Grade 8		Grade 10	
	N	%	*N*	%	*N*	%
IEP/504 STUDENTS	1024	100.0	956	100.0	794	100.0
Timing						
Flexible schedule over several days	17	1.66	12	1.26	9	1.13
Other	584	57.03	369	38.60	196	24.69
Setting						
Individual administration	108	10.55	57	5.96	52	6.55
Small group administration	720	70.31	776	81.17	636	80.10
Other	241	23.54	151	15.79	134	16.88
Response – Test Format						
Other	131	12.79	51	5.33	18	2.27

Table 9–3 (continued). Summary of Student Accommodations

Accommodations	Grade 4		Grade 8		Grade 10	
	N	%	*N*	%	*N*	%
Response – Assistive Devices/Supports						
Computer or keyboard without spell &	6	0.59	14	1.46	59	7.43
Alternative responses	1	0.10	6	0.63	2	0.25
Other	22	2.15	16	1.67	14	1.76
Presentation – Test Directions						
Student asks for clarification of directions	572	55.86	475	49.69	342	43.07
Clarifying directions by student restating	198	19.34	106	11.09	50	6.30
Providing written version of oral directions	3	0.29	9	0.94	1	0.13
Other	293	28.61	111	11.61	42	5.29
Presentation – Test Questions						
Reading/signing test questions	741	72.36	367	38.39	116	14.61
Other	127	12.40	31	3.24	9	1.13
Presentation – Assistive Devices/Supports						
Calculator (minimal functions)	7	0.68	91	9.52	67	8.44
Adaptive equipment to deliver assessment	1	0.10	0	0.00	0	0.00
Math manipulatives	7	0.68	1	0.10	2	0.25
Other	39	3.81	23	2.41	2	0.25
LEP STUDENTS	735	100.0	442	100.0	337	100.0
Indirect Linguistics Support – Timing						
Flexible schedule over several days	7	0.95	0	0.00	1	0.30
Test Administration Practices						
Individual administration	23	3.13	8	1.81	9	2.67
Small group administration	529	71.97	314	71.04	268	79.53
Direct Linguistic Support – Test Items						
Read aloud test items in English	524	71.29	153	34.62	102	30.27
Provide native language word for unknown word	48	6.53	4	0.90	8	2.37
Allow student to respond orally to constructed response items in English	9	1.22	3	0.68	1	0.30
Provide test contractor audio version	NA	NA	NA	NA	0	0.00
Direct Linguistic Support – Reference Materials						
Provide commercial word-to-word bilingual dictionary	14	1.90	52	11.76	72	21.36
Other	286	38.91	186	42.08	122	36.20

Great care has been taken to ensure that the items comprising the science SBAs are fair and representative of the content domain expressed in the content standards. Much scrutiny is applied to the items and their possible impact on minority or other subpopulations making up the population in the state of Alaska. Every effort is made to eliminate items that may have gender, ethnic, or cultural biases. See Chapter 2 for the discussion of how potential item bias is identified.

RELIABILITY

True-score theory considers all measures as having a "true" component and an error component. Errors occur as a natural part of the measurement process and can never be eliminated entirely. For example, uncontrollable factors such as differences in the physical world and changes in examinee disposition may work to increase error and decrease reliability. This is the fundamental premise of true-score reliability analysis and measurement theory. Stated explicitly, this relationship can be seen as the following:

$$X = T + E, \tag{1}$$

where X represents the observed test score, T, the student's true score, and E, random error.

If the variance of the observed measures is denoted by σ_X^2 and the variance of error by σ_E^2, then the reliability (ρ_{xx}) is given by:

$$\rho_{XX} = \frac{\sigma_X^2 - \sigma_E^2}{\sigma_X^2}. \tag{2}$$

The variance of the observed measures can be estimated from the variance of the raw scores using the usual variance formula and the error variance can be estimated by:

$$\Sigma\, p_i\,(1 - p_i), \tag{3}$$

where p_i is the proportion correct for each item.

The reliability index used for the 2012 administration of the science SBAs was Coefficient Alpha (Cronbach, 1951):

$$\alpha = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum \sigma_i^2}{\sigma_X^2}\right), \tag{4}$$

where k is the number of items, σ_i^2 is the variance of the set of scores associated with item i, and σ_X^2 is the variance of the set of observed total scores.

