Unpacked South Dakota State Mathematics Standards

Purpose: *In order for students to have the best chance of success, standards, assessment, curriculum resources, and instruction must be aligned in focus, coherence, and rigor. Unpacked standards documents are intended to help align instruction to the focus, coherence, and rigor of the South Dakota State Mathematics Standards. The standards have been organized in clusters as they are not so much built from topics, but rather woven out of progressions. Not all content in a given grade is emphasized equally in the mathematics standards. Some clusters require greater emphasis than others based on the depth of the ideas, the time that they take to master, and/or their importance to future mathematics or the demands of college and career readiness. To say that some things have greater emphasis is not to say that anything in the standards can safely be neglected in instruction. Neglecting standards will leave gaps in student skill and understanding and may leave students unprepared for the challenges of a later grade.*

Domain: Number and Quantity	**Grade Level: 12**

HS4.N.VM.B Cluster: Perform Operations on Vectors
Students determine the effect of scalar multiplication on a vector.

This is a SUPPORTING cluster. *Students should spend the large majority of their time (65-85%) on the major work of the grade. Supporting work and, where appropriate, additional work should be connected to and engage students in the major work of the grade.*

N.VM.4 Add and subtract vectors.

a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.
b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
c. Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

N.VM.5 Multiply a vector by a scalar.

a. Represent scalar multiplication graphically by scaling vectors and/or reversing their direction; perform scalar multiplication component-wise.
b. Compute the magnitude of a scalar multiple cv. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).

Aspects of Rigor for Student Learning: (Conceptual, Procedural, and/or Application)

N.VM.4 Add and subtract vectors.

a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.
b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
c. Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise

Conceptual Understanding	***Procedural Fluency***	***Application***
Students can represent vector operations both analytically and graphically and understand the relationship between the two.	Students can add and subtract vectors using a variety of approaches.	

N.VM.5 Multiply a vector by a scalar.

a. Represent scalar multiplication graphically by scaling vectors and/or reversing their direction; perform scalar multiplication component-wise.
b. Compute the magnitude of a scalar multiple cv. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).

Conceptual Understanding	***Procedural Fluency***	***Application***
Students understand that multiplying a vector by a positive scalar changes the magnitude but not the direction of the vector. Students should connect scalar multiplication of vectors to dilation.	Students will multiply a vector by a scalar to compute the direction and magnitude of the resulting vector.	

Enacting the Mathematical Practices - Evidence of Students Engaging in the Practices

1. **Make sense of problems and persevere in solving them.**
    - Students will investigate the nature of vector operations through different problem contexts and situations in which a quantity is being conveyed by magnitude and direction.
2. **Reason abstractly and quantitatively.**
3. **Construct viable arguments and critique the reasoning of others.**
4. **Model with mathematics.**
    - Students use the diagonal of a parallelogram to help build a conceptual foundation.
5. **Use appropriate tools strategically.**
    - Graphical computing tools can help students build an understanding of vectors.
6. **Attend to precision.**
7. **Look for and make use of structure.**
8. **Look for and express regularity in repeated reasoning.**

Vertical and Horizontal Coherence and Learning Progressions

Previous Learning Connections	***Current Learning Connections***	***Future Learning Connections***
In Geometry, students learned the properties of parallelograms and their diagonals.	Students are continuing to work with vectors, relating scalar multiplication to dilation and determining the effect of scalar multiplication.	Vectors are important in Calculus and Linear Algebra courses.

Vocabulary (key terms and definitions)

Relevance, Explanations, and Examples: