North Dakota
High School State Standards
Algebra II Pathway

July 2017
Overview
The North Dakota State Standards (NDSS) for Mathematics are organized by grade level in Grades K-8. At the high school level, the standards are organized by conceptual category (number and quantity, algebra, functions, geometry, modeling and probability and statistics), showing the body of knowledge students should learn in each category to be college and career ready, and to be prepared to study more advanced mathematics. As North Dakota school districts consider how to implement the high school standards, an important consideration is how the high school NDSS might be organized into courses that provide a strong foundation for post-secondary success. To address this need, the NDSS writing committee has provided a possible pathway to implement the NDSS in the traditional courses of Algebra I, Geometry, Algebra II and Course IV.

In considering this document, it is important to note the following:

1. The pathway is a model, not a mandate. It illustrates a possible approach to organize the content of the NDSS into coherent and rigorous courses that lead to college and career readiness. Districts are not expected to adopt these courses as is; rather, they may use this pathway as a starting point for developing their own.

2. All college and career ready standards have been included in the pathway. Standards with a (+) are included to increase coherence but are not necessarily expected to be addressed on high stakes assessments.

While the focus of this document is on organizing the Standards for Mathematical Content into a pathway to college and career readiness, the content standards must also be connected to the Standards for Mathematical Practice to ensure that the skills needed for alter success are developed. In particular, Modeling (defined by a * in the NDSS) is defined as both a conceptual category for high school mathematics and a mathematical practice and is an important avenue for motivating students to study mathematics, for building their understanding of mathematics, and for preparing them for future success. Development of the pathway into instructional programs will require careful attention to modeling and the mathematical practices. Assessments based on the pathway should reflect both the content and mathematical practice standards.

Strategic use of technology is expected in all work. This may include employing technological tools to assist students in forming and testing conjectures, creating graphs and data displays, as well as determining and assessing lines of fit for data. Geometric

Note:
(+) indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics
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constructions may also be performed using geometric software, as well as classical tools and technology aiding in three-dimensional visualization.

**Mathematical Practices**

It should be noted that throughout each course, the following mathematical practices from the NDSS are to be emphasized:

1. **Make sense of problems and persevere in solving them.**
   Mathematically proficient students:
   - Explain to themselves the meaning of a problem and looking for entry points to its solution.
   - Analyze givens, constraints, relationships, and goals.
   - Make conjectures about the form and meaning of the solution attempt.
   - Consider analogous problems, and try special cases and simpler forms of the original problem.
   - Monitor and evaluate their progress and change course if necessary.
   - Transform algebraic expressions or change the viewing window on their graphing calculator to get information.
   - Explain correspondences between equations, verbal descriptions, tables, and graphs.
   - Draw diagrams of important features and relationships, graph data, and search for regularity or trends.
   - Use concrete objects or pictures to help conceptualize and solve a problem.
   - Check their answers to problems using a different method.
   - Ask themselves, “Does this make sense?”
   - Understand the approaches of others to solving complex problems.

2. **Reason abstractly and quantitatively.**
   Mathematically proficient students:
   - Make sense of quantities and their relationships in problem situations.
     - **Decontextualize** (abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents) and
     - **Contextualize** (pause as needed during the manipulation process in order to probe into the referents for the symbols involved).

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• Use quantitative reasoning that entails creating a coherent representation of quantities, not just how to compute them.
• Know and flexibly use different properties of operations and objects.

3. Construct viable arguments and critique the reasoning of others.
Mathematically proficient students:
• Understand and use stated assumptions, definitions, and previously established results in constructing arguments.
• Make conjectures and build a logical progression of statements to explore the truth of their conjectures.
• Analyze situations by breaking them into cases.
• Recognize and use counterexamples.
• Justify their conclusions, communicate them to others, and respond to the arguments of others.
• Reason inductively about data, making plausible arguments that take into account the context.
• Compare the effectiveness of plausible arguments.
• Distinguish correct logic or reasoning from that which is flawed.
  ✓ Elementary students construct arguments using objects, drawings, diagrams, and actions.
  ✓ Later students learn to determine domains to which an argument applies.
• Listen or read the arguments of others, decide whether they make sense, and ask useful questions.

4. Model with mathematics.
Mathematically proficient students:
• Apply the mathematics they know to solve problems arising in everyday life, society, and the workplace.
  ✓ In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community.
  ✓ By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another.
• Simplify a complicated situation, realizing that these may need revision later.
• Identify important quantities in a practical situation.
• Map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas.
• Analyze those relationships mathematically to draw conclusions.

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• Interpret their mathematical results in the context of the situation.
• Reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

5. **Use appropriate tools strategically.**
Mathematically proficient students:
• Consider available tools when solving a mathematical problem.
• Are familiar with tools appropriate for their grade or course to make sound decisions about each of these tools.
• Detect possible errors by using estimations and other mathematical knowledge.
• Know that technology can enable them to visualize the results of varying assumptions, and explore consequences.
• Identify relevant mathematical resources and use them to pose or solve problems.
• Use technological tools to explore and deepen their understanding of concepts.

6. **Attend to precision.**
Mathematically proficient students:
• Try to communicate precisely to others.
• Use clear definitions in discussion with others and in their own reasoning.
• State the meaning of the symbols they choose, including using the equal sign consistently and appropriately.
• Specify units of measure and label axes to clarify the correspondence with quantities in a problem.
• Calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the context.
  ✓ In the elementary grades, students give carefully formulated explanations to each other.
  ✓ In high school, students have learned to examine claims and make explicit use of definitions.

7. **Look for and make use of structure.**
Mathematically proficient students:
• Look closely to discern a pattern or structure.
  ✓ Young students might notice that three and seven more is the same amount as seven and three more.
  ✓ Later, students will see $7 \times 8$ equals the well-remembered $7 \times 5 + 7 \times 3$, in preparation for the distributive property.
  ✓ In the expression $x^2 + 9x + 14$, older students can see the 14 as $2 \times 7$ and the 9 as $2 + 7$.
• Step back for an overview and can shift perspective.
• See complicated things, such as some algebraic expressions, as single objects or composed of several objects.

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8. Look for and express regularity in repeated reasoning.
  Mathematically proficient students:
  • Notice if calculations are repeated.
  • Look for both general methods and for shortcuts.
  • Maintain oversight of the process, while attending to the details.
  • Continually evaluate the reasonableness of intermediate results.

North Dakota HIGH SCHOOL State Standards: ALGEBRA II
Conceptual Category: Number and Quantity
Domain: The Real Number System
Cluster: Extend the properties of exponents to rational numbers

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.N-RN.1</td>
<td>use exponential properties to explain how rational exponents follow from integer exponents</td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary
- rational
- exponent

Annotations
For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.

