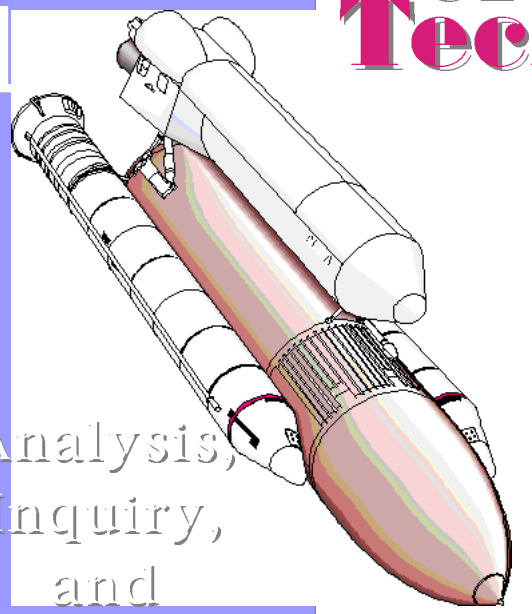
Mathematics, Science & Technology

Standard 1

Mathematics, Science & Technology



Analysis, Inquiry, and Design

Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Elementary Students:

Mathematical Analysis

1 *Abstraction and symbolic representation are used to communicate mathematically.*

- use special mathematical notation and symbolism to communicate in mathematics and to compare and describe quantities, express relationships, and relate mathematics to their immediate environments

2 *Deductive and inductive reasoning are used to reach mathematical conclusions.*

- use simple logical reasoning to develop conclusions, recognizing that patterns and relationships present in the environment assist them in reaching these conclusions

3 *Critical thinking skills are used in the solution of mathematical problems.*

Scientific Inquiry

1 *The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.*

- ask "why" questions in attempts to seek greater understanding concerning objects and events they have observed and heard about
- question the explanations they hear from others and read about, seeking clarification and comparing them with their own observations and understandings
- develop relationships among observations to construct descriptions of objects and events and to form their own tentative explanations of what they have observed use of what they have observed

2 *Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the conventional*

Engineering Design

1 *Engineering design is an iterative process involving modeling and optimization finding the best solution within given constraints which is used to develop technological solutions to problems within given constraints.*

- describe objects, imaginary or real, that might be modeled or made differently and suggest ways in which the objects can be changed, fixed, or improved
- investigate prior solutions and ideas from books, magazines, family, friends, neighbors, and community members
- generate ideas for possible solutions, individually and through group activity; apply age-appropriate mathematics and science skills; evaluate the ideas and determine the best solution; and explain reasons for the choices

Continued.

STANDARD 1

Elementary Students:

MATHEMATICAL ANALYSIS

- explore and solve problems generated from school, home, and community situations, using concrete objects or manipulative materials when possible

SCIENTIFIC INQUIRY

conventionaltechniques and procedures and usually requiring considerable inge - nuity.

- develop written plans for exploring phenomena or for evaluating explanations guided by questions or proposed explanations they have helped formulate
- share their research plans with others and revise them based on their suggestions
- carry out their plans for exploring phenomena through direct observation and through the use of simple instruments that permit measurements of quantities (e.g., length, mass, volume, temperature, and time)

3 *The observations made while testing proposed explanations, when ana - lyzed using conventional and invent - ed methods, provide new insights into phenomena.*

- organize observations and measurements of objects and events through classification and the preparation of simple charts and tables
- interpret organized observations and measurements, recognizing simple patterns, sequences, and relationships
- share their findings with others and actively seek their interpretations and ideas
- adjust their explanations and understandings of objects and events based on their findings and new ideas

ENGINEERING DESIGN

- plan and build, under supervision, a model of the solution using familiar materials, processes, and hand tools
- discuss how best to test the solution; perform the test under teacher supervision; record and portray results through numerical and graphic means; discuss orally why things worked or didn't work; and summarize results in writing, suggesting ways to make the solution better

Analysis, Inquiry, and Design

STANDARD 1

Intemediate Students:

MATHEMATICAL ANALYSIS

1 *Abstraction and symbolic representation are used to communicate mathematically.*

- extend mathematical notation and symbolism to include variables and algebraic expressions in order to describe and compare quantities and express mathematical relationships

2 *Deductive and inductive reasoning are used to reach mathematical conclusions.*

- use inductive reasoning to construct, evaluate, and validate conjectures and arguments, recognizing that patterns and relationships can assist in explaining and extending mathematical phenomena

3 *Critical thinking skills are used in the solution of mathematical problems.*

- apply mathematical knowledge to solve real-world problems and problems that arise from the investigation of mathematical ideas, using representations such as pictures, charts, and tables

SCIENTIFIC INQUIRY

1 *The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.*

- formulate questions independently with the aid of references appropriate for guiding the search for explanations of everyday observations
- construct explanations independently for natural phenomena, especially by proposing preliminary visual models of phenomena
- represent, present, and defend their proposed explanations of everyday observations so that they can be understood and assessed by others
- seek to clarify, to assess critically, and to reconcile with their own thinking the ideas presented by others, including peers, teachers, authors, and scientists

2 *Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.*

ENGINEERING DESIGN

1 *Engineering design is an iterative process involving modeling and optimization finding the best solution within given constraints which is used to develop technological solutions to problems within given constraints.*

- identify needs and opportunities for technical solutions from an investigation of situations of general or social interest
- locate and utilize a range of printed, electronic, and human information resources to obtain ideas
- consider constraints and generate several ideas for alternative solutions, using group and individual ideation techniques (group discussion, brainstorming, forced connections, role play); defer judgment until a number of ideas have been generated; evaluate (critique) ideas; and explain why the chosen solution is optimal
- develop plans, including drawings with measurements and details of construction, and construct a model of the solution, exhibiting a degree of craftsmanship

Continued.

STANDARD 1

Intermediate Students:

SCIENTIFIC INQUIRY

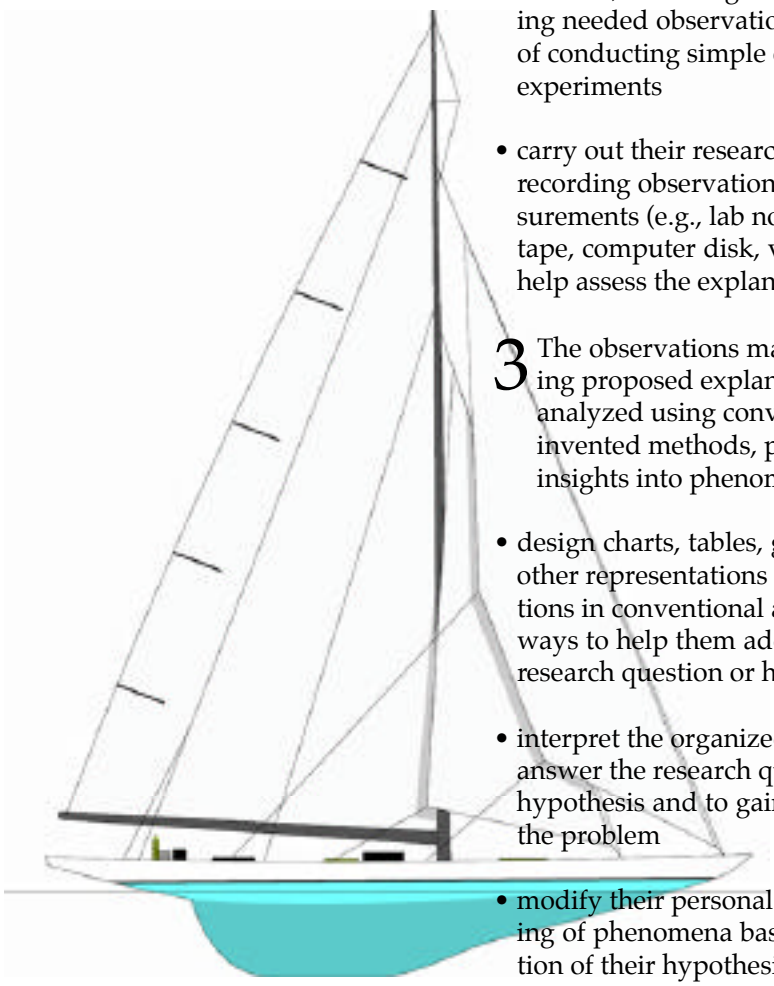
- use conventional techniques and those of their own design to make further observations and refine their explanations, guided by a need for more information
- develop, present, and defend formal research proposals for testing their own explanations of common phenomena, including ways of obtaining needed observations and ways of conducting simple controlled experiments
- carry out their research proposals, recording observations and measurements (e.g., lab notes, audio tape, computer disk, video tape) to help assess the explanation

