Review of the NAEP Mathematics Framework

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I was asked to review the *Mathematics Framework of the 2017 National Assessment of Educational Progress (*referred to as NAEP Mathematics Framework, hereafter) and answer the following questions: Does the NAEP Mathematics Framework need to be revised? If so, why and how? As I reviewed the document I continued to revisit the intent of the assessment framework, which "lays out the basic design of the assessment by describing the mathematics content that should be tested and the types of assessment questions that should be included" (p. 2). I viewed my charge as reviewing the entire document as well as reviewing the mathematics content addressed in the document. Although the NAEP Mathematics Framework is not intended to represent any particular curriculum, I reviewed the content of the *Common Core State Standards for Mathematics* (CCSS-M) (National Governors Association Center for Best Practices (NGA) & Council of Chief State School Officers (CCSSO), 2010) and the *Guidelines for Assessment and Instruction in Statistics Education* (GAISE) (Franklin et al., 2007) to ground my thinking in current expectations for K-12 students. I also considered how the type of information included in the NAEP Mathematics Framework might differ from the type of information included in an item specifications document, which "gives more detail about the development of the items and conditions for the 2017 NAEP Mathematics Assessment" (p. 2).

As I read each of the chapters of the NAEP Mathematics Framework, I asked myself the following questions: Does this chapter do what it is intended to do? Are clarifications needed? If so, what? Is anything missing? Does it reflect current understandings/interpretations in the field? In what ways might the field benefit from a revision of the document? Below I provide

conclusions drawn after reading each chapter of the NAEP Mathematics Framework. In some cases, I provide examples to illustrate what is meant.

Chapter One: Overview

Chapter 1 provides a historical overview of the development of the framework and the changes that were made over time. It outlines the intent of the assessment framework, clarifies what it is and what it is not; provides context for the changes that were made; and provides an advance organizer for the types of information to be provided in the remainder of the document. I wondered if the first chapter could include summary information about the administration of the test and the tools available to test takers during its administration (e.g., manipulatives and calculators, etc.). Although this information is discussed in chapter 5, it might be helpful to provide a brief overview of this information as an advance organizer as one reads some of the objectives discussed in chapter 2. For example, when I read "…use appropriate measurement instrument..." for grade 4, I wondered how that objective would be addressed as part of the assessment. However, because this is clarified in chapter 5, I present it here as something to consider rather than a change that must be made.

Also, I recommend expanding the discussion about the item specifications document to provide insights about "how" the objectives might be assessed. This would permit this document to address the Standards for Mathematics Practices (NGA & CCSSO, 2010) that characterize how the mathematics community expects students to engage with mathematics. For example, this section can acknowledge different assessment strategies that align with recommendations for how students should be taught, such as asking them to critique arguments presented by others or to model with mathematics.

Chapter 2: Framework for the Assessment

"This chapter presents the content areas, distribution of items by content, a description of the matrix format, and a detailed description of each content area followed by the specific objectives of the mathematics framework for that area" (p. 5). Overall, the broad areas of mathematics content (Number Properties and Operations; Measurement; Geometry; Data Analysis, Statistics, and Probability; and Algebra) continue to be relevant and the objectives identified for grades 4, 8, and 12 are clear and account for expected growth of knowledge across the grade levels. I believe the addition of mathematical reasoning that first appeared in the 2005 framework is an important one and it can be integrated with each of the content strands.

My recommendation is to take into consideration the results of the review of curriculum standards across the nation conducted by the Governing Board, which will highlight levels of alignment between the NAEP objectives and state standards. In particular, attention should be placed on the objectives for which there is no or limited alignment, such as Data Analysis, Statistics, and Probability. There are two possibilities for addressing areas of misalignment: (1) eliminate the objective(s) or (2) keep the objective, but make adjustment to how the item is assessed. Assuming nuanced information is provided as part of the standards study, in grade 4, for example, it might be possible to keep the data analysis and statistics objectives, but only include the types of representation to which students will likely be exposed (i.e., keep line plots, picture graphs, and bar graph, but do not use circle graphs, line graphs, etc.).