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<tr>
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</thead>
<tbody>
<tr>
<td>HS.N-RN.2</td>
<td>Rewrite expressions involving radicals and rational exponents using the properties of exponents.</td>
<td>Students can understand that the denominator of a rational exponent is the root index and the numerator is the exponent of the radicand. Convert an expression in radical form to rational exponents and vice-versa.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vocabulary</th>
<th>Annotations</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• root index</td>
<td>Example: $\sqrt{x^3} = x^{\frac{3}{2}}$</td>
<td></td>
</tr>
<tr>
<td>• radicand</td>
<td>Example: $(\sqrt{4})^3 = ((4)^{\frac{1}{2}})^3 = 2^3 = 8$</td>
<td></td>
</tr>
<tr>
<td>• radical</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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## North Dakota HIGH SCHOOL State Standards: ALGEBRA II

### Conceptual Category: Number and Quantity

#### Domain: The Real Number System

### Cluster: Use properties of rational and irrational numbers

<table>
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<tr>
<th>Standard</th>
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</table>
| HS.N-RN.3 Demonstrate that the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational, and that the product of a nonzero rational number and an irrational number is irrational. | • use the closure property or show by example the sum or product of two rational numbers is rational  
• show by example the sum of a rational number and an irrational number is irrational  
• show by example the product of a nonzero rational number and an irrational number is irrational | Rational and Irrational Numbers 1  
Rational and Irrational Numbers 2 |

### Vocabulary
- closure property
- irrational number
- rational number

### Annotations
Example: Evaluate $\sqrt{2} \cdot \sqrt{4}$ and identify which subset of the real number system the solution is in.

Solution: $\sqrt{8} = 2\sqrt{2}$, which is irrational.

### Notes

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### Conceptual Category: Number and Quantity

#### Domain: The Real Number System

#### Cluster: Use properties of rational and irrational numbers

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<tbody>
<tr>
<td>HS.N-RN.4</td>
<td>• perform basic operations on radicals • simplify radicals to write equivalent expressions</td>
<td></td>
</tr>
</tbody>
</table>

### Vocabulary

- radicals
- rationalizing the denominator

### Annotations

Basic operations include addition, subtraction, multiplication and division (e.g., rationalizing the denominator).

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North Dakota *HIGH SCHOOL* State Standards: *ALGEBRA II*

Conceptual Category: **Number and Quantity**

Domain: **Quantities** *(Mathematical Practices 1, 4, and 6)*

Cluster: **Reason quantitatively and use units to solve problems**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.N-Q.1*</td>
<td>• interpret units in the context of the problem</td>
<td><strong>Estimations and</strong></td>
</tr>
<tr>
<td></td>
<td>• use unit analysis to check the reasonability of your solution</td>
<td><strong>Approximations: The</strong></td>
</tr>
<tr>
<td></td>
<td>• choose and interpret an appropriate scale given data to be represented on a graph or display</td>
<td><strong>Money Munchers</strong></td>
</tr>
<tr>
<td></td>
<td>Choose and interpret units consistently in formulas.</td>
<td><strong>Leaky Faucet</strong></td>
</tr>
<tr>
<td></td>
<td>Choose and interpret the scale and the origin in graphs and data displays.</td>
<td><strong>Yogurt</strong></td>
</tr>
</tbody>
</table>

**Vocabulary**
- unit analysis

**Annotations**
Example: While driving in the United Kingdom (UK), a U.S. tourist puts 60 liters of gas in his car. The gas cost is £1.28 per liter. The exchange rate is £0.62978 for each US $1.00. The price for a gallon of gasoline in the United States is US $3.05. The driver wants to compare costs for the same amount and the same type of gasoline in UK and in the United States if he pays in UK Pounds.

**Notes**

Note:

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*: Indicates modeling standards
North Dakota *HIGH SCHOOL* State Standards: *ALGEBRA II*

**Conceptual Category:** Number and Quantity  
**Domain:** Quantities* (Mathematical Practices 1, 4, and 6)  
**Cluster:** Reason quantitatively and use units to solve problems

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<tr>
<th>Standard</th>
<th>Students Can</th>
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</table>
| HS.N-Q.2* | • determine an appropriate quantity to model a situation | Estimations and Approximations: The Money Munchers  
Yogurt  
Leaky Faucet | |

**Vocabulary**  
• modeling

**Annotations**  
Example: When carpeting a room, students might consider whether it is best to use square feet or square yards. When considering a remodeling project, they might choose such units as cost per room, cost per month of the project, or cost per contractor.

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North Dakota HIGH SCHOOL State Standards: ALGEBRA II
Conceptual Category: Number and Quantity
Domain: Quantities* (Mathematical Practices 1, 4, and 6)
Cluster: Reason quantitatively and use units to solve problems

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</thead>
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<tr>
<td>HS.N-Q.3*</td>
<td>• choose a level of accuracy or precision appropriate to the measuring tool or situation</td>
<td>Resources: Estimations and Approximations: The Money Munchers, Leaky Faucet, Yogurt</td>
</tr>
</tbody>
</table>

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<tr>
<th>Vocabulary</th>
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<tr>
<td>• significant digits</td>
<td>Example: When calculating the cost of a road trip, students are given the cost of gasoline to the thousandths place. When reporting the cost of the trip, students determine what level of precision—to the hundredths place or to the thousandths place—is appropriate and why.</td>
<td></td>
</tr>
<tr>
<td>• precision: refers to how much information is conveyed by a number (in terms of the number of digits)</td>
<td>Example: If you are playing soccer and you always hit the left goal post instead of scoring, then you are not accurate; you are precise.</td>
<td></td>
</tr>
<tr>
<td>• accuracy: the degree to which a measurement conforms to the correct value or a standard</td>
<td>Example: When calculating the cost of a road trip, students are given the cost of gasoline to the thousandths place. When reporting the cost of the trip, students determine what level of precision—to the hundredths place or to the thousandths place—is appropriate and why.</td>
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### Standard

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<tr>
<th>HS.N-CN.1</th>
<th>Students Can</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Know there is a complex number (i) such that (i^2 = -1), and every complex number has the form (a + bi) with (a) and (b) real.</td>
<td>• recognize every number as a complex number of the form (a+bi) where (a) and (b) are real numbers</td>
<td></td>
</tr>
<tr>
<td>Understand the hierarchal relationships among subsets of the complex number system.</td>
<td>• recognize (i) as complex and (i^2 = -1)</td>
<td></td>
</tr>
<tr>
<td>• classify a number into the correct subset</td>
<td>• classify a number into the correct subset</td>
<td></td>
</tr>
</tbody>
</table>

### Vocabulary

- real number
- imaginary number
- complex number
- whole number
- natural number
- integer
- rational number
- irrational number

### Annotations

Knowledge of complex numbers extends and reinforces student knowledge of the real number system.

Example: \(\sqrt{8}\) is a complex number because it can be written in the form \(\sqrt{8} + 0i\).

\(\sqrt{8}\) is also a real number since its imaginary coefficient is 0.

\(\sqrt{8}\) is also an irrational number because it cannot be written as a ratio of two integers.