3 The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

- design charts, tables, graphs and other representations of observations in conventional and creative ways to help them address their research question or hypothesis
- interpret the organized data to answer the research question or hypothesis and to gain insight into the problem
- modify their personal understanding of phenomena based on evaluation of their hypothesis

ENGINEERING DESIGN

- in a group setting, test their solution against design specifications, present and evaluate results, describe how the solution might have been modified for different or better results, and discuss tradeoffs that might have to be made



Analysis, Inquiry, and Design

STANDARD 1

Commencement Students:

MATHEMATICAL ANALYSIS

1 *Abstraction and symbolic representation are used to communicate mathematically.*

- use algebraic and geometric representations to describe and compare data

2 *Deductive and inductive reasoning are used to reach mathematical conclusions.*

- use deductive reasoning to construct and evaluate conjectures and arguments, recognizing that patterns and relationships in mathematics assist them in arriving at these conjectures and arguments

3 *Critical thinking skills are used in the solution of mathematical problems.*

- apply algebraic and geometric concepts and skills to the solution of problems

SCIENTIFIC INQUIRY

1 *The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.*

- elaborate on basic scientific and personal explanations of natural phenomena, and develop extended visual models and mathematical formulations to represent their thinking
- hone ideas through reasoning, library research, and discussion with others, including experts
- work toward reconciling competing explanations; clarifying points of agreement and disagreement
- coordinate explanations at different levels of scale, points of focus, and degrees of complexity and specificity and recognize the need for such alternative representations of the natural world

2 *Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.*

- devise ways of making observations to test proposed explanations.
- refine their research ideas through library investigations, including electronic information retrieval and reviews of the literature, and through peer feedback obtained from review and discussion

ENGINEERING DESIGN

1 *Engineering design is an iterative process involving modeling and optimization finding the best solution within given constraints which is used to develop technological solutions to problems within given constraints.*

- initiate and carry out a thorough investigation of an unfamiliar situation and identify needs and opportunities for technological invention or innovation
- identify, locate, and use a wide range of information resources, and document through notes and sketches how findings relate to the problem
- generate creative solutions, break ideas into significant functional elements, and explore possible refinements; predict possible outcomes using mathematical and functional modeling techniques; choose the optimal solution to the problem, clearly documenting ideas against design criteria and constraints; and explain how human understands, economics, ergonomics, and environmental considerations have influenced the solution

Continued.

Analysis, Inquiry, and Design

STANDARD

1

Commencement Students:

SCIENTIFIC INQUIRY

- develop and present proposals including formal hypotheses to test their explanations, i.e., they predict what should be observed under specified conditions if the explanation is true

- carry out their research plan for testing explanations, including selecting and developing techniques, acquiring and building apparatus, and recording observations as necessary

3 *The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.*

- use various means of representing and organizing observations (e.g., diagrams, tables, charts, graphs, equations, matrices) and insightfully interpret the organized data

- apply statistical analysis techniques when appropriate to test if chance alone explains the result

- assess correspondence between the predicted result contained in the hypothesis and the actual result and reach a conclusion as to whether or not the explanation on which the prediction was based is supported

- based on the results of the test and through public discussion, they revise the explanation and contemplate additional research

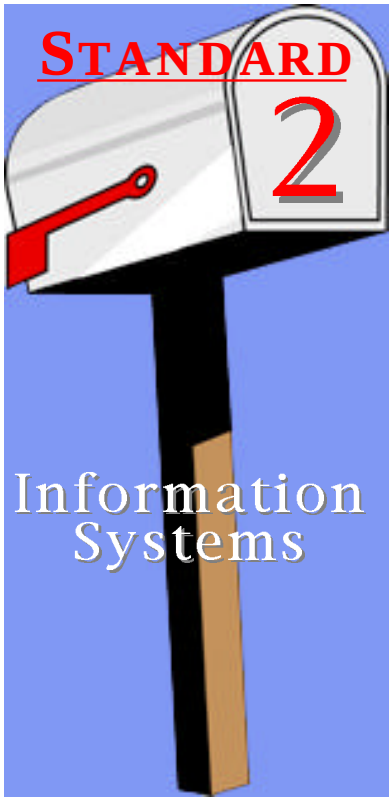
- develop a written report for public scrutiny that describes their proposed explanation, including a literature review, the research they carried out, its result, and suggestions for further research

ENGINEERING DESIGN

- develop work schedules and working plans which include optimal use and cost of materials, processes, time, and expertise; construct a model of the solution, incorporating developmental modifications while working to a high degree of quality (craftsmanship)

- devise a test of the solution according to the design criteria and perform the test; record, portray, and logically evaluate performance test results through quantitative, graphic, and verbal means. Use a variety of creative verbal and graphic techniques effectively and persuasively to present conclusions, predict impacts and new problems, and suggest and pursue modifications

Analysis, Inquiry, and Design



Mathematics, Science & Technology

Students will access, generate, process, and transfer information using appropriate technologies.

ELEMENTARY

1 *Information technology is used to retrieve, process, and communicate information and as a tool to enhance learning.*

- use a variety of equipment and software packages to enter, process, display, and communicate information in different forms using text, tables, pictures, and sound
- telecommunicate a message to a distant location with teacher help
- access needed information from printed media, electronic data bases, and community resources

2 *Knowledge of the impacts and limitations of information systems is essential to its effective and ethical use.*

- describe the uses of information systems in homes, schools, and businesses

INTERMEDIATE

1 *Information technology is used to retrieve, process, and communicate information and as a tool to enhance learning.*

- use a range of equipment and software to integrate several forms of information in order to create good quality audio, video, graphic, and text-based presentations
- use spreadsheets and data-base software to collect, process, display, and analyze information. Students access needed information from electronic data bases and on-line telecommunication services
- systematically obtain accurate and relevant information pertaining to a particular topic from a range of sources, including local and national media, libraries, museums, governmental agencies, industries, and individuals

COMMENCEMENT

1 *Information technology is used to retrieve, process, and communicate information and as a tool to enhance learning.*

- understand and use the more advanced features of word processing, spreadsheets, and data-base software
- prepare multimedia presentations demonstrating a clear sense of audience and purpose
- access, select, collate, and analyze information obtained from a wide range of sources such as research data bases, foundations, organizations, national libraries, and electronic communication networks, including the Internet
- students receive news reports from abroad and work in groups to produce newspapers reflecting the perspectives of different countries

Continued.

STANDARD

2

ELEMENTARY

- understand that computers are used to store personal information
- demonstrate ability to evaluate information

3 *Information technology can have positive and negative impacts on society, depending upon how it is used.*

- describe the uses of information systems in homes and schools
- demonstrate ability to evaluate information critically

INTERMEDIATE

- collect data from probes to measure events and phenomena
- use simple modeling programs to make predictions

2 *Knowledge of the impacts and limitations of information systems is essential to its effective and ethical use.*

- understand the need to question the accuracy of information displayed on a computer because the results produced by a computer may be affected by incorrect data entry
- identify advantages and limitations of data-handling programs and graphics programs
- understand why electronically stored personal information has greater potential for misuse than records kept in conventional form

3 *Information technology can have positive and negative impacts on society, depending upon how it is used.*

- use graphical, statistical, and presentation software to presents project to fellow classmates
- describe applications of information technology in mathematics, science, and other technologies that address needs and solve problems in the community
- explain the impact of the use and abuse of electronically generated information on individuals and families

COMMENCEMENT

- utilize electronic networks to share information
- model solutions to a range of problems in mathematics, science, and technology using computer simulation software

2 *Knowledge of the impacts and limitations of information systems is essential to its effective and ethical use.*

