Shifts in K–12 Mathematics: Moving to College and Career Readiness

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What is college and career readiness in mathematics?

This decade in education in the United States is marked by the shift to more rigorous standards in mathematics, with the K–12 system-wide goal of college and career readiness for each student. This has created resulting seismic shifts in the K–12 mathematics curriculum for school districts. Even if a state has abandoned or never adopted the Common Core State Standards (CCSS), it may be, as many states are doing, revising or rewriting its standards to be as or even more rigorous than those presented in the CCSS. These new, 21st-century standards are typically larger in grain size; each standard is more complex and must be unpacked to determine the knowledge, skills, and scaffolding required for students to show mastery at and across grade levels, thus creating huge implications for instruction. Educators are seeing the shifting of content across grade levels and the grouping of concepts in critical areas. However, the shifts are not only centered on the content and skills in each standard; the standards for mathematical practice require that students apply the content and skills in different and deeper ways. This may be the most significant shift in mathematics curriculum and instruction with the additional caveat that those practices are measured at all levels of assessment administration. This includes assessments ranging from the most informal such as classroom observations and classroom assessments, to more formal, district assessments and the accountability tests administered by each state. Teaching for understanding and students learning for understanding require a different approach to curriculum and instruction. How do students demonstrate this mastery of knowledge, skills, and application of concepts? They do so by justifying their conclusions and constructing viable arguments to make the case for a solution. One teacher recently shared that she has posters around her room that say, “Explain, explain, and when in doubt, explain some more!” By teaching students to write explanations using math vocabulary and sentence elaboration, teachers are noticing logic flaws much earlier in teaching the concept, helping teachers to correct misunderstandings before they become concrete for the student. This type of instruction also reinforces what students are learning in English Language Arts, where the standards require that students construct arguments, justify conclusions and explain ambiguities in thinking. Many schools are cross-teaming for this type of instruction, to help build the skills in mathematics and strengthen the instructional approaches in both content areas.

In addition, students are using technology, not as another discipline to learn, but as a tool to show what they know and can do in mathematics. The implications for instruction are huge when most states are administering the assessments online, requiring that students can manipulate content on the screen, explain solutions, and use graphing skills with the technology, just to name a few. These expectations represent another shift for many states in terms of not just having the hardware and devices available for instruction and assessments, but also providing the professional learning for teachers to increase skills in using technology for instruction. More rigorous complex standards, grade shifts of content, standards of practice in mathematics, implications for instruction and student products, as well as the use of technology as learning tools all come together to create seismic shifts in K–12 mathematics curriculum and instruction, thereby defining college and career readiness.

What has not changed?

A strong foundation of teacher knowledge and skills to work with standards as the backbone of the instructional system already exists in our schools. The majority of the nation shifted from outcome-based education to standards-based education in the mid-1990's. Teachers understand the curriculum process in standards-based systems. Therefore, beginning the instructional planning process with standards is not new to teachers. Likewise, planning assessments as a part of instruction is an essential element of planning standards-based instruction. However, this practice has stalled in application due to the No Child Left Behind era with emphasis on summative assessments. This has affected stakeholders' view of assessment, with some educators perceiving assessment negatively and as separate from instruction. Indeed, this has proven detrimental to the implementation of the college and career readiness standards in many districts.

Instructional leaders are working to help teachers understand that measuring for progress provides essential data for teachers and is very much part of instruction. This in turn leads to more sensitive assessment practices emerging to inform instruction. Teachers pull together instructional planning by beginning with the standards to understand the concepts and skills that are valued and should be taught, planning assessments for learning within the lessons of the unit, and transforming the content and skills with research-based instructional strategies, working to release portions of the responsibility for the learning to students. The resulting student products and assessments are measures of the learning in the classroom, the ultimate goal. Students in classrooms with teachers engaging in this work are in the optimal standards- based learning environments and are prepared to achieve at levels defined by the college and career readiness standards. Therefore, even though the standards have become more rigorous, the standards-based curriculum process has not changed, but likely needs to be reviewed and refreshed in professional learning opportunities for teachers.

How will we measure college and career readiness?

Educators working collaboratively to unpack and prioritize standards to create local curriculum is only the initial work in implementing more rigorous standards. Considering how educators measure the learning from complex standards leads to multiple questions that represent a real change in assessment design. These questions include:

- How will we measure student learning based on more rigorous standards?
- How will we elicit the evidence we need to determine if students are learning for understanding more complex content and skills?
- How will instruction have to change to support student learning so that students work deeper and understand more?
- How can formal and informal formative assessments work together to provide the information teachers need regarding student learning based on more rigorous standards?
- How will accountability systems change as a result of the deeper learning required of students to show mastery of the standards?
- How will the results be explained to parents?

These questions are at the center of the shifts occurring in standards-based instruction across the country as educators implement new curriculum plans in mathematics. As educators analyzed the standards, it was soon clear that the efficiency of multiple choice items alone would not provide the evidence that educators need to diagnose student learning. These questions also form the basis of action to create the next generation of assessments—those that would more effectively measure learning based on rigorous standards in mathematics.

The next generation assessments have several elements that differentiate the new assessments from those used previously in accountability systems and in formative assessment programs. The development of the new assessments required the development of new and different item types to build assessments that include these characteristics:

- assessment grounded in real-world, authentic tasks and experiences;
- students performing at a higher depth of knowledge and performance to provide evidence that shows their level of proficiency;
- assessments that require the use of technology;
- assessments that require diverse item types to provide opportunities for students to write, explain, demonstrate understanding, and produce work;
- assessments that measure growth and progress to show evidence of at least a year's growth for a year's work;

- assessment plans and blueprints that give equal emphasis to formative and summative assessments; and
- assessments that provide information to teachers and parents about students' depth of understanding, including partial understanding, of targeted skills and concepts.

What are the new approaches to assessment?

The next generation assessments are based on the principles of Evidence Centered Design (ECD). Applying these principles dictates that an assessment's purpose is to of elicit evidence from students to support the inferences or claims about what students know and can do. This need to elicit evidence coupled with advances in technology have allowed for the development of item types that better measure the complex math content, skills and concepts reflected in the college and career readiness standards. Technology has also played a pivotal role in development of the next generation of assessments, with assessments moving online to provide teachers with the immediate data needed to make "just in time" instructional adjustments as well as provide students with effective feedback on their performance. Technology is also affecting the design of the items on those online assessments. The leveraging of technology-enhanced items for the next generation assessments

- allows educators to elicit greater and deeper evidence of learning and more authentic performance of skills;
- provides stronger alignment of assessments to the more rigorous college and career readiness standards by aligning to real world authentic tasks for the independent performance of content, skills and concept attainment;
- allows students to interact with content directly in an independent assessment setting; and
- enhances scoring options including both the speed and degree of information, providing for scoring for full, partial and no credit to provide even stronger diagnostic information for teachers when determining gaps in the student's academic experience and mastery of the standards.

It is worth noting that selected response (multiple choice) and constructed response items are still important item types for reliable and valid measurement. This is especially true for items that measure discrete knowledge in the case of selected response and for constructed response with items that focus on math practices, such as making sense of problems, constructing viable arguments, and modeling with mathematics. These approaches to assessment provide teachers with more specific information about student learning, helping teachers diagnose their own instruction to meet the levels of rigor required for students to achieve the standards.

What are the new item types and tools often found on next generation math assessments?