### Notes

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### Standard

**HS.N-CN.2**

Use the definition $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

### Students Can

- apply the fact that the complex number $i^2 = -1$ to perform operations on complex numbers

### Resources

### Vocabulary

- distributive property
- commutative property
- associative property

### Annotations

Knowledge of complex numbers extends and reinforces student knowledge of basic operations and properties of the real number system.

**Example:**

$$
(2 + 3i) + (4 - 5i) = 6 - 2i \\
(2 + 3i) - (4 - 5i) = -2 + 8i \\
(2 + 3i)(4 - 5i) = 8 - 10i + 12i - 15i^2 = 8 + 2i + 15 \\
= 23 + 2i
$$

### Notes

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North Dakota *HIGH SCHOOL* State Standards: *ALGEBRA II*
Conceptual Category: *Number and Quantity*
Domain: *The Complex Number System*
Cluster: *Perform arithmetic operations with complex numbers*

<table>
<thead>
<tr>
<th>Standard</th>
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<tbody>
<tr>
<td>HS.N-CN.3 Use conjugates to find quotients of complex numbers.</td>
<td>• find the conjugate of a complex number&lt;br&gt;• use the conjugate to find the quotient of a complex number</td>
<td></td>
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</table>

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<tr>
<th>Vocabulary</th>
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<tbody>
<tr>
<td>conjugate</td>
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### Conceptual Category: Number and Quantity
### Domain: The Complex Number System
### Cluster: Use complex numbers in polynomial identities and equations

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</thead>
<tbody>
<tr>
<td>HS.N-CN.7</td>
<td>• solve quadratic equations with real coefficients that have solutions of the form (a+bi) and (a-bi)</td>
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<tr>
<th>Vocabulary</th>
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</tr>
</thead>
<tbody>
<tr>
<td>• quadratic equation</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>• complex solution</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annotations</th>
<th>This topic is also addressed in HS.A-REI.4.</th>
<th></th>
<th></th>
</tr>
</thead>
</table>

**Example:**

\[
x^2 + 2x + 5 = 0
\]

\[
x = \frac{-2 \pm \sqrt{(2)^2 - (4)(1)(5)}}{2 \cdot 1}
\]

\[
x = \frac{-2 \pm \sqrt{-16}}{2}
\]

\[
x = \frac{-2 \pm 4i}{2}
\]

\[
x = -1 \pm 2i
\]

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North Dakota HIGH SCHOOL State Standards: ALGEBRA II  
Conceptual Category: Number and Quantity  
Domain: The Complex Number System  
Cluster: Use complex numbers in polynomial identities and equations

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<tbody>
<tr>
<td>(+) HS.N-CN.8 Extend polynomial identities to the complex numbers.</td>
<td>• use polynomial identities to write equivalent expressions in the form of complex numbers</td>
<td></td>
</tr>
</tbody>
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<tr>
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<tbody>
<tr>
<td>• polynomial identities</td>
<td><strong>Example:</strong> Rewrite ( x^2 + 4 ) as ( (x + 2i)(x - 2i) ).</td>
<td></td>
</tr>
<tr>
<td>Polynomial identities include but are not limited to: &lt;br&gt;( (a + b)^2 = a^2 + 2ab + b^2 ) &lt;br&gt;( (a + b)(c + d) = ac + ad + bc + bd ) &lt;br&gt;( a^2 - b^2 = (a + b)(a - b) ) (Differences of Squares) &lt;br&gt;( a^2 + b^2 = (a + b)(a + b) ) (Sum and Differences of Cubes) &lt;br&gt;( x^2 + (a + b)x + ab = (x + a)(x + b) )</td>
<td></td>
<td></td>
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### North Dakota HIGH SCHOOL State Standards: ALGEBRA II

**Conceptual Category:** Number and Quantity  
**Domain:** The Complex Number System  
**Cluster:** Use complex numbers in polynomial identities and equations

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</table>
| (+) HS.N-CN.9  
Apply the Fundamental Theorem of Algebra to determine the number of zeros for polynomial functions.  
Find all solutions to a polynomial equation. | • recognize that the Fundamental Theorem of Algebra states that the number of complex solutions to a polynomial equation is equal to the degree of the polynomial  
• find all the solutions to a polynomial equation | |

**Vocabulary**  
- Fundamental Theorem of Algebra: The number of complex solutions to a polynomial equation is equal to the degree of the polynomial.  
- zeros  
- degree

**Annotations**

**Notes**

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### North Dakota HIGH SCHOOL State Standards: ALGEBRA II

#### Conceptual Category: Algebra

#### Domain: Seeing Structure in Expressions

#### Cluster: Interpret the structure of expressions

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<tbody>
<tr>
<td>HS.A-SSE.1*</td>
<td>Interpret expressions that represent a quantity in terms of its context.</td>
<td>Forming Quadratics</td>
</tr>
</tbody>
</table>

- Interpret parts of an expression, such as terms, factors, and coefficients.
- Interpret complicated expressions by viewing one or more of their parts as a single entity.

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<tr>
<td>expression</td>
<td>Example: Interpret $\frac{1}{2}h(b_1 + b_2)$ as the product of the height of a trapezoid and the average of its base lengths.</td>
<td>Algebra II students extend their focus to polynomial and rational expressions.</td>
</tr>
<tr>
<td>term</td>
<td></td>
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<tr>
<td>factor</td>
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<tr>
<td>coefficient</td>
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### Conceptual Category: Algebra

#### Domain: Seeing Structure in Expressions

#### Cluster: Interpret the structure of expressions

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</table>
| HS.A-SSE.2 | - rewrite algebraic expressions in equivalent forms such as factoring or combining like terms  
- use factoring techniques such as common factors, grouping, the difference of two squares, the sum or difference of two cubes, or a combination of methods to factor an expression completely  
- simplify expressions by combining like terms, using the distributive property and using other operations with polynomials  
- recognize patterns and structures in expressions | Forming Quadratics |

**Vocabulary**

**Annotations**

Example:

See $9a^2 - 4b^2$ as $(3a)^2 - (2b)^2$ and recognize it as a difference of squares that can be factored as $(3a - 2b)(3a + 2b)$.

Example: See $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$, and further to $(x-y)(x+y)(x^2+y^2)$.

Algebra II students extend their focus to polynomial and rational expressions.