- explain the impact of the use and abuse of electronically generated information on individuals and families
- evaluate software packages relative to their suitability to a particular application and their ease of use
- discuss the ethical and social issues raised by the use and abuse of information systems

3 *Information technology can have positive and negative impacts on society, depending upon how it is used.*

- work with a virtual community to conduct a project or solve a problem using the network
- discuss how applications of information technology can address some major global problems and issues
- discuss the environmental, ethical, moral, and social issues raised by the use and abuse of information technology

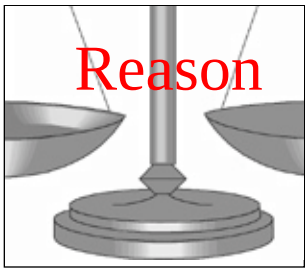
STANDARD

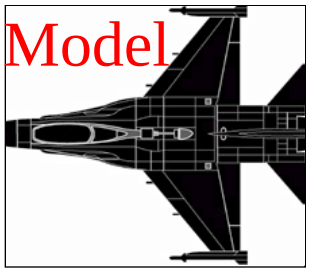
3

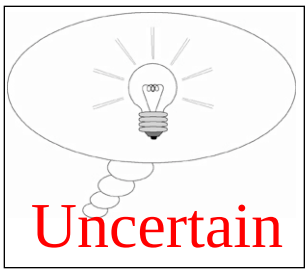
Mathematics

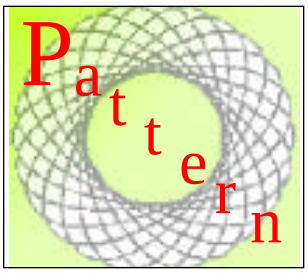
Mathematics, Science & Technology

Students will understand mathematics and become mathematically confident by communicating and reasoning mathematically, by applying mathematics in real-world settings, and by solving problems through the integrated study of number systems, geometry, algebra, data analysis, probability, and trigonometry.

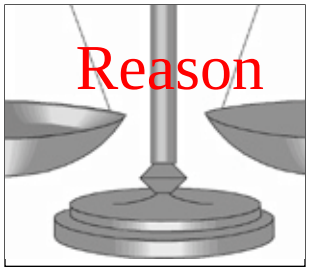








STANDARD 3



MATHEMATICAL REASONING

Students use mathematical reasoning to analyze mathematical situations, make conjectures, gather evidence, and construct an argument. **Students will:**

ELEMENTARY

- use models, facts, and relationships to draw conclusions about mathematics and explain their thinking
- use patterns and relationships to analyze mathematical situations
- justify their answers and solution processes
- use logical reasoning to reach simple conclusions

INTERMEDIATE

- apply a variety of reasoning strategies
- make and evaluate conjectures and arguments using appropriate language
- make conclusions based on inductive reasoning
- justify conclusions involving simple and compound (i.e., and/or) statements

COMMENCEMENT

- derive and apply formulas to find measures such as length, area, volume, weight, time, and angle in real-world contexts
- choose the appropriate tools for measurement
- use dimensional analysis techniques
- use statistical methods including measures of central tendency to describe and compare data
- use trigonometry as a method to measure indirectly
- apply proportions to scale drawings, computer-assisted design blueprints, and direct variation in order to compute indirect measurements
- relate absolute value, distance between two points, and the slope of a line to the coordinate plane
- understand error in measurement and its consequence on subsequent calculations
- use geometric relationships in relevant measurement problems involving geometric concepts

FOUR-YEAR SEQUENCE

- construct indirect proofs or proofs using mathematical induction
- investigate and compare the axiomatic structures of various geometries

STANDARD 3

NUMBER & NUMERATION

Students use number sense and numeration to develop an understanding of multiple uses of numbers in the real world, use of numbers to communicate mathematically, and use of numbers in the development of mathematical ideas.

Students will:

ELEMENTARY

- use whole numbers and fractions to identify locations, quantify groups of objects, and measure distances
- use concrete materials to model numbers and number relationships for whole numbers and common fractions, including decimal fractions
- relate counting to grouping and to place-value
- recognize the order of whole numbers and commonly used fractions and decimals
- demonstrate the concept of percent through problems related to actual situations

INTERMEDIATE

- understand, represent, and use numbers in a variety of equivalent forms (integer, fraction, decimal, percent, exponential, expanded and scientific notation)
- understand and apply ratios, proportions, and percents through a wide variety of hands-on explorations
- develop an understanding of number theory (primes, factors, and multiples)
- recognize order relations for decimals, integers, and rational numbers

COMMENCEMENT

- judge the reasonableness of results obtained from applications in algebra, geometry, trigonometry, probability, and statistics
- judge the reasonableness of a graph produced by a calculator or computer
- use experimental or theoretical probability to represent and solve problems involving uncertainty
- use the concept of random variable in computing probabilities
- determine probabilities using permutations and combinations

FOUR-YEAR SEQUENCE

- understand the concept of infinity.
- recognize the hierarchy of the complex number system.
- model the structure of the complex number system.
- recognize when to use and how to apply the field properties.

STANDARD 3

OPERATION

Students use mathematical operations and relationships among them to understand mathematics. **Students will:**

ELEMENTARY

- add, subtract, multiply, and divide whole numbers
- develop strategies for selecting the appropriate computational and operational method in problem-solving situations
- know single digit addition, subtraction, multiplication, and division facts
- understand the commutative and associative properties

INTERMEDIATE

- add, subtract, multiply, and divide fractions, decimals, and integers
- explore and use the operations dealing with roots and powers
- use grouping symbols (parentheses) to clarify the intended order of operations
- apply the associative, commutative, distributive, inverse, and identity properties
- demonstrate an understanding of operational algorithms (procedures for adding, subtracting, etc.)
- develop appropriate proficiency with facts and algorithms
- apply concepts of ratio and proportion to solve problems

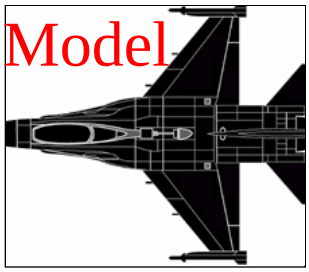
COMMENCEMENT

- use function vocabulary and notation
- represent and analyze functions using verbal descriptions, tables, equations, and graphs
- translate among the verbal descriptions, tables, equations and graphic forms of functions
- analyze the effect of parametric changes on the graphs of functions.
- apply linear, exponential, and quadratic functions in the solution of problems
- apply and interpret transformations to functions
- model real-world situations with the appropriate function
- apply axiomatic structure to algebra and geometry
- use computers and graphing calculators to analyze mathematical phenomena

FOUR-YEAR SEQUENCE

- use appropriate techniques, including graphing utilities, to perform basic operations on matrices.
- use rational exponents on real numbers and all operations on complex numbers.
- combine functions using the basic operations and the composition of two functions.

STANDARD 3



MODELING/MULTIPLE REPRESENTATION

Students use mathematical modeling/multiple representation to provide a means of presenting, interpreting, communicating, and connecting mathematical information and relationships.