Acceptable α values generally range in the high 0.80s to low 0.90s. When there is no error, the reliability index is the true score variance divided by the true score variance, which is one. Tables 5–2 through 5–7 provide Coefficient Alpha for each grade. As can be seen in the tables, the grades 4, 8, and 10 forms have Coefficient Alphas of 0.91, 0.91, and 0.90 respectively. These

high α values provide evidence for good reliability. Appendix 19 provides the reliability of the assessments for each subpopulation required by NCLB.

Standard Error of Measurement

The standard error of measurement uses the information from the test along with an estimate of reliability to make statements about the degree to which error is impacting individual scores. The standard error of measurement is based on the premise that underlying traits, such as academic achievement, cannot be measured exactly. The standard error expresses unreliability in terms of the raw score metric. Using the standard error of measurement, an error band can be placed around an individual score indicating the degree to which error might be affecting that score. In true-score test theory, the standard error of measurement can be calculated by:

$$SEM = \sigma_X \sqrt{1 - \rho_{XX}} \ , \qquad (5)$$

where, σ_X is the standard deviation of the total test (observed measure scores), and ρ_{xx} is the reliability estimate (Coefficient Alpha) for the test.

The true-score test theory approach to judging a test's consistency can be useful for making overall comparisons between alternate forms. However, it is not very useful for judging the precision with which a specific student's score is known. The Rasch measurement model provides asymptotic standard errors that pertain to each unique ability estimate (i.e., raw score).

Ability estimates from scores near the center of the test are known with greater precision than are abilities associated with extremely high or low scores. The expression for computing the asymptotic standard error via WINSTEPS was provided in Chapter 6. This value is then transformed to the science SBA scale to obtain the final SEM for each raw score. These values for the spring 2012 science SBAs are provided in the raw-to-scale score tables in Appendix 14. In addition, person separation reliability and item separation reliability values, which use these asymptotic standard errors, are provided in Tables 5–2 through 5–7. Person separation reliability is the Rasch equivalence of reliability described in Equation 2.

Indicators of Consistency

Criterion-referenced tests are often used to place the examinees into two or more performance classifications. It is then useful to have some indication of how consistent such classifications are.

Method I

In a personal communication to DRC from Dr. Huynh Huynh on the DRC/South Carolina project, an extension of the two-parameter beta-binomial model (Huynh, 1976) to polytomous constructed-response items was detailed. This extension was used in these computations. Table 9–4 depicts the general framework of multiple decisions.

Table 9–4. Multiple Decisions—General Framework

	Category 1	Category 2	Category 3	Category 4	Total
Category 1	p_{11}				$p_{1.}$
Category 2		p_{22}			$p_{2.}$
Category 3			p_{33}		$p_{3.}$
Category 4				p_{44}	$p_{4.}$
Total	$p_{.1}$	$p_{.2}$	$p_{.3}$	$p_{.4}$	$p_{..}$

From this general framework the reliability index can be computed:

$$\kappa = \frac{1-p}{p-p_c},$$

where $p = p_{..}$,

$$p_c = \sum_i p_{i.}^2,$$

$$p_{11} = \sum_{x,y=c_1}^{n} f(x,y),$$

and

$$p_1 = \sum_{x=c_1}^{n} f(x).$$

Method II

To solve the problem of a complex assessment, Livingston and Lewis (1995) proposed an effective test length,

$$n = \frac{(\mu_x - X_{\min})(X_{\max} - \mu_x) - r\sigma_x^2}{\sigma_x^2(1-r)},$$

which transforms the original raw score random variable from $X = 0,\ldots,K$ into a new random variable $X' = 0,\ldots,n$, where n is the number of dichotomous, locally independent, equally difficult items required to produce a raw score of the same reliability. Then, using the transformed observed distribution X', parameters are estimated for a four parameter beta-binomial model where the conditional error distribution is assumed to be binomial. The X' distribution is then converted back onto the original X scale using interpolation. This method is designed only to estimate a contingency table, not a full bivariate distribution which means the probability of a consistent decision by chance, and subsequently kappa, cannot be estimated.