**Notes**

Note:

(+) indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics

* indicates modeling standards
### North Dakota HIGH SCHOOL State Standards: ALGEBRA II

**Conceptual Category:** Algebra  
**Domain:** Seeing Structure in Expressions  
**Cluster:** Write expressions in equivalent forms to solve problems

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
</table>
| HS.A-SSE.3* | - choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.  
- a. Factor a quadratic expression to reveal the zeros of the function it defines.  
- b. Complete the square in a quadratic expression to produce and equivalent expression.  
- c. Use the properties of exponents to transform exponential expressions. | Forming Quadratics |

**Vocabulary**  
- equivalent form  
- quadratic function  
- zero of a function  
- complete the square  
- maximum  
- minimum  
- vertex  
- exponent  
- exponential  
- rate of growth or decay

**Annotations**  
Example: Given a quadratic function explain the meaning of the zeros of the function. That is if \( f(x) = x^2-7x+12 = (x - 4) (x - 3) \) then \( f(4) = 0 \) and \( f(3) = 0 \).  
Example: A toy rocket is shot up at 128 ft/sec from a height of 5 ft. What is the maximum height of the rocket and when does it reach that height?  
Solution: After 4 seconds the rocket is 261 ft high  
Example: Write the equation of a circle in standard form to find the center and radius.  
Example: \( 8^t = 2^{3t} \)  
Example: The expression \( 1.15^t \) can be rewritten as \( (1.15^{1/12})^{12t} \approx 1.012^{12t} \) to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

**Notes:**  
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North Dakota HIGH SCHOOL State Standards: ALGEBRA II
Conceptual Category: Algebra
Domain: Arithmetic with Polynomials and Rational Expressions
Cluster: Perform arithmetic operations on polynomials

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.A-APR.1</td>
<td>• identify polynomials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• add, subtract, and multiply polynomials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• recognize how closure applies under these operations</td>
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</tr>
<tr>
<td></td>
<td>• relate the addition, subtraction, and multiplication of polynomials to the</td>
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<td></td>
<td>same operations with integers</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Vocabulary</th>
<th>Annotations</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• polynomial</td>
<td>Algebra II students extend their understanding beyond the quadratic</td>
<td></td>
</tr>
<tr>
<td>• closure</td>
<td>polynomials.</td>
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</tbody>
</table>

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<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.A-APR.2</td>
<td>• apply the Remainder Theorem to a polynomial</td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary**

- Remainder Theorem: For a polynomial $p(x)$ and a number $a$, the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$.

- zero of a polynomial

**Annotations**

Pre-requisite knowledge for this standard includes understanding of polynomial division and factoring.

**Notes**

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## North Dakota HIGH SCHOOL State Standards: ALGEBRA II

**Conceptual Category:** Algebra  
**Domain:** Arithmetic with Polynomials and Rational Expressions  
**Cluster:** Understand the relationship between zeros and factors of polynomials

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.A-APR.3</td>
<td>Identify zeros of polynomials when suitable factorizations are available.</td>
<td>Use the zeros to construct a rough graph of the function defined by the polynomial.</td>
</tr>
<tr>
<td></td>
<td>- factor a polynomial</td>
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<tr>
<td></td>
<td>- find the zeros of a factored polynomial function</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- use the zeros (x-intercepts) of a polynomial function to sketch a graph of the function</td>
<td></td>
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</tbody>
</table>

**Vocabulary**

**Annotations**

**Notes**

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**Note:**

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### North Dakota HIGH SCHOOL State Standards: ALGEBRA II

Conceptual Category: Algebra  
Domain: Arithmetic with Polynomials and Rational Expressions  
Cluster: Use polynomial identities to solve problems

<table>
<thead>
<tr>
<th>Standard</th>
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</thead>
<tbody>
<tr>
<td>(+) HS.A-APR.5</td>
<td>Know and apply the Binomial Theorem for the expansion of ((x + y)^n) in powers of (x) and (y) for a positive integer (n).</td>
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<tr>
<td></td>
<td>• use Pascal’s Triangle to determine the coefficients of the binomial expansion ((x+y)^n)</td>
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<tr>
<td></td>
<td>• use the Binomial Theorem to find the (n)th term in the expansion of a binomial to a positive integer power</td>
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</table>

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<thead>
<tr>
<th>Vocabulary</th>
<th>Annotations</th>
<th>Notes</th>
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<tbody>
<tr>
<td>• Pascal’s Triangle</td>
<td></td>
<td></td>
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<tr>
<td>• Binomial Theorem</td>
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# North Dakota HIGH SCHOOL State Standards: ALGEBRA II

## Conceptual Category: Algebra

## Domain: Arithmetic with Polynomials and Rational Expressions

## Cluster: Rewrite rational expressions

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.A-APR.6</td>
<td>rewrite rational expressions, ( \frac{a(x)}{b(x)} ), in the form ( q(x) + \frac{r(x)}{b(x)} ), where ( a(x) ), ( b(x) ), ( q(x) ), and ( r(x) ) are polynomials with the degree of ( r(x) ) less than the degree of ( b(x) ), using inspection, long division, or, for the more complicated examples, a computer algebra system.</td>
<td>Simplifying Rational Expressions Resource</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Vocabulary</th>
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<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>rational expression</td>
<td>Example: Use long division to rewrite: [ \frac{3x^3 - 2x^2 + 4x - 3}{x^2 + 3x + 3} ] in the form: ( (3x - 11) + \frac{28x + 30}{x^2 + 3x + 3} )</td>
<td></td>
</tr>
</tbody>
</table>

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### North Dakota HIGH SCHOOL State Standards: ALGEBRA II
Conceptual Category: Algebra
Domain: Arithmetic with Polynomials and Rational Expressions
Cluster: Rewrite rational expressions

<table>
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<tr>
<th>Standard</th>
<th>Students Can</th>
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</thead>
<tbody>
<tr>
<td>HS.A-APR.7</td>
<td>• add, subtract, multiply, and divide rational expressions</td>
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<tr>
<td></td>
<td>• recognize that rational expressions are closed under addition, subtraction, multiplication, and division by a nonzero rational expression</td>
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<td></td>
<td>• relate the rational expressions system to the rational numbers system</td>
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<thead>
<tr>
<th>Vocabulary</th>
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</thead>
<tbody>
<tr>
<td>• closure</td>
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</table>

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North Dakota *HIGH SCHOOL* State Standards: *ALGEBRA II*
Conceptual Category: *Algebra*
Domain: *Creating Equations and Inequalities* *
Cluster: *Create equations that describe numbers or relationships*

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.A-CED.1*</td>
<td>• create linear, quadratic, rational and exponential equations and inequalities in one variable and use them in a contextual situation to solve problems</td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary**
- linear equations
- quadratic equations
- rational equations
- exponential equations
- inequalities

**Annotations**
Algebra II students use all available types of functions to create such equations, including root functions, but constrain to simple cases.

**Notes**

Note:
(+*) indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics
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<tr>
<th>Standard</th>
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</thead>
</table>
| HS.A-CED.2*     | • create equations in two or more variables to represent relationships between quantities  
|                 | • graph equations in two variables on a coordinate plane and label the axes and scales |           |

**Vocabulary**
- coordinate plane
- scale

**Annotations**
Example: The cost to rent a car is $50 plus $0.25 per mile driven. Write and graph an equation to represent the situation.

In Algebra II, the linear, exponential, or quadratic types of problems should draw from more complex situations than those addressed in Algebra I.

**Notes**
(+) indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics
* indicates modeling standards
### Standard

**Architecture**: 
- **Domain**: Creating Equations and Inequalities*  
  **Cluster**: Create equations that describe numbers or relationships

**HS.A-CED.3***

- Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context.