Students will:

ELEMENTARY

- use concrete materials to model spatial relationships
- construct tables, charts, and graphs to display and analyze real-world data
- use multiple representations (simulations, manipulative materials, pictures, and diagrams) as tools to explain the operation of everyday procedures
- use variables such as height, weight, and hand size to predict changes over time
- use physical materials, pictures, and diagrams to explain mathematical ideas and processes and to demonstrate geometric concepts

INTERMEDIATE

- visualize, represent, and transform two- and three-dimensional shapes
- use maps and scale drawings to represent real objects or places
- use the coordinate plane to explore geometric ideas
- represent numerical relationships in one- and two-dimensional graphs
- use variables to represent relationships
- use concrete materials and diagrams to describe the operation of real world processes and systems
- develop and explore models that do and do not rely on chance
- investigate both two- and three-dimensional transformations
- use appropriate tools to construct and verify geometric relationships
- develop procedures for basic geometric constructions

COMMENCEMENT

- represent problem situations symbolically by using algebraic expressions, sequences, tree diagrams, geometric figures, and graphs
- manipulate symbolic representations to explore concepts at an abstract level
- choose appropriate representations to facilitate the solving of a problem
- use learning technologies to make and verify geometric conjectures
- justify the procedures for basic geometric constructions
- investigate transformations in the coordinate plane
- develop meaning for basic conic sections
- develop and apply the concept of basic loci to compound loci
- use graphing utilities to create and explore geometric and algebraic models
- model real-world problems with systems of equations and inequalities

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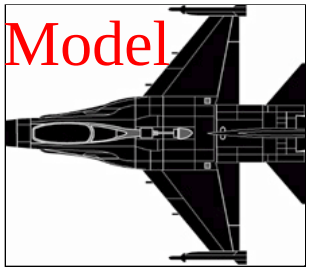
STANDARD 3



MODELING/MULTIPLE REPRESENTATION

FOUR-YEAR SEQUENCE

- model vector quantities both algebraically and geometrically
- represent graphically the sum and difference of two complex numbers
- model and solve problems that involve absolute value, vectors, and matrices
- model quadratic inequalities both algebraically and graphically
- model the composition of transformations
- determine the effects of changing parameters of the graphs of functions
- use polynomial, rational, trigonometric, and exponential functions to model real-world relationships
- use algebraic relationships to analyze the conic sections
- use circular functions to study and model periodic real-world phenomena
- illustrate spatial relationships using perspective, projec-tions, and maps
- represent problem situations using discrete structures such as finite graphs, matrices, sequences, and recurrence relations
- analyze spatial relationships using the Cartesian coordinate system in three dimensions

STANDARD 3

MEASUREMENT

Students use measurement in both metric and English measure to provide a major link between the abstractions of mathematics and the real world in order to describe and compare objects and data.. **Students will:**

ELEMENTARY

- understand that measurement is approximate, never exact
- select appropriate standard and nonstandard measurement tools in measurement activities
- understand the attributes of area, length, capacity, weight, volume, time, temperature, and angle
- estimate and find measures such as length, perimeter, area, and volume using both nonstandard and standard units
- collect and display data
- use statistical methods such as graphs, tables, and charts to interpret data

INTERMEDIATE

- estimate, make, and use measurements in real-world situations
- select appropriate standard and nonstandard measurement units and tools to measure to a desired degree of accuracy
- develop measurement skills and informally derive and apply formulas in direct measurement activities
- use statistical methods and measures of central tendencies to display, describe, and compare data
- explore and produce graphic representations of data using calculators/computers
- develop critical judgment for the reasonableness of measurement

COMMENCEMENT

- derive and apply formulas to find measures such as length, area, volume, weight, time, and angle in real-world contexts
- the appropriate tools for measurement
- use dimensional analysis techniques
- use statistical methods including measures of central tendency to describe and compare data
- use trigonometry as a method to measure indirectly
- apply proportions to scale drawings, computer-assisted design blueprints, and direct variation in order to compute indirect measurements
- relate absolute value, distance between two points, and the slope of a line to the coordinate plane
- understand error in measurement and its consequence on subsequent calculations
- use geometric relationships in relevant measurement problems involving geometric concepts

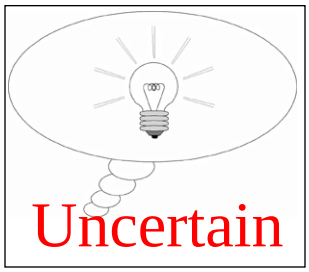
Continued.

MEASUREMENT

FOUR-YEAR SEQUENCE

- derive and apply formulas relating angle measure and arc degree measure in a circle
- prove and apply theorems related to lengths of segments in a circle
- define the trigonometric functions in terms of the unit circle
- relate trigonometric relationships to the area of a triangle and to the general solutions of triangles
- apply the normal curve and its properties to familiar contexts
- design a statistical experiment to study a problem and communicate the outcomes, including dispersion
- use statistical methods, including scatter plots and lines of best fit, to make predictions
- apply the conceptual foundation of limits, infinite sequences and series, the area under a curve, rate of change, inverse variation, and the slope of a tangent line to authentic problems in mathematics and other disciplines
- determine optimization points on a graph
- use derivatives to find maximum, minimum, and inflection points of a function

STANDARD 3



UNCERTAINTY

Students use ideas of uncertainty to illustrate that mathematics involves more than exactness when dealing with everyday situations. **Students will:**

ELEMENTARY

- make estimates to compare to actual results of both formal and informal measurement
- make estimates to compare to actual results of computations
- recognize situations where only an estimate is required
- develop a wide variety of estimation skills and strategies
- determine the reasonableness of results
- predict experimental probabilities
- make predictions using unbiased random samples
- determine probabilities of simple events

INTERMEDIATE

- use estimation to check the reasonableness of results obtained by computation, algorithms, or the use of technology
- use estimation to solve problems for which exact answers are inappropriate
- estimate the probability of events
- use simulation techniques to estimate probabilities
- determine probabilities of independent and mutually exclusive events

COMMENCEMENT

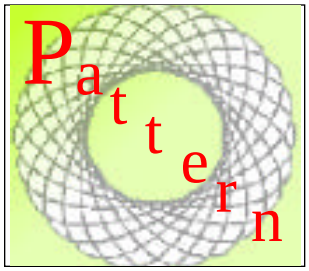
- judge the reasonableness of a graph produced by a calculator or computer
- use experimental or theoretical probability to represent and solve problems involving uncertainty
- use the concept of random variable in computing probabilities
- determine probabilities using permutations and combinations

FOUR -YEAR SEQUENCE

- interpret probabilities in real-world situations
- use a Bernoulli experiment to determine probabilities for experiments with exactly two outcomes
- use curve fitting to predict from data
- apply the concept of random variable to generate and interpret probability distributions
- create and interpret applications of discrete and continuous probability distributions
- make predictions based on interpolations and extrapolations from data
- obtain confidence intervals and test hypotheses using appropriate statistical methods
- approximate the roots of polynomial equations

STANDARD 3

Mathematics



PATTERNS/FUNCTIONS

Students use patterns and functions to develop mathematical power, appreciate the true beauty of mathematics, and construct generalizations that describe patterns simply and efficiently
Students will: .

ELEMENTARY

- recognize, describe, extend, and create a wide variety of patterns
- represent and describe mathematical relationships
- explore and express relationships using variables and open sentences
- solve for an unknown using manipulative materials
- use a variety of manipulative materials and technologies to explore patterns
- interpret graphs
- explore and develop relationships among two- and three-dimensional geometric shapes
- discover patterns in nature, art, music, and literature

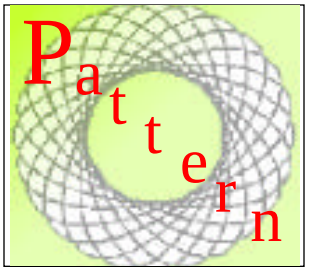
INTERMEDIATE

- recognize, describe, and generalize a wide variety of patterns and functions
- describe and represent patterns and functional relationships using tables, charts and graphs, algebraic expressions, rules, and verbal descriptions
- develop methods to solve basic linear and quadratic equations
- develop an understanding of functions and functional relationships: that a change in one quantity (variable) results in change in another
- verify results of substituting variables
- apply the concept of similarity in relevant situations
- use properties of polygons to classify them
- explore relationships involving points, lines, angles, and planes
- develop and apply the Pythagorean principle in the solution of problems
- explore and develop basic concepts of right triangle trigonometry
- use patterns and functions to represent and solve problems

COMMENCEMENT

- use function vocabulary and notation
- represent and analyze functions using verbal descriptions, tables, equations, and graphs
- translate among the verbal descriptions, tables, equations and graphic forms of functions
- analyze the effect of parametric changes on the graphs of functions
- apply linear, exponential, and quadratic functions in the solution of problems
- apply and interpret transformations to functions
- model real-world situations with the appropriate function
- apply axiomatic structure to algebra and geometry
- use computers and graphing calculators to analyze mathematical phenomena

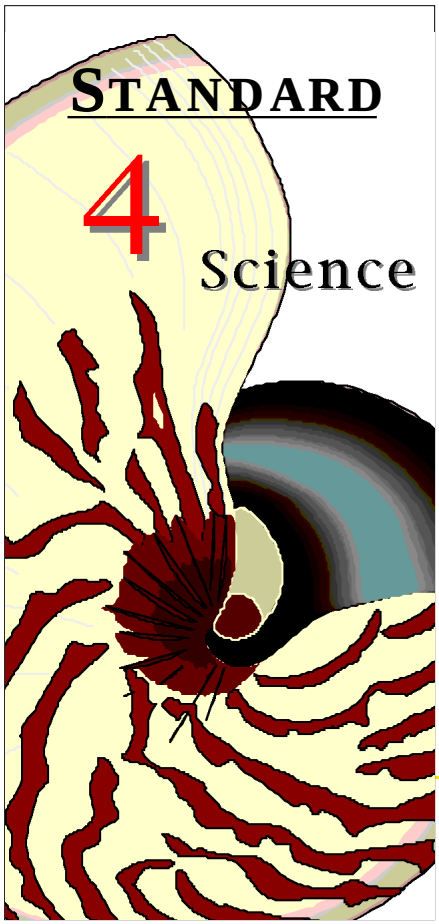
Continued.