The results of both consistency analyses are presented in Table 9–5.

Table 9–5. Decision Consistency Indices

	Huynh (1976)				Livingston and Lewis (1995)	
	4 categories (FBP, BP, P, A)		2 categories (Not Proficient, Proficient)		4 categories (FBP, BP, P, A)	2 categories (Not Proficient, Proficient)
Grade	Consistency Index	κ	Consistency Index	κ	Consistency Index	Consistency Index
4	0.73	0.59	0.86	0.72	0.74	0.88
8	0.69	0.58	0.87	0.74	0.68	0.88
10	0.69	0.57	0.87	0.72	0.69	0.88

REFERENCES

American Educational Research Association, American Psychological Association, & National Council on Measurement in Education (1999). Standards for educational and psychological testing. (2nd ed.). Washington, DC: American Educational Research Association.

Bloom, B. S., Englehart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. 1956. Taxonomy of Educational Objectives: The classification of educational goals: Handbook 1: Cognitive Domain. New York: McKay.

Center for Universal Design (1997). *What is universal design?* Raleigh, NC: Center for Universal Design, North Carolina State University.

Cronbach, L. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16,* 297–334.

Holland, P., & Thayer, D. (1986, April). *Differential item performance and the Mantel-Haenszel procedure*. Paper presented at the American Educational Research Association annual meeting, San Francisco, CA.

Huynh, H. (1976). On the reliability of decisions in domain-referenced testing. *Journal of Educational Measurement, 13*, 253–64.

Linacre, J. M. (2011). WINSTEPS Rasch measurement (Version 3.71.0.1). [Computer program]. Chicago: WINSTEPS.com.

Linn, R., & Gronlund, N. (1995). *Measurement in assessment and teaching* (7th ed.). Upper Saddle River, NJ: Prentice-Hall.

Livingston, S. A., & Lewis, C. (1995). Estimating the consistency and accuracy of classifications based on test scores. *Journal of Educational Measurement, 32*, 179–197.

Mead, R. J. (1978). Examining residuals from the Rasch model. *Proceedings of the 1978 conference on adaptive testing.* Minneapolis, MN: University of Minnesota.

Mogilner, A. (1992). Children's Writer's Word Book. Cincinnati, OH: Writer's Digest Books.

Rasch, G. (1960). *Probabilistic models for some intelligence and attainment tests*. Copenhagen, Denmark: Danish Institute for Educational Research (Expanded edition, 1980. Chicago: University of Chicago Press).

Smith, R. M. (2000). Fit analysis in latent trait measurement models. *Journal of Applied Measurement, 1*, 199–218.

Stout, W. (1987). A non-parametric approach to assessing latent trait unidimensionality. *Psychometrika, 52*, 589–617.

Taylor, S. E., Frackenpohl, H., White, C. E., Nieroroda, B. W., Browning, C. L., & Brisner, E. P. (1989). EDL Core Vocabularies in Reading, Mathematics, Science, and Social Studies. Orlando, FL: Steck-Vaughn Company.

Thompson, S., Johnston, C. J., & Thurlow, M. L. (2002). Universal design applied to large scale assessments. National Center on Educational Outcomes Synthesis Report 44. Minneapolis, MN: University of Minnesota.

Webb, N. (2006). *Research monograph number 6: Criteria for alignment of expectations and assessments on mathematics and science education*. Washington, D.C.: CCSSO

Webb, N. L. (2002). Alignment Study in Language Arts, Mathematics, Science, and Social Studies of State Standards and Assessment for Four States. Washington, D.C.: Council of Chief State School Officers.

Wright, B. D., & Bell, S. R. (1984). Item banks: What, why, how. *Journal of Educational Measurement, 21*, 331–345.

Wright, B. D., & Masters, G. N. (1982). *Rating scale analysis*. Chicago: MESA Press.

Wright, B. D., & Stone, M. H. (1979). *Best test design.* Chicago: MESA Press.

Zwick, R., & Thayer, D. (1996). Evaluating the magnitude of differential item functioning in polytomous items. *Journal of Educational and Behavioral Statistics*, *21*, 187–201.