### Students Can

- write and use a system of equations and/or inequalities to solve a real world problem
- use equations and inequalities to represent problem constraints and objectives (linear programming)
- interpret solutions to problems as viable or non-viable in a problem context

### Resources

- **Vocabulary**
  - linear programming
  - constraint
  - feasible region

- **Annotations**
  - Example: Willy Wonka’s Chocolate Factory makes Wonka Bars and The Everlasting Gobstopper, among other amazing treats. Oompa Loompas and Fuzzy Fizzies work on each item. The Oompa Loompas spend 6 minutes making a Wonka Bar and 4 minutes mixing the ingredients for an Everlasting Gobstopper. There are enough Oompa Loompas for up to 6000 worker-minutes per day. The Fuzzy Fizzies spend about 1 minute wrapping each Wonka Bar and 2 minutes wrapping each Everlasting Gobstopper. There are enough Fuzzy Fizzies for a maximum of 1200 worker-minutes per day.

Given the above constraints, find the feasible region for the number of Wonka Bars and Everlasting Gobstoppers that can be made per day.

**Solution:**

- Oompa Loompas: \(6 \text{ min/bar}(x \text{ bars}) + 4 \text{ min/gob}(y \text{ gob}) \leq 6000 \text{ min}\).
- Fuzzy Fizzies: \((1 \text{ min/bar})(x \text{ bars}) + 2 \text{ min/gob}(y \text{ gob}) \leq 1200 \text{ min}\).

Using substitution, \(y = 150, x = 900\) if the maximum number of hours are worked. Therefore, the feasible region for the number of Wonka Bars made in a day is \(0 \leq x \leq 900\), and the feasible region for the number of Everlasting Gobstoppers is \(0 \leq y \leq 150\).

### Notes

- In Algebra II, the linear, exponential, or quadratic types of problems should draw from more complex situations than those addressed in Algebra I.

Note:

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## North Dakota HIGH SCHOOL State Standards: ALGEBRA II

**Conceptual Category:** Algebra  
**Domain:** Creating Equations and Inequalities*  
**Cluster:** Create equations that describe numbers or relationships

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<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
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</thead>
<tbody>
<tr>
<td>HS.A-CED.4*</td>
<td>• solve multi-variable formulas or literal equations for a specific variable</td>
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</tbody>
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</thead>
</table>
| • literal equation | Example: Rearrange Ohm’s law $V = IR$ to highlight resistance $R$.  

In Algebra II, the linear, exponential, or quadratic types of problems should draw from more complex situations than those addressed in Algebra I. | |
### Standard

**HS.A-REI.2**  
Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

### Students Can

- solve simple rational equations in one variable
- solve simple radical equations in one variable
- provide examples of how extraneous solutions arise from solving simple rational and radical equations

### Vocabulary

- extraneous solutions

### Annotations

**Example:**  
Solve \( \sqrt{6 - x} = x \)

\[
\begin{align*}
(\sqrt{6 - x})^2 &= x^2 \\
6 - x &= x^2 \\
x^2 + x - 6 &= 0 \\
(x - 2)(x + 3) &= 0 \\
x &= 2 \text{ or } x = -3
\end{align*}
\]

Check 2 and -3 in the original equation:

\[
\begin{align*}
\sqrt{6 - 2} &= \sqrt{4} = 2 \\
\sqrt{6 - 3} &= \sqrt{9} \neq -3
\end{align*}
\]

Because -3 does not satisfy the original equation, -3 is an extraneous solution. 2 is the only solution to the equation.

### Notes

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North Dakota *HIGH SCHOOL* State Standards: *ALGEBRA II*

**Conceptual Category:** Algebra  
**Domain:** Reasoning with Equations and Inequalities  
**Cluster:** Solve equations and inequalities in one variable

<table>
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<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
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</thead>
<tbody>
<tr>
<td>HS.A-REI.4 Solve quadratic equations in one variable.</td>
<td></td>
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</tbody>
</table>
  a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form \((x – p)^2 = q\) that has the same solutions.  
  b. Solve quadratic equations by inspection (e.g., for \(x^2=49\)) taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. |  
  Recognize when the quadratic formula gives complex solutions and write them as \(a\pm bi\) for real numbers \(a\) and \(b\).  
  - solve quadratic equations in one variable  
  - transform a quadratic equation to an equation in the form \((x-p)^2=q\) by completing the square  
  - solve quadratic equations in one variable by simple inspection, taking the square root, factoring, and completing the square  
  - recognize which method of solving a quadratic equation is appropriate for a given equation  
  - explain why taking the square root of both sides of an equation can yield two solutions  
  - use the quadratic formula to solve any quadratic equation, recognizing the formula produces all complex solutions and write the solutions in the form \(a \pm bi\), where \(a\) and \(b\) are real numbers |

<table>
<thead>
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</thead>
</table>
| - completing the square  
- quadratic formula | This standard is related to HS.N-CN.7. | (+) indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics  
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### North Dakota HIGH SCHOOL State Standards: ALGEBRA II

**Conceptual Category:** Algebra  
**Domain:** Reasoning with Equations and Inequalities  
**Cluster:** Solve systems of equations

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>HS.A-REI.7</td>
<td>Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• solve a system containing a linear equation and a quadratic equation in two variables algebraically and graphically</td>
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<tbody>
<tr>
<td></td>
<td>Example: Find the points of intersection between the line ( y = -3x ) and the circle ( x^2 + y^2 = 3 ).</td>
<td></td>
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</tbody>
</table>

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### Standard

**HS.A-REI.11**

Using graphs, technology, tables, or successive approximations, show that the solution(s) to the equation \( f(x) = g(x) \) are the x-value(s) that result in the y-values of \( f(x) \) and \( g(x) \) being the same.

### Students Can

- explain why the intersection of \( y = f(x) \) and \( y = g(x) \) is the solution of \( f(x) = g(x) \) for any combination of linear, polynomial, rational, absolute value, exponential, and logarithmic functions
- use technology to graph the equations and find their points of intersection
- use tables of values or successive approximations to find solutions

### Resources

- **Vocabulary**
  - intersection

- **Annotations**
  Algebra II will include combinations of linear, polynomial, rational, radical, absolute value, exponential, and logarithmic functions.