PATTERNS/FUNCTIONS

FOUR-YEAR SEQUENCE

- solve equations with complex roots using a variety of algebraic and graphical methods with appropriate tools
- understand and apply the relationship between rectangular form and polar form of a complex number
- evaluate and form the composition of functions
- use the definition of a derivative to examine properties of a function
- solve equations involving fractions, absolute values, and radicals
- use basic transformations to demonstrate similarity and congruence of figures
- identify and differentiate between direct and indirect isometries
- analyze inverse functions using transformations
- apply ideas of symmetries in sketching and analyzing graphs of functions
- use the normal curve to answer questions about data
- develop methods to solve trigonometric equations and verify trigonometric functions
- describe patterns produced by processes of geometric change, formally connecting iteration, approximations, limits, and fractals
- extend pattern and compute the nth term in numerical and geometric sequences
- use the limiting process to analyze infinite sequences and series
- use algebraic and geometric iteration to explore patterns and solve problems
- solve optimization problems
- use linear programming and difference equations in the solution of problems



Mathematics, Science & Technology

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Elementary Students:

PHYSICAL SETTING

1 *The Earth and celestial phenomena can be described by principles of relative motion and perspective.*

- describe patterns of daily, monthly, and seasonal changes in their environment

2 *Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.*

- describe the relationships among air, water, and land on Earth

3 *Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.*

- observe and describe properties of materials using appropriate tools
- describe chemical and physical changes, including changes in states of matter

4 *Energy exists in many forms, and when these forms change energy is conserved.*

- describe a variety of forms of energy (e.g., heat, chemical, light) and the changes that occur in objects when they interact with those forms of energy
- observe the way one form of energy can be transformed into another form of energy present in common situations (e.g., mechanical to heat energy, mechanical to electrical energy, chemical to heat energy)

5 *Energy and matter interact through forces that result in changes in motion.*

- describe the effects of common forces (pushes and pulls) on objects, such as those caused by gravity, magnetism, and mechanical forces
- describe how forces can operate across distances

Continued.

STANDARD 4

Science

Elementary Students:

THE LIVING ENVIRONMENT

1 *Living things are both similar to and different from each other and nonliving things.*

- describe the characteristics of and variations between living and nonliving things
- describe the life processes common to all living things

2 *Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parents and offspring.*

- recognize that traits of living things are both inherited and acquired or learned
- recognize that for humans and other living things there is genetic continuity between generations

3 *Individual organisms and species change over time.*

- describe how the structures of plants and animals complement the environment of the plant or animal
- observe that differences within a species may give individuals an advantage in surviving and reproducing

4 *The continuity of life is sustained through reproduction and development.*

- describe the major stages in the life cycles of selected plants and animals
- describe evidence of growth, repair, and maintenance, such as nails, hair, and bone, and the healing of cuts and bruises

5 *Organisms maintain a dynamic equilibrium that sustains life.*

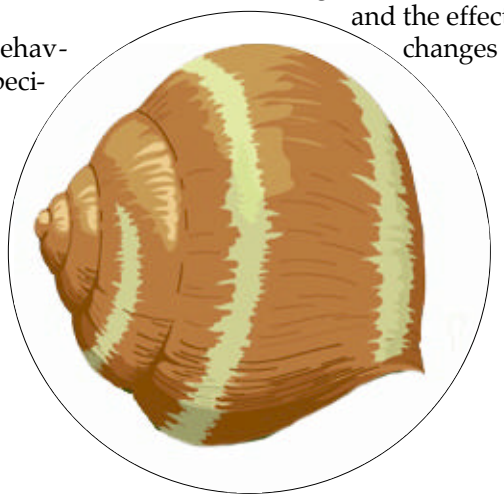
- describe basic life functions of common living specimens (guppy, mealworm, gerbil)
- describe some survival behaviors of common living specimens
- describe the factors that help promote good health and growth in humans

6 *Plants and animals depend on each other and their physical environment.*

- describe how plants and animals, including humans, depend upon each other and the nonliving environment
- describe the relationship of the sun as an energy source for living and nonliving cycles

7 *Human decisions and activities have had a profound impact on the physical and living environment.*

- identify ways in which humans have changed their environment and the effects of those changes



STANDARD 4

Science

Intermediate Students:

PHYSICAL SETTING

1 *The Earth and celestial phenomena can be described by principles of relative motion and perspective.*

- explain daily, monthly, and seasonal changes on earth

2 *Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.*

- explain how the atmosphere (air), hydrosphere (water), and lithosphere (land) interact, evolve, and change
- describe volcano and earthquake patterns, the rock cycle, and weather and climate changes

3 *Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.*

- observe and describe properties of materials, such as density, conductivity, and solubility
- distinguish between chemical and physical changes
- develop their own mental models to explain common chemical reactions and changes in states of matter

4 *Energy exists in many forms, and when these forms change energy is conserved.*

- describe the sources and identify the transformations of energy observed in everyday life
- observe and describe heating and cooling events
- observe and describe energy changes as related to chemical reactions
- observe and describe the properties of sound, light, magnetism, and electricity
- describe situations that support the principle of conservation of energy

5 *Energy and matter interact through forces that result in changes in motion.*

- describe different patterns of motion of objects
- observe, describe, and compare effects of forces (gravity, electric current, and magnetism) on the motion of objects

Continued.

STANDARD 4

Science

Intermediate Students:

THE LIVING ENVIRONMENT

1 *Living things are both similar to and different from each other and nonliving things.*

- compare and contrast the parts of plants, animals, and one-celled organisms
- explain the functioning of the major human organ systems and their interactions

2 *Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parents and offspring.*

- describe sexual and asexual mechanisms for passing genetic materials from generation to generation
- describe simple mechanisms related to the inheritance of some physical traits in offspring

3 *Individual organisms and species change over time.*

- describe sources of variation in organisms and their structures and relate the variations to survival
- describe factors responsible for competition within species and the significance of that competition

4 *The continuity of life is sustained through reproduction and development.*

- observe and describe the variations in reproductive patterns of organisms, including asexual and sexual reproduction
- explain the role of sperm and egg cells in sexual reproduction
- observe and describe developmental patterns in selected plants and animals (e.g., insects, frogs, humans, seed-bearing plants)
- observe and describe cell division at the microscopic level and its macroscopic effects

5 *Organisms maintain a dynamic equilibrium that sustains life.*

- compare the way a variety of living specimens carry out basic life functions and maintain dynamic equilibrium
- describe the importance of major nutrients, vitamins, and minerals in maintaining health and promoting growth and explain the need for a constant input of energy for living organisms

6 *Plants and animals depend on each other and their physical environment.*

- describe the flow of energy and matter through food chains and food webs
- provide evidence that green plants make food and explain the significance of this process to other organisms

7 *Human decisions and activities have had a profound impact on the physical and living environment.*

- describe how living things, including humans, depend upon the living and nonliving environment for their survival
- describe the effects of environmental changes on humans and other populations

Commencement Students:

PHYSICAL SETTING

1 *The Earth and celestial phenomena can be described by principles of relative motion and perspective.*

- explain complex phenomena, such as tides, variations in day length, solar insolation, apparent motion of the planets, and annual traverse of the constellations
- describe current theories about the origin of the universe and solar system

2 *Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.*

- use the concepts of density and heat energy to explain observations of weather patterns, seasonal changes, and the movements of the Earth's plates
- explain how incoming solar radiations, ocean currents, and land masses affect weather and climate

3 *Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.*

- explain the properties of materials in terms of the arrangement and properties of the atoms that compose them
- use atomic and molecular models to explain common chemical reactions
- apply the principle of conservation of mass to chemical reactions
- use kinetic molecular theory to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance

4 *Energy exists in many forms, and when these forms change energy is conserved.*

- observe and describe transmission of various forms of energy
- explain heat in terms of kinetic molecular theory
- explain variations in wavelength and frequency in terms of the source of the vibrations that produce them, e.g., molecules, electrons, and nuclear particles
- explain the uses and hazards of radioactivity

5 *Energy and matter interact through forces that result in changes in motion.*

- explain and predict different patterns of motion of objects (e.g., linear and angular motion, velocity and acceleration, momentum and inertia)
- explain chemical bonding in terms of the motion of electrons
- compare energy relationships within an atom's nucleus to those outside the nucleus

Continued.

