

Zome System in Standards Based Education

The lesson plans make reference to the educational standards they address. Due to space constraints it was only possible to refer to the title of each standard. This section contains more extensive text, including the various benchmarks the plans address. The mathematics-related standards are based on those developed by National Council of Teachers of Mathematics (NCTM). Most US states have based their standards on the NCTM documents. The art and science standards have very general language borrowed from the standards used in the Jefferson County, Colorado, school district. These standards will be substantially re-written in later versions of the lesson plans.

Fine Art Standards

- * Fine Arts standards that **identify and apply the elements of art in a variety of media**. Addressed components include:
 - Identify, define, and practice the elements of art.
- * Fine Arts standards that **relate the visual arts to historical, cultural and personal heritage**. Addressed components include:
 - Creating works that are influenced by various cultures, and personal heritages;
 - Create art based on personal interpretation of historical and cultural context.

Language Arts Standards

- * Language Arts standards requiring students to **write and speak for a variety of purposes**. Addressed components include:
 - choosing vocabulary and figures of speech that communicate clearly;
 - writing and speaking in the content areas, using the technical vocabulary of the subject accurately.
- * Language Arts standards requiring students to **apply thinking skills to their reading, writing, speaking, listening, and viewing**. Addressed components include:
 - using reading, writing, speaking, listening, and viewing skills to solve problems and answer questions;
 - recognizing, expressing and defending a point of view orally in an articulate manner and in writing.

Physical Science Standards

- * Physical Science standards requiring students to **know and understand common properties, forms, and changes in matter and energy**. Addressed components include :
 - examining, describing, comparing, measuring, and classifying objects based on common physical properties;
 - developing simple models to explain observed properties of matter.

Mathematics Standards for Grades K-4

- * Mathematics standards addressing **mathematical connections** (NCTM Standard 4). Students are required to:
 - link conceptual and procedural knowledge;
 - relate various representations of concepts or procedures to one another;
 - recognize relationships among different topics in mathematics;
 - use mathematics in other curriculum areas;
 - use mathematics in their daily lives.

- * Mathematics standards addressing **number sense and numeration** (NCTM Standard 6). Students are required to:
 - construct number meanings through real-world experiences and the use of physical materials;
 - understand our numeration system by relating counting, grouping, and place-value concepts;
 - develop number sense;
 - interpret the multiple uses of numbers encountered in the real world;

- * Mathematics standards addressing **geometry and spatial sense** (NCTM Standard 9). Students are required to:
 - describe, model, draw, and classify shapes;
 - investigate and predict the results of combining, subdividing, and changing shapes;
 - develop spatial sense;
 - relate geometric ideas to number and measurement ideas;
 - recognize and appreciate geometry in their world.

- * Mathematics standards addressing **measurement** (NCTM Standard 10). Students are required to:
 - understand the attributes of length, capacity, weight, mass, area, volume, time, temperature, and angle;
 - develop the process of measuring and concepts related to units of measurements;
 - make and use estimates of measurement;
 - make and use measurements in problem and everyday situations.

Mathematics Standards for Grades 5-8

- * Mathematics standards addressing **mathematical problem solving as a method of inquiry and application** (NCTM Standard 1). Students are required to:
 - use problem-solving approaches to investigate and understand mathematical content;
 - formulate problems from situations within and outside mathematics;
 - develop and apply a variety of strategies to solve problems, with emphasis on multi-step and non-routine problems;
 - verify and interpret results with respect to the original problem situation;
 - generalize solutions and strategies to new problem situations;
 - acquire confidence in using mathematics meaningfully.

- * Mathematics standards addressing **mathematics as a means of communications** (NCTM Standard 2). Students are required to:
 - model situations using oral, written, concrete, pictorial, graphical, and algebraic methods;
 - reflect on and clarify their own thinking about mathematical ideas and situations;
 - develop common understandings of mathematical ideas, including the role of definitions;
 - use the skills of reading, listening, and viewing to interpret and evaluate mathematical ideas;
 - discuss mathematical ideas and make conjectures and convincing arguments;
 - appreciate the value of mathematical notation and its role in the development of mathematical ideas.

- * Mathematics standards addressing **mathematics as reasoning** (NCTM Standard 3). Students are required to:
 - recognize and apply deductive and inductive reasoning;
 - understand and apply reasoning processes, with special attention to spatial reasoning and reasoning with proportions and graphs;
 - make and evaluate mathematical conjectures and arguments;
 - validate their own thinking;
 - appreciate the pervasive use and power of reasoning as part of mathematics.

