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.*

<table>
<tr><td colspan="2">Domain: Numbers and Quantity</td><td>Grade Level: Algebra 2</td></tr>
<tr><td colspan="3">A2.N.CN.A Cluster: Perform arithmetic operations with complex numbers.

This is an introduction to imaginary numbers. Learners will recognize that all of the properties of real numbers apply to complex numbers.</td></tr>
<tr><td colspan="3">**This is an ADDITIONAL 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.

A2.N.CN.A.1 Know there is a complex number i such that i² = –1, and every complex number has the form a + bi where a and b are real numbers.

A2.N.CN.A.2 Use the relation i² = –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.</td></tr>
<tr><td colspan="3">Aspects of Rigor for Students: (Conceptual, Procedural, and/or Application)</td></tr>
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<tr><td>Conceptual Understanding</td><td>Procedural Fluency</td><td>Application</td></tr>
<tr><td>Learners understand that $i^2 = -1$, therefore i is equal to $\sqrt{-1}$. Learners understand the need for imaginary numbers when simplifying negative square root values.

For example: finding solutions using the quadratic formula.</td><td>Learners will be able to:
Simplify square roots
Simplify imaginary numbers raised to a power</td><td></td></tr>
<tr><td colspan="3">A2.N.CN.A.2 Use the relation i² = –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.</td></tr>
<tr><td>Conceptual Understanding</td><td>Procedural Fluency</td><td>Application</td></tr>
<tr><td></td><td>Learners extend the properties of real numbers to simplify complex numbers.</td><td></td></tr>
</table>

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

1. **Make sense of problems and persevere in solving them.**
2. **Reason abstractly and quantitatively.**
3. **Construct viable arguments and critique the reasoning of others.**
4. **Model with mathematics.**
5. **Use appropriate tools strategically.**
6. **Attend to precision.**
7. **Look for and make use of structure.**
   - All of the operations that students have learned in mathematics courses, apply to complex numbers.
8. **Look for and express regularity in repeated reasoning.**
   - Students see patterns in regards to i to any power. (Example: $i^{8} = 1$; $i^{15} = -i$, etc.)

Vertical and Horizontal Coherence and Learning Progressions

Previous Learning Connections	***Current Learning Connections***	***Future Learning Connections***
In Algebra 1, students solve quadratic equations using a variety of methods. Their solutions are limited to real solutions.	*Students learn to solve quadratic and higher-order polynomial equations that have complex answers.*	*Students will relate this knowledge of complex numbers to solving rational equations, trigonometric equations and trigonometric form in subsequent math courses (Pre-Calculus, AP Calculus, College Algebra, etc).*

Vocabulary (key terms and definitions)

- Complex number
- Imaginary number

Relevance, Explanations, and Examples:

Achievement Level Descriptors

Cluster: Perform arithmetic operations with complex numbers.

Concepts and Procedures	***Level 1:*** Students should be able to base arguments on concrete referents such as objects, drawings, diagrams, and actions and identify obvious flawed arguments in familiar contexts.
	Level 2: Students should be able to find and identify the flaw in an argument by using examples or particular cases. Students should be able to break a familiar argument given in a highly scaffolded situation into cases to determine when the argument does or does not hold.
	Level 3: Students should be able to use stated assumptions, definitions, and previously established results and examples to test and support their reasoning or to identify, explain, and repair the flaw in an argument. Students should be able to break an argument into cases to determine when the argument does or does not hold.
	Level 4: Students should be able to use stated assumptions, definitions, and previously established results to support their reasoning or repair and explain the

	flaw in an argument. They should be able to construct a chain of logic to justify or refute a proposition or conjecture and to determine the conditions under which an argument does or does not apply.