STANDARD 4

Science

Commencement Students:

THE LIVING ENVIRONMENT

1 *Living things are both similar to and different from each other and nonliving things.*

- explain how diversity of populations within ecosystems relates to the stability of ecosystems
- describe and explain the structures and functions of the human body at different organizational levels (e.g., systems, tissues, cells, organelles)
- explain how a one-celled organism is able to function despite lacking the levels of organization present in more complex organisms

2 *Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parents and offspring.*

- explain how the structure and replication of genetic material result in offspring that resemble their parents
- explain how the technology of genetic engineering allows humans to alter the genetic makeup of organisms

3 *Individual organisms and species change over time.*

- explain the mechanisms and patterns of evolution

4 *The continuity of life is sustained through reproduction and development.*

- explain how organisms, including humans, reproduce their own kind

5 *Organisms maintain a dynamic equilibrium that sustains life.*

- explain the basic biochemical processes in living organisms and their importance in maintaining dynamic equilibrium
- explain disease as a failure of homeostasis
- relate processes at the system level to the cellular level in order to explain dynamic equilibrium in multicelled organisms

6 *Plants and animals depend on each other and their physical environment.*

- explain factors that limit growth of individuals and populations
- explain the importance of preserving diversity of species and habitats
- explain how the living and nonliving environments change over time and respond to disturbances

7 *Human decisions and activities have had a profound impact on the physical and living environment.*

- describe the range of interrelationships of humans with the living and nonliving environment
- explain the impact of technological development and growth in the human population on the living and non-living environment
- explain how individual choices and societal actions can contribute to improving the environment

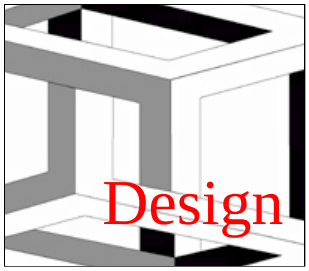
STANDARD

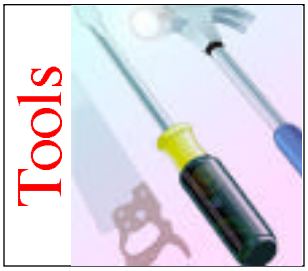
5

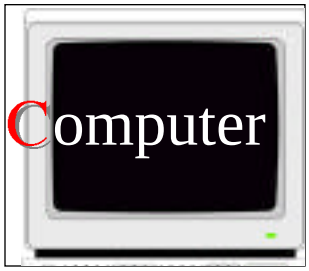
Technology

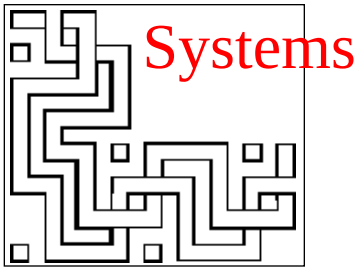
Mathematics, Science & Technology

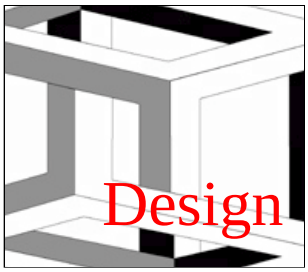
Students will apply technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs.











ENGINEERING DESIGN

Engineering design is an iterative process involving *modeling* and *optimization* used to develop technological solutions to problems within given constraints. **Students will:**

ELEMENTARY

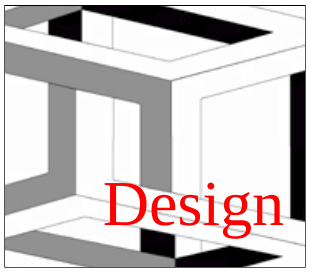
- describe objects, imaginary or real, that might be modeled or made differently and suggest ways in which the objects can be changed, fixed, or improved
- investigate prior solutions and ideas from books, magazines, family, friends, neighbors, and community members
- generate ideas for possible solutions, individually and through group activity; apply age-appropriate mathemat-ics and science skills; evaluate the ideas and determine the best solution; and explain reasons for the choices
- plan and build, under supervision, a model of the solution using familiar materials, processes, and hand tools
- discuss how best to test the solution; perform the test under teacher supervision; record and portray results through numerical and graphic means; discuss orally why things worked or didn't work; and summarize results in writing, suggesting ways to make the solution better

INTERMEDIATE

- identify needs and opportunities for technical solutions from an investigation of situations of general or social interest
- locate and utilize a range of printed, electronic, and human information resources to obtain ideas
- consider constraints and generate several ideas for alternative solutions, using group and individual ideation techniques (group discussion, brainstorming, forced connections, role play); defer judgment until a number of ideas have been generated; evaluate (critique) ideas; and explain why the chosen solution is optimal
- develop plans, including drawings with measurements and details of construction, and construct a model of the solution, exhibiting a degree of craftsmanship
- in a group setting, test their solution against design specifications, present and evaluate results, describe how the solution might have been modified for different or better results, and discuss tradeoffs that might have to be made

Continued.

STANDARD 5



COMMENCEMENT

- initiate and carry out a thorough investigation of an unfamiliar situation and identify needs and opportunities for technological invention or innovation

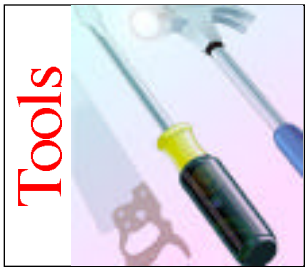
- identify, locate, and use a wide range of information resources including subject experts, library references, magazines, videotapes, films, electronic data bases and on-line services, and discuss and document through notes and sketches how findings relate to the problem

- generate creative solution ideas, break ideas into the significant functional elements, and explore possible refinements; predict possible outcomes using mathematical and functional modeling techniques; choose the optimal solution to the problem, clearly documenting ideas against design criteria and constraints; and explain how human values, economics, ergonomics, and environmental considerations have influenced the solution

- develop work schedules and plans which include optimal use and cost of materials, processes, time, and expertise; construct a model of the solution, incorporating developmental modifications while working to a high degree of quality (craftsmanship)

- in a group setting, devise a test of the solution relative to the design criteria and perform the test; record, portray, and logically evaluate performance test results through quantitative, graphic, and verbal means; and use a variety of creative verbal and graphic techniques effectively and persuasively to present conclusions, predict impacts and new problems, and suggest and pursue modifications

STANDARD 5



TOOLS, RESOURCES & TECHNOLOGICAL PROCESSES

Technological tools, materials, and other resources should be selected on the basis of safety, cost, availability, appropriateness, and environmental impact; technological processes change energy, information, and material resources into more useful forms. **Students will:**

ELEMENTARY

- explore, use, and process a variety of materials and energy sources to design and construct things
- understand the importance of safety, cost, ease of use, and availability in selecting tools and resources for a specific purpose
- develop basic skill in the use of hand tools
- use simple manufacturing processes (e.g., assembly, mul-tiple stages of production, quality control) to produce a product
- use appropriate graphic and electronic tools and techniques to process information

