

Teacher Quality Standard I

Teachers demonstrate mastery of and pedagogical expertise in the content they teach. The elementary teacher is an expert in literacy and mathematics and is knowledgeable in all other content that he or she teaches (e.g., science, social studies, arts, physical education, or world languages). The secondary teacher has knowledge of literacy and mathematics and is an expert in his or her content endorsement area(s).

The key to distinguishing the knowledge base of teaching rests at the intersection of content and pedagogy.
—L. S. Shulman

To teach all students according to today's standards, teachers need to understand subject matter deeply and flexibly so they can help students create useful cognitive maps, relate one idea to another, and address misconceptions. Teachers need to see how ideas connect across fields and to everyday life. This kind of understanding provides a foundation for pedagogical content knowledge that enables teachers to make ideas accessible to others. (Shulman, 1987)

Although Shulman's work dates back to the late 1980s, the importance of teacher content knowledge and pedagogical expertise has never been more important than it is now as teachers ensure students are college and career ready for the demands of the 21st century.

Element C: All Teachers

Teachers demonstrate knowledge of mathematics and understand how to promote student development in numbers and operations, algebra, geometry and measurement, and data analysis and probability.

This section describes professional practices that should be demonstrated by ALL TEACHERS, regardless of grade level or subject.

The great book of nature can be read only by those who know the language in which it was written ... and that language is mathematics.
—Galileo

Professional practices referenced under each element of the Rubric for Evaluating Colorado Teachers are cumulative. Therefore, for teachers to be proficient in demonstrating knowledge of mathematics and how to promote student development of mathematical concepts and skills, they must encourage students to make explicit math connections to the content being taught. These connections can be emphasized by stressing the need to learn math skills and by using instructional strategies that require students to apply these skills. Students are supported in this work when the teacher emphasizes interdisciplinary connections and mathematical thinking.



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ACCOMPLISHED AND EXEMPLARY RATING LEVELS

The impact of a proficient implementation of the professional practices found in Element C ALL TEACHERS will be students who are able to share ideas and solutions to challenging problems through the use of mathematical language. Students will also be able to interpret mathematical information in ways relevant to their learning.

PROFESSIONAL PRACTICES: STUDENTS:

- *Share ideas and solutions to challenging problems.*
- *Use the language of math to talk about what they are doing.*
- *Interpret mathematical information in ways that make it relevant to their learning.*

Classroom Examples

Elementary science: Students are working on Colorado Academic Standard 2: Life Science, Grade Level Expectation 1--The duration and timing of life cycle events such as reproduction and longevity vary across organism and species. *(Implements lesson plans based on: Colorado Academic Standards)*

Third-grade students are learning about plants and the factors that impact their growth. They plant seeds and modify the environments by placing some plants in direct sunlight, others under a lamp, and still others under a dark cover. Students consistently water the plants on designated days. The teacher has explained to students that as scientists, they will collect data daily and draw what they observe. She reviews how to accurately measure objects so students can correctly track the growth of each plant. The teacher concludes the unit by showing students how to illustrate the data by creating bar graphs and analyze it for the purpose of drawing scientific conclusions. *(Encourages students to make explicit math connections across content. Uses instructional strategies that require students to apply and transfer mathematical knowledge to different content areas.)* She shows students examples of scientific journals to emphasize the need to be detailed and specific in their language. The unit concludes with students working in groups of three to create graphs and a book of their drawings that demonstrate the impact of each environment on the plants. *(Emphasizes interdisciplinary connections to math.)* They collaborate to write what they learned about plant growth based on their findings.

Middle school reading, writing, and communicating: Students are working on Colorado Academic Standard 3: Writing and Composition, Grade Level Expectation 2—Ideas and supporting details in informational and persuasive texts are organized for a variety of audiences and purposes and evaluated for quality. *(Implements lesson plans based on: Colorado Academic Standards)*

Eighth-grade students are writing an argument that includes comparisons to support their points of view. The teacher presents examples of argumentative writing that use graphs to show comparisons between different products, locations, businesses, etc., to help students understand the importance of using visuals to support their points of view. *(Encourages students to make explicit math connections*



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across content.) He shows students his writing and how he incorporates bar and line graphs to support his argument about the importance of reducing sugar in one’s diet. As he continues to demonstrate his writing and thinking, he uses mathematical vocabulary associated with the creation of graphs and explains how he decides which type of graph to use for each point of view. He then connects his writing to each graph to explain how the visuals support his argument. ***(Uses instructional strategies that require students to apply and transfer mathematical knowledge to different content areas. Emphasizes interdisciplinary connections to math.)***

Integrated Example (Connecting Visual Arts and Mathematics): Students are working on an integrated lesson that includes Colorado Academic Standard 3 in Visual Arts: Invent and discover to create, Grade Level Expectation 2: Assess and produce art with various materials and methods. ***(Implements lesson plans based on: Colorado Academic Standards)***

This 10th-grade lesson focuses on proportional reasoning/scaling, which is an important element of architectural design. The teacher begins by pointing out proportions as an application of mathematics in art and, following Practices 5 and 6 of the Standards for Mathematical Practice, he also incorporates into the lesson the use of tools in determining and using scales. ***(Uses instructional strategies that require students to apply and transfer mathematical knowledge to different content areas.)*** With the aim of helping students understand the importance of tools in improving the visual appearance of a final product, he leads a discussion about art tools and precision. Tools that students might use include diagrams, two-way tables, graphs, flowcharts, and formulas. The teacher explains that students will be creating architectural models that must be both pleasing to the eye and foundationally strong, and for this to be the case, they will first be using their mathematical knowledge, as is reflected in Practice 4 of the Standards for Mathematical Practice. Throughout the model-building process, students will use tools, analyze relationships mathematically, and draw conclusions. As they reflect on the situation and interpret the mathematical results in the context of the situation, they will return to the model to improve it. ***(Emphasizes interdisciplinary connections to math.)***

Planning/Coaching Questions

- How will I encourage students to make explicit math connections across content?
- How will I emphasize the need for students to learn math content and skills?
- What instructional strategies will I use to support students in applying mathematical knowledge to the content I am teaching?
- How will I require students to apply mathematical knowledge to the content I am teaching?
- How will I emphasize interdisciplinary connections to math?



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