  Example: Use a graphing calculator to find and justify the approximate solution(s) to the system below.

  \[
  \begin{align*}
  f(x) &= x + 4 \\
  g(x) &= 4 - x^2 \\
  \end{align*}
  \]

  Solutions: \( x = 0 \) and \( x = -1 \).

  \[
  f(0) = 4, \ g(0) = 4; \ f(-1)=3, \ g(-1)=3
  \]

### Notes

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* indicates modeling standards
North Dakota HIGH SCHOOL State Standards: ALGEBRA II
Conceptual Category: Functions
Domain: Interpreting Functions
Cluster: Interpret functions that arise in applications in terms of the context

<table>
<thead>
<tr>
<th>Standard</th>
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</thead>
</table>
| HS.F-IF.4* | • identify key features in graphs and tables to include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior for a given function  
• use appropriate notation to indicate where functions are increasing, decreasing, positive, and negative  
• sketch the graph of a function given its key features | Interpreting Distance-Time Graphs  
Forming Quadratics |

<table>
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</thead>
</table>
| • intercepts  
• relative maximum  
• relative minimum  
• end behavior  
• periodicity  
• symmetry | Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.  
Example: Given \( f(x) = x^2 - 4 \). Graph the function and identify the intercepts, intervals where the function is increasing, decreasing, positive, and negative, the relative maximum and minimum, and any symmetry.  
Solution:  
Intercepts: \((-2,0), (2,0), (0,-4)\)  
Relative Minimum: \((0,-4)\)  
Increasing: \(x > 0\)  
Decreasing: \(x < 0\)  
Positive: \(x < -2\) and \(x > 2\)  
Negative: \(-2 < x < 2\)  
Symmetric to the y axis | Algebra II emphasizes the selection of a model function based on behavior of data and context. |

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<tbody>
<tr>
<td>HS.F-IF.5*</td>
<td>- interpret a graph to determine the</td>
<td>Interpreting Distance-Time Graphs</td>
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<tr>
<td></td>
<td>appropriate numerical domain being</td>
<td>Forming Quadratics</td>
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<td>described</td>
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<tr>
<td>Vocabulary</td>
<td>Annotations</td>
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<tr>
<td></td>
<td>Example: If the function h(n) gives the</td>
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<td>number of person-hours it takes to</td>
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<td>assemble n engines in a factory, then the</td>
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<td>positive integers would be an appropriate</td>
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<td>domain for the function.</td>
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<td>Algebra II emphasizes the selection of a</td>
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<td>model function based on behavior of data and</td>
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<td>content.</td>
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* indicates modeling standards
### Standard

**HS.F-IF.6***

Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

### Students Can

- calculate and interpret the average rate of change of a function presented symbolically or as a table
- estimate the average rate of change over a specified interval of a function from its graph

### Resources

- Interpreting Distance-Time Graphs
- The High School Gym

### Vocabulary

- rate of change
- interval

### Annotations

**Example:** Estimate the rate of change given the graph below:

![Graph](image)

Solution: The average rate of change of a function \( y = f(x) \) over an interval \([a, b]\) is

\[
\frac{dy}{dx} = \frac{f(b) - f(a)}{b - a}.
\]

Therefore, the estimated average rate of change for the function graphed above is:

\[
\frac{(5-0)}{(0-(-1.75))} \approx 2.86
\]

### Notes

Algebra II emphasizes the selection of a model function based on behavior of data and context.

---

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* indicates modeling standards
### Conceptual Category: Functions

#### Domain: Interpreting Functions

#### Cluster: Analyze functions using different representations

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<thead>
<tr>
<th>Standard</th>
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</tr>
</thead>
</table>
| HS.F-IF.7* | - graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.  
  b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.  
  c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.  
  e. Graph exponential and logarithmic functions, showing intercepts and end behavior.  
  f. Graph f(x) = sin x and f(x) = cos x as representations of periodic phenomena. | Interpreting Distance-Time Graphs  
 Forming Quadratics  
 Functions and Everyday Situations |

#### Vocabulary

- square root function  
- cube root function  
- piecewise-defined function  
- step function  
- absolute value function  
- polynomial function  
- exponential function  
- logarithmic function  
- asymptote  
- period  
- midline  
- amplitude

#### Annotations

Example: Solve the annual compound interest formula $A = P(1 + r)^t$ for $t$ and draw a graph of time vs. amount for a given rate and principle amount, showing intercepts and end behavior. Compare this graph to the graph of amount vs. time.

#### Notes

Algebra II focuses on applications, how key features relate to characteristics of situations, and making selections of a particular type of function model.

---

**Note:**

(+) indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics  
* indicates modeling standards
North Dakota *HIGH SCHOOL* State Standards: *ALGEBRA II*

Conceptual Category: **Functions**
Domain: **Interpreting Functions**
Cluster: **Analyze functions using different representations**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
</table>
| HS.F-IF.8* | - write a function in equivalent forms (e.g., factored vs. general form) to show different properties of the function  
- explain different properties of a function that are revealed by writing a function in equivalent forms  
- use the process of factoring and completing the square in a quadratic function to show zeros, a maximum or minimum, and symmetry of the graph, and interpret these in terms of a real-world situation  
- use the properties of exponents to interpret exponential functions as growth or decay | **Interpreting Distance-Time Graphs**  
**Forming Quadratics**  
**Drug Filtering**  
**Which Equation** |

<table>
<thead>
<tr>
<th>Vocabulary</th>
<th>Annotations</th>
<th>Notes</th>
</tr>
</thead>
</table>
| - exponential growth  
- exponential decay  
- extreme values | Example: Identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth or decay. | Algebra II focuses on using key features to guide selection of appropriate type of function model. |

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### North Dakota HIGH SCHOOL State Standards: ALGEBRA II

**Conceptual Category:** Functions  
**Domain:** Interpreting Functions  
**Cluster:** Analyze functions using different representations

<table>
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</tr>
</thead>
</table>
| HS.F-IF.9* | • compare the key features of two functions that are represented in different ways | Interpreting Distance-Time Graphs  
Forming Quadratics | |

#### Vocabulary

- **Annotations**
  - Example: Given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.
  - Example: Compare the intercepts of two functions, one of which is represented graphically and the other is represented symbolically.
  - Algebra II focuses on using key features to guide selection of the appropriate type of model function.

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</thead>
</table>
| HS.F-BF.1* | - write a function that describes a relationship between two quantities.  
- combine function types, such as linear and exponential, using arithmetic operations.  
- compose functions and interpret the result in a real-world situation | Generalizing Patterns: Table Tiles  
Printing Tickets | Algebra II will develop models for more complex or sophisticated situations than in previous courses. |

**Conceptual Category:** Functions  
**Domain:** Building Functions*  
**Cluster:** Build a function that models a relationship between two quantifiers

**Vocabulary**  
- composition of functions

**Annotations**  
Example: Build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

Example: If \( T(y) \) is the temperature in the atmosphere as a function of height, and \( h(t) \) is the height of a weather balloon as a function of time, then \( T(h(t)) \) is the temperature at the location of the weather balloon as a function of time.