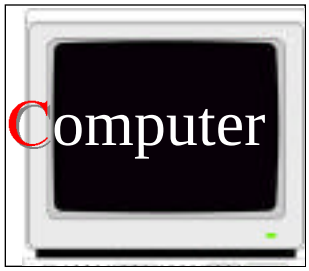
INTERMEDIATE

- choose and use resources for a particular purpose based upon an analysis and understanding of their properties, costs, availability, and environmental impact
- use a variety of hand tools and machines to change materials into new forms through forming, separating, and combining processes, and processes which cause internal change to occur
- combine manufacturing processes with other technological processes to produce, market, and distribute a product
- process energy into other forms and information into more meaningful information

COMMENCEMENT

- test, use, and describe the attributes of a range of material (including synthetic and composite materials), information, and energy resources
- select appropriate tools, instruments, and equipment and use them correctly to process materials, energy, and information
- explain tradeoffs made in selecting alternative resources in terms of safety, cost, properties, availability, ease of processing, and disposability
- describe and model methods (including computer-based methods) to control system processes and monitor system outputs

STANDARD 5



COMPUTER TECHNOLOGY

Computers, as tools for design, modeling, information processing, communication, and system control, have greatly increased human productivity and knowledge. **Students will:**

ELEMENTARY

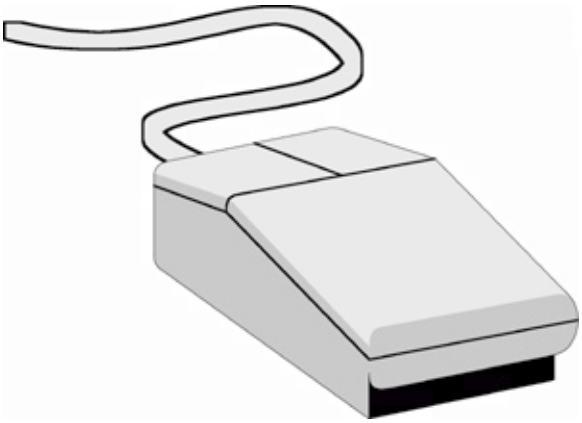
- identify and describe the function of the major components of a computer system
- use the computer as a tool for generating and drawing ideas
- control computerized devices and systems through programming
- model and simulate the design of a complex environment by giving direct commands

INTERMEDIATE

- assemble a computer system including keyboard, central processing unit and disc drives, mouse, modem, printer, and monitor
- use a computer system to connect to and access needed information from various Internet sites
- use computer hardware and software to draw and dimension prototypical designs
- use a computer as a modeling tool
- use a computer system to monitor and control external events and/or systems

COMMENCEMENT

- understand basic computer architecture and describe the function of computer subsystems and peripheral devices
- select a computer system that meets personal needs
- attach a modem to a computer system and telephone line, set up and use communications software, connect to various on-line networks, including the Internet, and access needed information using e-mail, telnet, gopher, ftp, and web searches
- use computer-aided drawing and design (CADD) software to model realistic solutions to design problems
- develop an understanding of computer programming and attain some facility in writing computer programs



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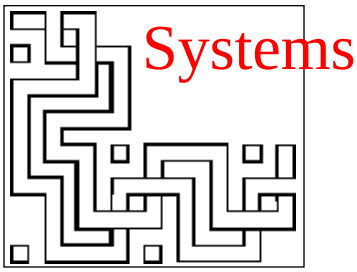


TECHNOLOGICAL SYSTEMS

Technological systems are designed to achieve spe-cific results and produce outputs, such as products, structures, services, energy, or other systems. **Students will:**

ELEMENTARY

- identify familiar examples of technological systems that are used to satisfy human needs and wants, and select them on the basis of safety, cost, and function
- assemble and operate simple technological systems, including those with interconnecting mechanisms to achieve different kinds of movement
- understand that larger systems are made up of smaller component subsystems

INTERMEDIATE

- select appropriate technological systems on the basis of safety, function, cost, ease of operation, and quality of post-purchase support
- assemble, operate, and explain the operation of simple open- and closed-loop electrical, electronic, mechanical, and pneumatic systems
- describe how subsystems and system elements (inputs, processes, outputs) interact within systems
- describe how system control requires sensing information, processing it, and making changes

COMMENCEMENT

- explain why making tradeoffs among characteristics, such as safety, function, cost, ease of operation, quality of post-purchase support, and environmental impact, is necessary when selecting systems for specific purposes
- model, explain, and analyze the performance of a feedback control system
- explain how complex technological systems involve the confluence of numerous other systems

STANDARD 5

Technology

HISTORY & EVOLUTION OF TECHNOLOGY

Technology has been the driving force in the evolution of society from an agricultural to an industrial to an information base. **Students will:**

ELEMENTARY

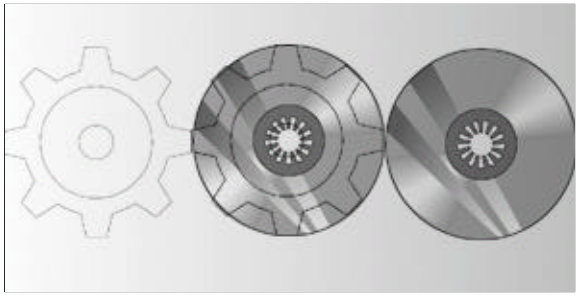
- identify technological developments that have significantly accelerated human progress

INTERMEDIATE

- describe how the evolution of technology led to the shift in society from an agricultural base to an industrial base to an information base
- understand the contributions of people of different genders, races, and ethnic groups to technological development
- describe how new technologies have evolved as a result of combining existing technologies (e.g., photography combined optics and chemistry; the airplane combined kite and glider technology with a lightweight gasoline engine)

COMMENCEMENT

- explain how technological inventions and innovations have caused global growth and interdependence, stimulated economic competitiveness, created new jobs, and made other jobs obsolete



STANDARD 5

IMPACTS OF TECHNOLOGY

Technology can have positive and negative impacts on individuals, society, and the environment and humans have the capability and responsibility to constrain or promote technological development. **Students will:**

ELEMENTARY

- describe how technology can have positive and negative effects on the environment and on the way people live and work

INTERMEDIATE

- describe how outputs of a technological system can be desired, undesired, expected, or unexpected
- describe through examples how modern technology reduces manufacturing and construction costs and produces more uniform products

COMMENCEMENT

- explain that although technological effects are complex and difficult to predict accurately, humans can control the development and implementation of technology.
- explain how computers and automation have changed the nature of work
- explain how national security is dependent upon both military and nonmilitary applications of technology

STANDARD 5

MANAGEMENT OF TECHNOLOGY

Project management is essential to ensuring that technological endeavors are profitable and that products and systems are of high quality and built safely, on schedule, and within budget. **Students will:**

ELEMENTARY

- participate in small group projects and in structured group tasks requiring planning, financing, production, quality control, and follow-up
- speculate on and model possible technological solutions that can improve the safety and quality of the school or community environment

INTERMEDIATE

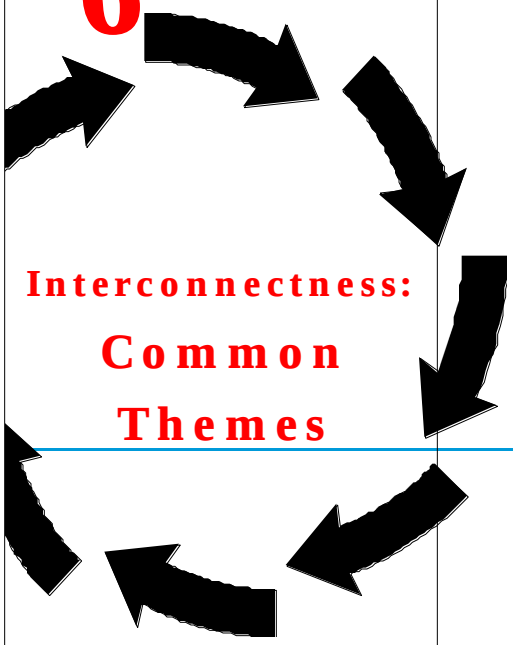
- manage time and financial resources in a technological project
- provide examples of products that are well (and poorly) designed and made, describe their positive and negative attributes, and suggest measures that can be implemented to monitor quality during production
- assume leadership responsibilities within a structured group activity