Chapter 3: Mathematical Complexity of Items

Chapter 3 describes the three levels of mathematical complexity of items (e.g., low, moderate, or high), which describes the cognitive demand associated with specific test items This section includes sufficient information to understand the intent and focus of each of the complexity

levels and includes examples to clarify why items are labeled as they are. I do not recommend major changes to this section. However, I highlight a minor editorial suggestion for a sentence in the rationale section of example 11 (p. 44).

- Current statement: "At grade 8, students have not learned a procedure for answering this type of question."
- Proposed revisions bolded: "At grade 8, students **might not** have ~~**not**~~ learned a procedure for answering this type of question."

I am noting this statement because I found it to be substantively unlike the other statements in this section because it implied definitive knowledge about what students at a particular grade have not learned. I am suggesting the use of tentative language to acknowledge the increasing number of eighth grade students who are enrolled in the equivalent of a high school Algebra 1 course who may have greater exposure to this type of reasoning.

Chapter 4: Item Formats

Chapter 4 describes the item formats (multiple choice, short constructed response, and extended constructed response) that continue to be appropriate for the assessment. However, it is important to acknowledge that the use of a digital platform may provide different options for item formats, which include multi-select items, grid items, table items, or equations as are used in other digital assessment platforms such as those used by *Smarter Balanced Assessment Consortium* (SBAC) or *Partnership for Assessment of Readiness for College and Career* (PARCC).

The examples and the scoring guide adequately clarify the intent of each type of format and how assessment items are scored. However, all examples illustrated in this section reflect the

types of questions found on a paper-pencil type of exam. Because the NAEP assessment will be administered in a digital environment with dynamic capabilities, it should include examples that highlight the assessment tools and the dynamic options that will be available as well as the various ways available to provide a response. For example, the grade 4 and grade 8 sample items from SBAC shown in figure 1 provide some indication of the features that will be available as part of the assessment.

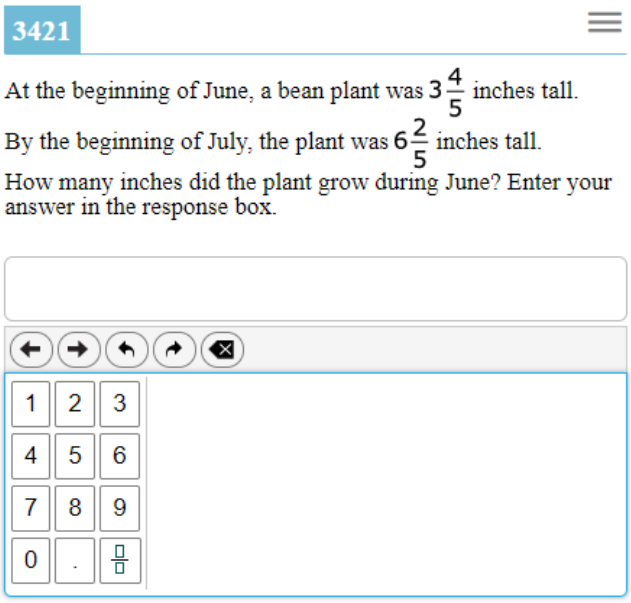

Figure 1. Sample Items from Smarter Balance Assessment.