- * Mathematics standards addressing **investigation of mathematical connections** (NCTM Standard 4). Students are required to:
 - see mathematics as an integrated whole;
 - explore problems and describe results using graphical, numerical, physical, algebraic, and verbal mathematical models or representations;
 - use a mathematical idea to further their understanding of other mathematical ideas;
 - apply mathematical thinking and modeling to solve problems that arise in other disciplines, such as art, music, psychology, science, and business;
 - value the role of mathematics in our culture and society.

- * Mathematics standards addressing **the development of number and number relationships** (NCTM Standard 5). Students are required to:
 - understand, represent, and use numbers in a variety of equivalent forms (integer, fraction, decimal, percent, exponential, and scientific notation) in real-world and mathematical problem situations;
 - develop number sense for whole numbers, fractions, decimals, integers, and rational numbers;
 - understand and apply ratios, proportions, and percents in a wide variety of situations;
 - investigate relationships among fractions, decimals, and percents;
 - represent numerical relationships in one- and two-dimensional graphs.

- * Mathematics standards addressing **number systems and number theory** (NCTM Standard 6). Students are required to:
 - understand and appreciate the need for number beyond the whole numbers;
 - develop and use order relationships for whole numbers, fractions, decimals, integers, and rational numbers;

- extend their understanding of whole number operations to fractions, decimals, integers, and rational numbers;
 - understand how the basic arithmetic operations are related to one another;
 - develop and apply number theory concepts (e.g. primes, factors, and multiples) in real-world and mathematical problem situations.
- * Mathematics standards addressing the **exploration of patterns and function** (NCTM Standard 8). Students are required to:
- describe, extend, analyze, and create a wide variety of patterns;
 - describe and represent relationships with tables, graphs, and rules;
 - analyze functional relationships to explain how a change in one quantity results in a change in another;
 - use patterns and functions to represent and solve problems.
- * Mathematics standards addressing **the exploration of algebraic concepts and processes** (NCTM Standard 9). Students are required to:
- understand the concepts of variable, expression, and equation;
 - represent situations and number patterns with tables, graphs, verbal rules, and equations, and explore the interrelationships of these representations;
 - analyze tables and graphs to identify properties and relationships;
 - develop confidence in solving linear equations using concrete, informal, and formal methods;
 - investigate inequalities and nonlinear equations informally;
 - apply algebraic methods to solve a variety of real-world and mathematical problems.
- * Mathematics standards addressing **the study of the geometry of one, two, and three dimensions** in a variety of situations (NCTM Standard 12). Students are required to:
- identify, describe, compare, and classify geometric figures;
 - visualize and represent geometric figures with special attention to developing spatial sense;
 - explore transformations of geometric figures;
 - represent and solve problems using geometric models;
 - understand and apply geometric properties and relationships;
 - develop and appreciation of geometry as a means of describing the physical world.
- * Mathematics standards addressing extensive **concrete experiences using measurement** (NCTM Standard 13). Students are required to:
- extend their understanding of the process of measurement;
 - estimate, make, and use measurements to describe and compare phenomena;
 - select appropriate units and tools to measure to the degree of accuracy required in a particular situation;
 - understand the structure and use of systems of measurement;

- extend their understanding of the concepts of perimeter, area, volume, angle measure, capacity, and weight and mass.
- develop the concepts of rates and other derived and indirect measurements;
- develop formulas and procedures for determining measures to solve problems.

Mathematics Standards for Grades 9-12

* Mathematics standards addressing **the extension of problem solving** (NCTM Standard 1). Students are required to:

- use, with increasing confidence, problem-solving approaches to investigate and understand mathematical content;
- apply integrated mathematical problem solving strategies to solve problems from within and outside mathematics;
- recognize and formulate problems from situations within and outside mathematics;
- apply the process of mathematical modeling to real-world problem situations.

* Mathematics standards addressing **language and symbolism to communicate mathematical ideas** (NCTM Standard 2). Students are required to:

- reflect upon and clarify their thinking about mathematical ideas and relationships;
- formulate mathematical definitions and express generalizations discovered through investigations;
- express mathematical ideas orally and in writing;
- read written presentations of mathematics with understanding;
- ask clarifying and extending questions related to mathematics they have read or heard about;
- appreciate the economy, power, and elegance of mathematical notation and its role in the development of mathematical ideas.