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>HS.F-BF.2*</td>
<td>write and translate between the recursive and explicit formula for a geometric sequence and use the formulas to model a situation</td>
<td>Generalizing Patterns: Table Tiles</td>
</tr>
<tr>
<td></td>
<td>write and translate between the recursive and explicit formula for a geometric sequence and use the formulas to model a situation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>make connections between linear functions and arithmetic sequences, and exponential functions and geometric sequences</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vocabulary</th>
<th>Annotations</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>sequence</td>
<td>Example: Allen is training for a biking race and begins his workout regimen by biking 10 miles on day one and increasing his mileage by 2 miles per day for the next 15 days. Express the situation with a recursive and explicit formula. Solution: $a_n=2n+8$ (explicit) $a_{n}=a_{n-1}+2$ with $n&gt;1$ (recursive)</td>
<td></td>
</tr>
<tr>
<td>recursive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>explicit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>arithmetic sequences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>geometric sequences</td>
<td></td>
<td></td>
</tr>
</tbody>
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</thead>
<tbody>
<tr>
<td>HS.F-BF.3*</td>
<td>- identify, the transformational effects on the graph of a function f(x) when f(x) is replaced by f(x)+k, k·f(x), f(kx), and f(x+k) for specific values of k, both positive and negative</td>
<td>- find the value of k given the graph of a transformed function</td>
</tr>
<tr>
<td></td>
<td>- recognize even and odd functions from their graphs.</td>
<td>- recognize even and odd functions from their graphs and equations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vocabulary</th>
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<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>- transformation</td>
<td>Technology may be used to experiment with the effects of transformations on a graph.</td>
<td></td>
</tr>
<tr>
<td>- even functions</td>
<td>Algebra II will use transformations of functions to find models as students consider increasingly more complex situations; note the effect of multiple transformations on a single graph and the common effect of each transformation across function types.</td>
<td></td>
</tr>
<tr>
<td>- odd functions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<tbody>
<tr>
<td>HS.F-BF.4*</td>
<td>• find the inverse of a given function</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• verify that one function is the inverse of the other by composition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• read values of an inverse function from a graph or table</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• restrict the domain on a function that is not one-to-one so that its inverse is a function</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vocabulary</th>
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<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>inverse function</td>
<td>Example: Find the inverse for each function: f(x) = 2 x³ or f(x) = (x + 1)/(x - 1) for x ≠ 1.</td>
<td></td>
</tr>
<tr>
<td>independent variable</td>
<td>Algebra II will extend to simple rational, simple radical, and simple exponential functions.</td>
<td></td>
</tr>
<tr>
<td>dependent variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>one-to-one function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>invertible function</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:

(+): *indicates modeling standards
North Dakota *HIGH SCHOOL* State Standards: *Algebra II*
Conceptual Category: **Functions**
Domain: **Building Functions***
Cluster: **Build new functions from existing functions**

<table>
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<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.F-BF.5*</td>
<td>- write an exponential function in logarithmic form and vice-versa</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- solve problems involving logarithms and exponents</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vocabulary</th>
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</tr>
</thead>
<tbody>
<tr>
<td>• logarithm</td>
<td></td>
<td></td>
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</tbody>
</table>

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### Standard

**HS.F-LE.4***

Use logarithms to express the solution to $ab^c = d$ where $a$, $c$, and $d$ are real numbers and $b$ is a positive real number. Evaluate the logarithm using technology when appropriate.

<table>
<thead>
<tr>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>• express the solution to an exponential function as a logarithm</td>
<td><strong>Basketball Rebounds</strong> <em>(exponential/logarithms utilized)</em></td>
</tr>
<tr>
<td>• use properties of logarithms to simplify logarithmic expressions</td>
<td></td>
</tr>
<tr>
<td>• evaluate logarithms using technology</td>
<td></td>
</tr>
</tbody>
</table>

### Vocabulary

- natural logarithm
- common logarithm

### Annotations

Example: $3e^{2t} = 317$

\[
e^{2t} = \frac{317}{3}
\]

\[
\ln e^{3t} = \ln \left(\frac{317}{3}\right)
\]

\[
3t = \ln \left(\frac{317}{3}\right)
\]

Using a calculator and rounding $t$ to the nearest hundredth: $t \approx 1.55$.

### Notes

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### Standard

**HS.F-TF.2**

Extend right triangle trigonometry to the four quadrants.

### Students Can

- use a reference triangle to extend the domain of the trigonometric functions beyond quadrant I and interpret the positive angles as counterclockwise rotations in radian form and negative angles as clockwise rotations in radian form.

### Resources

**Vocabulary**
- reference triangle
- radian

**Annotations**
Example: Find sin 210°
### North Dakota HIGH SCHOOL State Standards: Algebra II

**Conceptual Category:** Functions  
**Domain:** Trigonometric Functions  
**Cluster:** Extend the domain of trigonometric functions using the unit circle

<table>
<thead>
<tr>
<th>Standard</th>
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<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.F-TF.3</td>
<td>Use special triangles to determine geometrically the values of sine, cosine, tangent for ( \pi/3 ), ( \pi/4 ) and ( \pi/6 ).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use special triangles (45°-45°-90° and 30°-60°-90°) to determine the values of sine, cosine and tangent for ( \pi/3 ), ( \pi/4 ) and ( \pi/6 )</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vocabulary</th>
<th>Annotations</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>special triangles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>reference triangle</td>
<td></td>
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</tr>
</tbody>
</table>

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### North Dakota HIGH SCHOOL State Standards: ALGEBRA II

**Conceptual Category:** Functions  
**Domain:** Trigonometric Functions  
**Cluster:** Prove and apply trigonometric identities

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
</table>
| HS.F-TF.8 | **Prove the Pythagorean identity** $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle. | **Use the unit circle to prove the Pythagorean Identity** $\sin^2(\theta) + \cos^2(\theta) = 1$  
**Use the Pythagorean Identity** $\sin^2(\theta) + \cos^2(\theta) = 1$ to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle. |

<table>
<thead>
<tr>
<th>Vocabulary</th>
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<th>Notes</th>
</tr>
</thead>
</table>
| • Pythagorean Identity | Students might "prove" by providing a formal proof, demonstrating, or justifying.  
Example: Given $\theta$ is a Quadrant II angle and $\sin \theta = 4/5$, find $\cos \theta$ using the Pythagorean Identity. | |

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## Standard

**HS.G-GPE.1**  
Derive the equation of a circle of given center and radius. Derive the equation of a parabola given a focus and directrix.

### Students Can
- use the Pythagorean Theorem to derive the equation of a circle, given the center and radius
- derive the equation of a parabola given the focus and directrix

### Vocabulary
- complete the square
- center
- radius
- focus
- directrix

### Resources

### Notes

---

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## North Dakota HIGH SCHOOL State Standards: ALGEBRA II

**Conceptual Category:** Geometry  
**Domain:** Expressing Geometric Properties with Equations  
**Cluster:** Understand and use conic sections

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
</table>
| HS.G-GPE.2 Convert between the standard form and general form of conic sections. | • complete the square to create an equivalent expression  
• convert between standard form and general form of conic section equations | |

### Vocabulary

**Annotations**  
Conic sections include the circle, ellipse, parabola, and hyperbola.

### Notes

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North Dakota HIGH SCHOOL State Standards: ALGEBRA II
Conceptual Category: Geometry
Domain: Expressing Geometric Properties with Equations
Cluster: Understand and use conic sections