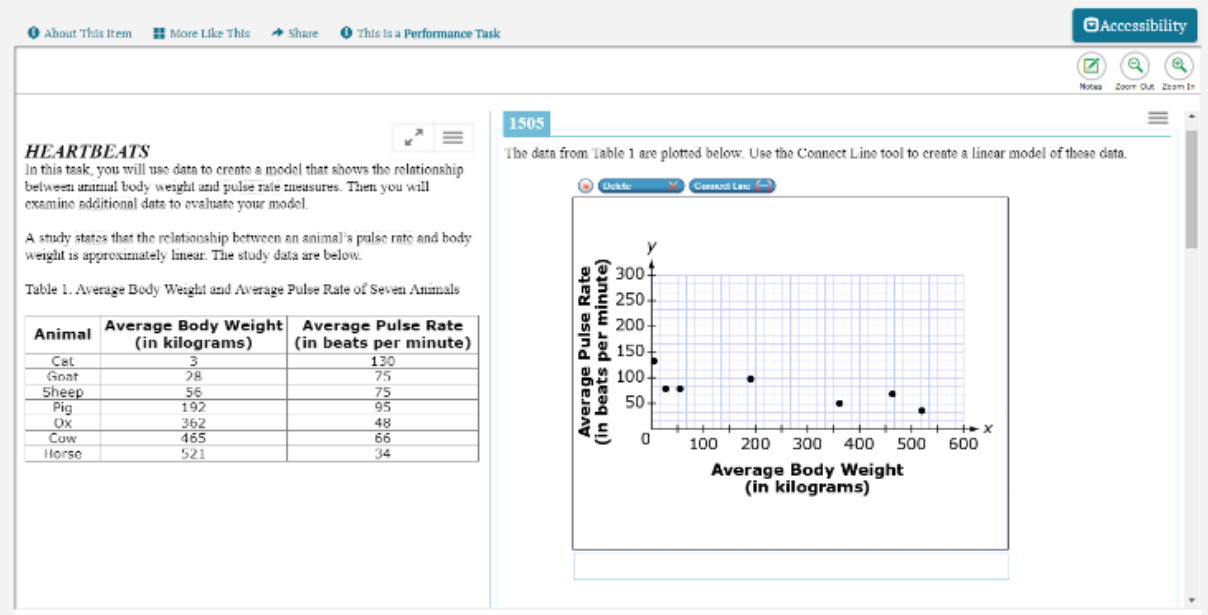

Figure 1 *cont'd*. Sample Items from Smarter Balance Assessment.

Chapter 5: Design of Test and Items

Chapter 5 describes the guidelines for balancing a number of factors, "including content, level of complexity, and format" (p. 4). Overall, I found the balance of content, mathematical complexity and item formats to be appropriate, therefore I am not recommending changes in those areas.

Calculators and Manipulatives. If the digital assessment will permit students to use virtual tools (e.g., calculator, manipulatives), it will be important to include examples to show the types of online calculators that will be available as was suggested in the previous section (see figure 1).

Accessibility. This section currently states that the "exam provides accommodations for students with special needs" (p. 66). I believe this is a limited perspective given the use of a digital platform, which may permit different options for making the content accessible. I recommend the use of universal design, which allows accommodations that are typically made available for a specific group to be available to all test takers. Then, accommodations can be identified for

specific situations that cannot be addressed within the digital platform (e.g., the need to administer the test in an alternative location). For example, screen readers (i.e., text to speech) can be made available to all students, including students who are not identified with specials needs such as low-ability readers, without compromising the integrity of the mathematics content being assessed. Also, with the availability of online translators, it might be possible to offer primary or home language translations of the test content beyond the focus on Spanish.

Overall, this section should reflect the nature of the technological tools that are available on the digital platform and highlight how these features provide access to all students, including those with specific special needs. This shifts the focus to the accessibility of the exam for all students and away from the types of students who might receive particular accommodations.

Conclusion

Overall, the recommendations provided above makes the case for revising the NAEP assessment framework. Although a complete overhaul is not recommended, the revision should take into account information learned from the standards review, but should maintain its focus on the intent of the NAEP Assessment. The administration of the test using technology also represents a significant shift that expands the ways in which objectives might be assessed. The framework needs to be updated to reflect such changes and the opportunities it provides. Lastly, the bibliography must be updated to reflect current research and other information available since the NAEP assessment framework was last updated.

References

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Partnership for Assessment of Readiness for College and Career. https://parcc.pearson.com/practice-tests/math/

Smarter Balanced Assessment Consortium. http://sampleitems.smarterbalanced.org/