* Mathematics standards addressing numerous and varied experiences that reinforce and extend **logical reasoning skills** (NCTM Standard 3). Students are required to:

- make and test conjectures;
- formulate counter-examples;
- follow logical arguments;
- judge the validity of arguments;
- construct simple valid arguments;

For college-intending students:

- construct proofs for mathematical assertions, including indirect proofs and proofs by mathematical induction.

* Mathematics standards addressing **the connections and interplay among various mathematical topics** and their applications (NCTM Standard 4). Students are required to:

- recognize equivalent representations of the same concept;
- relate procedures in one representation to procedures in an equivalent representation;

- use and value the connections among mathematical topics;
 - use and value the connections between mathematics and other disciplines.
- * Mathematics standards addressing **the continued study of algebraic concepts and methods** (NCTM Standard 5). Students are required to:
- represent situations that involve variable quantities with expressions, equations, inequalities, and matrices;
 - use tables and graphs as tools to interpret expressions, equations, and inequalities;
 - operate on expressions and matrices, and solve equations and inequalities;
 - appreciate the power of mathematical abstraction and symbolism;

For college-intending students:

- use matrices to solve linear systems;
- demonstrate technical facility with algebraic transformations, including techniques based on the theory of equations.

* Mathematics standards addressing **the continued study of functions** (NCTM Standard 6). Students are required to:

- model real-world phenomena with a variety of functions;
- represent and analyze relationships using tables, verbal rules, equations, and graphs;
- translate among tabular, symbolic, and graphical representations of functions;
- recognize that a variety of problem situations can be modeled by the same type of function;
- analyze the effects of parameter changes on the graphs of functions;

for college-intending students:

- understand operations on, and the general properties and behavior of, classes of functions.

* Mathematics standards addressing **the continued study of the geometry of two and three dimensions** (NCTM Standard 7). Students are required to:

- interpret and draw three dimensional objects;
- represent problem situations with geometric models and apply properties of figures;
- classify figures in terms of congruence and similarity and apply these relationships;
- deduce properties of, and relationships between, figures from given assumptions;

for college-intending students:

- develop and understanding of an axiomatic system through investigating and comparing various geometries.

* Mathematics standards addressing **the study of geometry of two and three dimensions from an algebraic point of view** (NCTM Standard 8). Students are required to:

- translate between synthetic and coordinate representations;
- deduce properties of figures using transformations and using coordinates;

- identify congruent and similar figures using transformations;
 - analyze properties of Euclidean transformations and relate translations to vectors;
- for college-intending students:
- deduce properties of figures using vectors;
 - apply transformations, coordinates, and vectors in problem-solving.
- * Mathematics standards addressing **the study of trigonometry** (NCTM Standard 9). Students are required to:
- apply trigonometry to problem situations involving triangles;
 - explore periodic real-world phenomena using the sine and cosine functions;
- for college-intending students:
- understand the connection between trigonometric and circular functions;
 - use circular functions to model periodic real world phenomena;
 - solve trigonometric equations and verify trigonometric identities;
 - understand the connections between trigonometric functions and polar coordinates, complex numbers, and series.
- * Mathematics standards addressing **the topics from discrete mathematics** (NCTM Standard 12). Students are required to:
- represent problem situations using discrete structures such as finite graphs, matrices, sequences, and recurrence relations;
 - represent and analyze finite graphs using matrices;
 - develop and analyze algorithms;
 - solve enumeration and finite probability problems;
- for college-intending students:
- represent and solve problems using linear programming and difference equations;
 - investigate problem situations that arise in connection with computer validation and the application of algorithms.
- * Mathematics standards addressing **the informal exploration of calculus concepts from both a graphical and numerical perspective** (NCTM Standard 13). Students are required to:
- determine maximum and minimum points of a graph and interpret the results in problem situations;
 - investigate limiting processes by examining infinite sequences and series and areas under curves;
- for college-intending students:
- understand the conceptual foundations of limit, the area under a curve, the rate of change, and the slope of a tangent line, and their applications in other disciplines;
 - analyze the graphs of polynomial, rational, radical, and transcendental functions.

* Mathematics standards addressing **the study of mathematical structure** (NCTM Standard 14).

Students are required to:

- compare and contrast the real number system and its various subsystems with regard to their structural characteristics;
- understand the logic of algebraic procedures;
- appreciate that seemingly different mathematical systems may be essentially the same;

For college-intending students:

- develop the complex number system and demonstrate facility with its operations
- prove elementary theorems within various mathematical structures, such as groups and fields;
- develop an understanding of the nature and purpose of axiomatic systems.