Several item types are used on the next generation math assessments that may be new or less familiar to teachers. Each of these items types is listed below, along with implications for instruction to assist teachers with planning instruction aligned with the complexity of the college and career readiness standards. The item types are:

- **Multiple select items:** These items present with more than four options and more than one correct response. The purpose of this item type is to present students with a more thorough set of solutions for multiple ways to demonstrate evidence of learning. To be successful with this item type, students must analyze and/or evaluate each answer choice and choose the responses that satisfy given solutions and problem conditions. Implications for instruction include providing students with independent and collaborative opportunities for problem solving where multiple procedures and solutions are considered and requiring students to provide rationales as the evidence of the analysis of each procedure and solution.
- **Drag and drop:** These items allow interaction with a wide range of ideas or examples within one concept on a device screen. The purpose of this item type is to require students to analyze ideas to clarify, order, and/or categorize them within a concept. The implications for instruction include providing students with multiple opportunities to manipulate content in parts of a concept, requiring that students compare and contrast, organize, and explain their manipulation of the content on the screen.
- **Matching table:** These items present as a grid and allow analysis of multiple ideas within one concept by checking boxes or moving symbols or graphics to the correct position on the matching table. The purpose of this item type is to require that students analyze ideas to compare and contrast how they fit into a concept and then determine the relationship among the ideas to be matched. The implications for instruction include providing students with many opportunities to organize content, to define relationships between pieces of content, and to use tables or charts when doing so.
- **Graphing items:** These items require students to demonstrate graphing skills by placing points and/or lines on the graph. Graphing items require that students create, analyze and compare graphs. For this item type, students provide evidence of skills in graphing and create visual representations of the numbers, equations, and problem situations on a graph. The implications for instruction include teaching for understanding to include graphic representations of the number concepts so that students can explain verbally, pictorially, and in writing why the graph is important to understanding the concept.

- **Online calculator:** These items require students to use an on-screen calculator to present evidence of their understanding of the use of the calculator as well as the math content and practices measured by the item. Additionally, this item type measures the math practice regarding the use of mathematical tools. The implications for instruction include providing students with opportunities to make decisions about when tools should or should not be used to solve problems and which mathematical tool is most appropriate for the problem situations. In the case of the online calculator, students should receive explicit instruction regarding the use of an online calculator as aligned to the standards at the grade level.
- **Equation/numeric/gridded items:** These items allow for a greater range of responses and/or solution choices. The purpose of this item is to require that students apply their knowledge to solve the problem. These items measure content and application of math practices, producing a high level of quality evidence of student learning. The implications for instruction include multiple opportunities for students to present solutions to problems in all of these forms, verbally, in writing, and graphically.
- **Performance tasks:** These items require students to independently apply multiple skills, usually presented as layers of smaller tasks, all directly related to an authentic task scenario that emulates “real world” content and experiences. The purpose of this extended item type is to measure content, skills, and math practices in relationship to an authentic task. Students must persevere through the layers of the task and remain focused on the scenario. The implications for instruction include using authentic tasks based on real world scenarios as a regular part of the classroom routine, aligned with the standards and appropriate for the grade level. These items are rich and include the measure of several to many standards across the task, many times requiring of students higher levels of analysis and producing several pieces of evidence of learning.

These item types help teachers to evaluate student learning and determine student proficiency in relation to the complexity of the college and career readiness standards. By measuring student knowledge and skills using differentiated item types to produce evidence of learning at multiple depths of knowledge, teachers diagnose student learning and determine instructional adjustments needed for their students.

The shifts are happening in K–12 mathematics!

Now that assessment practices are aligned with the college and career readiness standards, teachers are working in instructional systems that provide the information and tools to diagnose student learning in math like never before. However, the transition is still happening, where teachers need more information regarding the shifts in standards-based instruction in the new assessment era of Evidence Centered Design. Great ways to help educators implement more effectively and efficiently is to design collaborative professional learning regarding

- standards based alignment of the instructional system,
- the roles and purposes of assessments and the expectations of the use of the data from those assessments,
- the new item types and how those items gather evidence regarding student learning of complex standards, and
- the implications for data driven instruction to ensure students are learning at the levels expected by the standards.

The shifts are happening in K–12 mathematics and education is moving toward the ultimate goal of college and career readiness for each student.