NAEP Framework Response

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The *2017 NAEP Mathematics Framework* lays a respected foundation for assessing student knowledge in mathematics at grades 4, 8, and 12 and is a useful portrait of trends in student abilities. However, there are considerations that should be addressed in the revision of the framework to better represent current research and practice regarding student learning.

The NAEP assessment is highly valued in many states to measure progress over time and assess local standards, programs, and student achievement. As the National Assessment Governing Board considers changes to the framework, they should also assess how the continuity of reporting can be maintained so that researchers and policy-makers can make connections to previous years, policies, and practices.

A primary consideration for change must be linking the framework to current research and practice while eliminating anachronistic material. Citations in the current NAEP Mathematics Framework are mostly from the turn of the 21st Century, ignoring advancements such as the Common Core State Standards for Mathematics (CCSS-M), the Guidelines for Assessment and Instruction in Statistic Education (GAISE), the Guidelines for Assessment and Instruction in Mathematical Modeling Education (GAIMME), and the national focus on Science, Technology, Engineering, and Mathematics (STEM). These advancements, along with research about how children learn mathematics, must be attended to in the next revision of the NAEP framework. A helpful bibliography of other more recent research can be found in *Principles to Actions: Ensuring Mathematical Success for All* (NCTM, 2014).

Even though not every state has adopted the CCSS-M, the development of the standards and their widespread implementation, coupled with agreement about learning trajectories, have resulted in an era where states agree regarding placement of most topics in mathematics. Even states that have not adopted the CCSS-M have adjusted timelines so that students across the United States experience many of the same topics at the same grade level. NAEP should not assess at the 4th grade level what students in most states are not learning until 8th grade.

State standards across the United States have also placed more emphasis on reasoning and modeling with mathematics to solve problems. Although this paper is too short to give a comprehensive accounting of potential issues with the current framework, a few examples will illustrate the point.

The current NAEP framework recognizes geometry as an essential topic in mathematics; however, it does not capture the academic importance of transformational geometry at the appropriate ages. Transformations are an important facet of developing concepts of congruence and similarity so that students not only are able to identify aspects of geometry, but also justify them. No more are transformations the “flips,” “turns,” and “slides” in the current framework, but rather the building blocks of “reflections,” “rotations,” and “translations.” As such, what could previously be assessed in 4th grade, must now be assessed in 8th grade, at which level these concepts are established. The precise language of mathematics supported in the CCSS-M and in state standards can and should be used in grade 8 where these ideas are developmentally appropriate.

Statistics is another area where framework writers must look at new research in recognition of its increasing importance in society. The GAISE Standards informed the CCSS-M, and as a result

there has been considerable movement in the study of statistics. Probability and measures of central tendency are no longer topics in elementary school. Grade 4 items should be limited to bar and picture graphs, while grade 8 items may include more sophisticated data displays. In addition to considering grade placement, NAEP should consider adding emphasis at grades 8 and 12, thus ensuring our nation that a statistically literate populace is equipped with knowledge and skill to make decisions.

As a final illustration, revising authors should consider learning trajectories for proper placement in the framework. The current framework assesses proportionality in 4th grade, yet 4th grade students are just solidifying their knowledge of rational number and will not be fully prepared to understand proportionality until 8th grade. The topics in the framework are important, but the result of states aligning expectations to research is that not all topics are placed at the appropriate level of the framework.

No doubt placement of specific mathematics topics will be a challenge. Despite the CCSS-M and state efforts at alignment, there are still regional differences. One potential answer to this challenge is to provide students with more opportunities for modeling and problem solving throughout the assessment, thus providing multiple entry points and multiple paths to solutions. State standards now emphasize reasoning, precision, and justification through communication. Ideally, NAEP would capture the results of efforts in these areas. Such items have been a strength of NAEP in the past and might be an area for further focus in the future.

In 2009, the NAEP Mathematics Framework added a new topic, mathematical reasoning, at grades 4, 8, and 12. While it is commendable that the NAEP attend to mathematical reasoning, separating it from the content of mathematics gives a false sense that reasoning is somehow

separate from number, data analysis, algebra or geometry. Mathematical reasoning is not a mathematical topic to be segregated from more traditional aspects of mathematics but is a tool to be used whenever approaching an unfamiliar mathematics problem. There may be some value in reporting on student abilities in mathematical reasoning, yet it is more important that reasoning permeate the assessment. Currently, important opportunities are lost. There should be many occasions for students to justify thinking in multiple areas not limited to geometry, and certainly not limited to recall of definitions or theorems. Students should be expected to justify their thinking in algebra, number, and probability and can do so either formally or informally if given a chance.

In addition to the content issues, the framework authors could consider revision as an opportunity for other improvements. In writing introductory paragraphs regarding the history of mathematics, authors should take care to represent more than a Western approach. One cannot help but notice that Descartes is mentioned by name, yet Muhammad ibn Musa-al-Khwarizmi, the father of algebra, is not. This omission leads one to wonder how equity issues are considered in the development of the assessment. A statement in the framework regarding the selection of contexts for mathematics that ensure equitable access would give notice that equity is attended to.

For the NAEP assessment to equitably assess student learning, the framework should also address current accommodations. While Spanish is the most common non-English language spoken by children in the United States and Spanish forms are helpful, there are many more languages spoken in schools today. In some states, languages other than Spanish are more common, such as Ilokano in Hawaii. Accessible online dictionaries in other languages could be a first step towards providing access for English Language Learners.

In addition, students with disabilities now have many more accommodations available to them than are included in the NAEP framework. Braille and assistive technology communication devices should be considered to accommodate access for more students. As equity is a priority for all of us, it is an area that NAEP could address more completely in the framework.

There are also many opportunities for increasing student access and interest by tapping into mathematics associated fields such as by making more connections with other STEM fields. This could be explained in the introductory paragraphs where it could be made clear that STEM contexts are an important way for students to show their ability to use mathematics in purposeful settings. In addition, there are opportunities for item writers to increase interest and relevance by formulating items in the fields of financial literacy and statistics. This would result in a more authentic assessment not only of mathematics itself but also as a tool to be used in many disciplines.

Many improvements could be realized by making a thorough analysis of the verbs used in the framework. Verbs such as “solve,” “perform,” and “evaluate” are important and should be balanced with verbs such as “construct,” “model,” and “justify.” Use of technology, somewhat new to NAEP, enables the design of more robust items where students create quick constructions and models that bridge the world between selected and constructed response.

One further non-content suggestion would be to consider adding a “Below Basic” reporting category. This would align much better with how states typically assess students and recognizes the unfortunate reality that there are students who are not able to do what is expected of them, especially considering the increased rigor of the CCSS-M and newly adopted state standards.

NAEP can help uncover pockets where these deficiencies are most profound and give states much needed data to inform resource acquisition and allocation.

There are many considerations for the Board in revising the NAEP framework, ranging from grade alignment to research, to connections to other disciplines (STEM). If the NAEP framework is rewritten to consider content alignment with commonly accepted standards and trajectories, equitable access and equity in presentation, and attention to the practices of mathematics, it will continue to be the trusted report card that it currently is.

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