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</tr>
</thead>
<tbody>
<tr>
<td>HS.G-GPE.3</td>
<td>Identify key features of conic sections given their equations.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apply properties of conic sections in real-world situations.*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• complete the square to create an equivalent expression</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• convert between standard form and general form of conic sections</td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Vocabulary</th>
<th>Annotations</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• center</td>
<td>Conic sections include the circle, ellipse, parabola, and hyperbola.</td>
<td></td>
</tr>
<tr>
<td>• radius</td>
<td>Key features include: Circle – center, radius</td>
<td></td>
</tr>
<tr>
<td>• vertex</td>
<td>Parabola – vertex, focus, directrix</td>
<td></td>
</tr>
<tr>
<td>• focus</td>
<td>Ellipse – center, foci, vertices, length of major and minor axis</td>
<td></td>
</tr>
<tr>
<td>• directrix</td>
<td>Hyperbola – center, foci, asymptotes</td>
<td></td>
</tr>
<tr>
<td>• major axis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• minor axis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• asymptotes</td>
<td></td>
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</tbody>
</table>

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North Dakota HIGH SCHOOL State Standards: ALGEBRA II
Conceptual Category: Statistics and Probability
Domain: Interpreting Categorical and Quantitative Data*
Cluster: Summarize, represent, and interpret data on a single count or measurement variable

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>HS.S-ID.4*</td>
<td>Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.</td>
<td>Resource: Progressions for the Common Core State Standards HS Statistics &amp; Probability</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• normal distribution</td>
<td>Example: An example of a data set that does not fit to a normal distribution is age at retirement. Most people retire in their mid 60s or older, with increasingly fewer retiring at increasingly earlier ages. This results in a skewed-left distribution.</td>
<td></td>
</tr>
</tbody>
</table>

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### HS.S-ID 6* 
Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

<table>
<thead>
<tr>
<th>Students Can</th>
</tr>
</thead>
<tbody>
<tr>
<td>• create a scatter plot from two quantitative variables</td>
</tr>
<tr>
<td>• describe the form, strength and direction of the relationship</td>
</tr>
<tr>
<td>• categorize data as linear, exponential, quadratic or neither</td>
</tr>
<tr>
<td>• use algebraic methods or technology to fit the data to a linear, exponential or quadratic function</td>
</tr>
<tr>
<td>• use the function to predict values</td>
</tr>
<tr>
<td>• explain the meaning of slope and y-intercept (linear model) or the meaning of the growth rate and y-intercept (exponential model) or the meaning of the coefficients (quadratic model) in context</td>
</tr>
<tr>
<td>• calculate a residual</td>
</tr>
<tr>
<td>• create and analyze a residual plot</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpreting Statistics: A Case of Muddying the Waters</td>
</tr>
<tr>
<td>Resource: Progressions for the Common Core State Standards HS Statistics &amp; Probability</td>
</tr>
</tbody>
</table>

#### Standard
HS.S-ID.6* 
Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

<table>
<thead>
<tr>
<th>a.</th>
<th>Fit a function to the data (with or without technology).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use functions fitted to data to solve problems in the context of the data.</td>
<td></td>
</tr>
</tbody>
</table>

| b. | (+) Informally assess the fit of a function by plotting and analyzing residuals. |

#### Vocabulary
- scatter plot
- residual: the observed value minus the predicted value. It is the difference of the results obtained by observation, and by computation from a formula.
- residual plot

#### Annotations
Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.
### Standard

<table>
<thead>
<tr>
<th>HS.S-IC.1*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand the process of making inferences about population parameters based on a random sample from that population.</td>
</tr>
</tbody>
</table>

### Students Can

- explain how to make inferences about a population based on a sample of that population

### Resources

- Interpreting Statistics: A Case of Muddying the Waters
- Resource: Progressions for the Common Core State Standards HS Statistics & Probability

### Vocabulary

- sample
- population

### Annotations

Example: Suppose 50 fish are tagged in a pond. A fisherman catches 5 fish from the pond and one has a tag. What conclusion can you draw about the fish population?

### Notes

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### North Dakota HIGH SCHOOL State Standards: ALGEBRA II

**Conceptual Category:** Statistics and Probability  
**Domain:** Making Inferences and Justifying Conclusions  
**Cluster:** Understand and evaluate random processes underlying statistical experiments

<table>
<thead>
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<th><strong>Resources</strong></th>
</tr>
</thead>
</table>
| HS.S-IC.2*   | - demonstrate understanding of the different kinds of sampling methods  
- design simulations of random sampling: assign digits in appropriate proportions for events, carry out the simulation using random number generators and random number tables and explain the outcomes in context of the population and the known proportions |  
**Interpreting Statistics: A Case of Muddying the Waters**  
The Hermit's Epidemic  
**Resource: Progressions for the Common Core State Standards HS Statistics & Probability** |

<table>
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<tr>
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<tbody>
<tr>
<td></td>
<td>Example: A model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?</td>
<td></td>
</tr>
</tbody>
</table>

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**North Dakota HIGH SCHOOL State Standards: ALGEBRA II**

**Conceptual Category:** Statistics and Probability  
**Domain:** Making Inferences and Justifying Conclusions*  
**Cluster:** Make inferences and justify conclusions from sample surveys, experiments, and observational studies

<table>
<thead>
<tr>
<th>Standard</th>
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<th>Resources</th>
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</thead>
</table>
| HS.S-IC.3*        | • identify situations as sample survey, experiment, or observational study and discuss the appropriateness of each one’s use in contexts with limiting factors  
                  | • design or evaluate sample surveys, experiments and observational studies with randomization and discuss the importance of randomization in these processes | [Interpreting Statistics: A Case of Muddying the Waters](#)  
                  |                                                               | Resource: Progressions for the Common Core State Standards HS Statistics & Probability |

<table>
<thead>
<tr>
<th>Vocabulary</th>
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</thead>
<tbody>
<tr>
<td>• sample survey</td>
<td>Example: Design a simple study and explain the impact of sampling methods, bias and the phrasing of questions asked during data collection.</td>
</tr>
<tr>
<td>• experiment</td>
<td></td>
</tr>
<tr>
<td>• observational study</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**  
(+ indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics  
* indicates modeling standards
North Dakota HIGH SCHOOL State Standards: ALGEBRA II
Conceptual Category: Statistics and Probability
Domain: Making Inferences and Justifying Conclusions*
Cluster: Make inferences and justify conclusions from sample surveys, experiments, and observational studies

<table>
<thead>
<tr>
<th>Standard</th>
<th>Students Can</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS.S-IC.6*</td>
<td>• evaluate reports based on data</td>
<td>Interpreting Statistics: A Case of Muddying the Waters</td>
</tr>
<tr>
<td></td>
<td>• evaluate articles, reports or websites</td>
<td>Resource: Progressions for the Common Core</td>
</tr>
<tr>
<td></td>
<td>• identify and explain the misleading use of data</td>
<td>State Standards HS Statistics &amp; Probability</td>
</tr>
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<td>• recognize when claims based on data confuse</td>
<td></td>
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<tr>
<td></td>
<td>correlation and causation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• recognize and describe how graphs can be</td>
<td></td>
</tr>
<tr>
<td></td>
<td>distorted to support different points of view</td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary**

**Annotations**

**Notes**

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