# 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: Functions</td><td>Grade Level: 4th Year</td></tr>
<tr><td colspan="3">HS4.F.BF.B Cluster: Build new functions from existing functions.<br>Students learn more about functions, relationships between functions, domain, range, and building new functions using various tools, such as composition, inverses,and reciprocals.</td></tr>
<tr><td colspan="3">This is a MAJOR 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.<br><br>F.BF.4 Find inverse functions.<br>b. Verify by composition that one function is the inverse of another.<br>c. Read values of an inverse function from a graph or a table, given that the function has an inverse.<br>d. Produce an invertible function from a non-invertible function by restricting the domain.<br>F.BF.5 Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.<br>F.BF.6 Use reciprocal properties to develop definitions for cotangent, cosecant, and secant.</td></tr>
<tr><td colspan="3">Aspects of Rigor of Student Learning: (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>Students recognize that a function must be one-to-one in order for an inverse to exist. If the function is not one-to-one, students can determine an appropriate domain that will allow an inverse function to be created.</td><td>Students use $f(f^{-1}(x) =x$ and $f^{-1}(f(x) = x$ to verify that $f^{-1}(x)$ is the inverse of f(x).<br><br>Students can use graphs and or tables to determine ordered pairs for an inverse function.</td><td></td></tr>
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<tr><td>Conceptual Understanding</td><td>Procedural Fluency</td><td>Application</td></tr>
<tr><td>Students should be able to explain the relationship between exponential functions and logarithmic functions verbally, graphically, and symbolically.</td><td>Students use the inverse relationship between exponential and logarithmic functions to solve problems.</td><td>Students should be able to apply exponential and logarithmic functions in real life contexts.</td></tr>
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**F.BF.6** Use reciprocal properties to develop definitions for cotangent, cosecant, and secant.

| ***Conceptual Understanding*** | ***Procedural Fluency*** | ***Application*** |
|---|---|---|
| Students should understand that cotangent is the reciprocal of tangent, cosecant is the reciprocal of sine, and secant is the reciprocal of cosine. Students should be clear that trigonometric functions and their reciprocals are not inverses. | Students should be able to use and evaluate all trigonometric functions. | |

**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.**
    - Students will apply exponential and logarithmic functions to model real world situations.
5. **Use appropriate tools strategically.**
6. **Attend to precision.**
7. **Look for and make use of structure.**
    - When combining existing functions students are using mathematical structures with which they are familiar.
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 Algebra II, students have learned to solve an equation for the independent variable of a function f that has an inverse function to write an expression for the inverse.<br><br>In Geometry, students have learned to define and evaluate the basic trigonometric functions; sine, cosine, and tangent. | Students continue to learn more about functions, relationships between functions, domain, range, and building new functions using various tools, such as composition, inverses, reciprocals, etc. | For many advanced mathematics courses, students will need a deeper understanding of inverse functions, including appropriate language and notation. Calculus will require students to understand and be able to use all six trigonometric functions. |

***Vocabulary (key terms and definitions)***

- Cotangent
- Secant
- Cosecant

***Relevance, Explanations, and Examples:***

Logarithmic Application Problem
The current population of Jonesville is 25,000 people. The population is growing at a rate of 2.7% per year. Write an equation and solve it to find the first year the population will exceed 30,000.