COMMENCEMENT

- develop and use computer-based scheduling and project tracking tools, such as flow charts and graphs
- explain how statistical process control helps to assure high quality output
- discuss the role technology has played in the operation of successful U.S. businesses and under what circumstances they are competitive with other countries
- explain how technological inventions and innovations stimulate economic competitiveness and how, in order for an innovation to lead to commercial success, it must be translated into products and services with marketplace demand
- describe new management techniques (e.g., computer-aided engineering, computer-integrated manufacturing, total quality management, just-in-time manufacturing), incorporate some of these in a technological endeavor, and explain how they have reduced the length of design-to- manufacture cycles, resulted in more flexible factories, and improved quality and customer satisfaction
- help to manage a group engaged in planning, designing, implementation, and evaluation of a project to gain understanding of the management dynamics

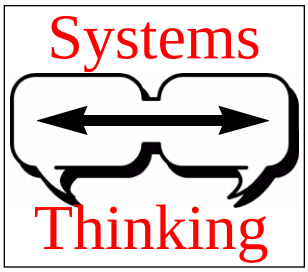
Mathematics, Science & Technology

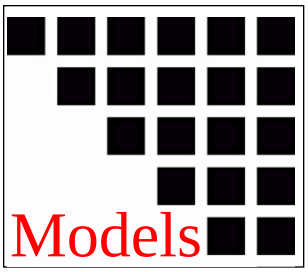
STANDARD 6

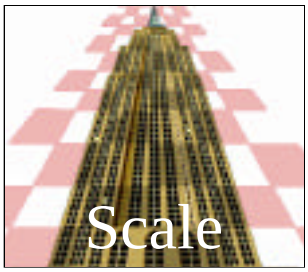


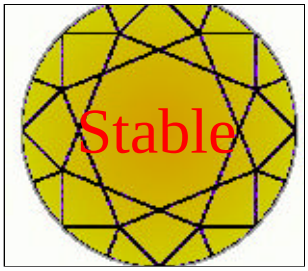
Interconnectness: Common Themes

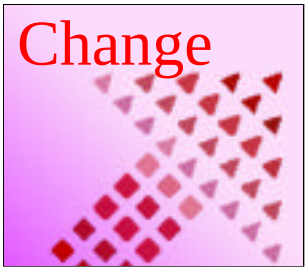
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.











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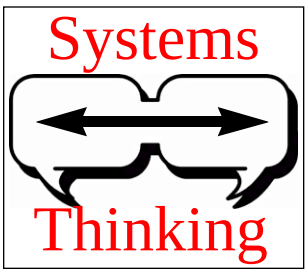

SYSTEM THINKING

Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

Students will:

ELEMENTARY

- observe and describe interactions among components of simple systems
- identify common things that can be considered to be systems (e.g., a plant population, a subway system, human beings)

INTERMEDIATE

- describe the differences between dynamic systems and organizational systems
- describe the differences and similarities between engineering systems, natural systems, and social systems
- describe the differences between open- and closed-loop systems
- describe how the output from one part of a system (which can include material, energy, or information) can become the input to other parts

COMMENCEMENT

- explain how positive feedback and negative feedback have opposite effects on system outputs
- use an input-process-output-feedback diagram to model and compare the behavior of natural and engineered systems
- define boundary conditions when doing systems analysis to determine what influences a system and how it behaves

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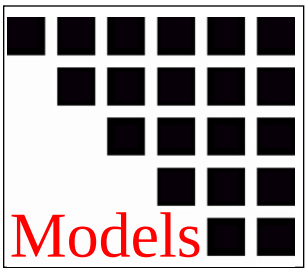


MODELS

Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

Students will:

ELEMENTARY

- analyze, construct, and operate models in order to discover attributes of the real thing
- discover that a model of something is different from the real thing but can be used to study the real thing
- use different types of models, such as graphs, sketches, diagrams, and maps, to represent various aspects of the real world

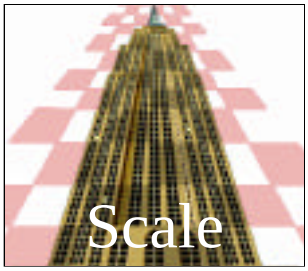
INTERMEDIATE

- select an appropriate model to begin the search for answers or solutions to a question or problem
- use models to study processes that cannot be studied directly (e.g., when the real process is too slow, too fast, or too dangerous for direct observation)
- demonstrate the effectiveness of different models to represent the same thing and the same model to represent different things

COMMENCEMENT

- revise a model to create a more complete or improved representation of the system
- collect information about the behavior of a system and use modeling tools to represent the operation of the system
- find and use mathematical models that behave in the same manner as the processes under investigation
- compare predictions to actual observations using test models

STANDARD 6



MAGNITUDE & SCALE

The grouping of magnitudes of size, time, frequency, and pressures or other units of measurement into a series of relative order provides a useful way to deal with the immense range and the changes in scale that affect the behavior and design of systems. **Students will:**

ELEMENTARY

- provide examples of natural and manufactured things that belong to the same category yet have very different sizes, weights, ages, speeds, and other measurements
- identify the biggest and the smallest values as well as the average value of a system when given information about its characteristics and behavior

INTERMEDIATE

- cite examples of how different aspects of natural and designed systems change at different rates with changes in scale
- use powers of ten notation to represent very small and very large numbers

COMMENCEMENT

- describe the effects of changes in scale on the functioning of physical, biological, or designed systems
- extend their use of powers of ten notation to understanding the exponential function and performing operations with exponential factors

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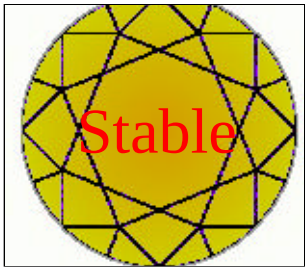


EQUILIBRIUM & STABILITY

Equilibrium is a state of stability due either to a lack of changes (static equilibrium) or a balance between opposing forces (dynamic equilibrium). **Students will:**

ELEMENTARY

- cite examples of systems in which some features stay the same while other features change
- distinguish between reasons for stability—from lack of changes to changes that counterbalance one another to changes within cycles

INTERMEDIATE

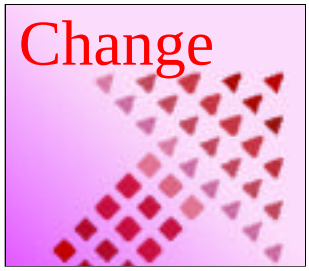
- describe how feedback mechanisms are used in both designed and natural systems to keep changes within desired limits
- describe changes within equilibrium cycles in terms of frequency or cycle length and determine the highest and lowest values and when they occur

COMMENCEMENT

- describe specific instances of how disturbances might affect a system's equilibrium, from small disturbances that do not upset the equilibrium to larger disturbances (threshold level) that cause the system to become unstable
- cite specific examples of how dynamic equilibrium is achieved by equality of change in opposing directions

STANDARD 6

Common Themes



PATTERNS OF CHANGE

Identifying patterns of change is necessary for making predictions about future behavior and conditions. **Students will:**

ELEMENTARY

- use simple instruments to measure such quantities as distance, size, and weight and look for patterns in the data
- analyze data by making tables and graphs and looking for patterns of change

INTERMEDIATE

- use simple linear equations to represent how a parameter changes with time
- observe patterns of change in trends or cycles and make predictions on what might happen in the future

COMMENCEMENT

- use sophisticated mathematical models, such as graphs and equations of various algebraic or trigonometric functions
- search for multiple trends when analyzing data for patterns, and identify data that do not fit the trends

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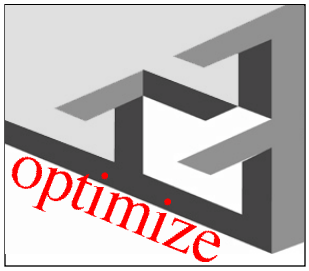


OPTIMIZATION

In order to arrive at the best solution that meets criteria within constraints, it is often necessary to make trade-offs.
Students will:

ELEMENTARY

- determine the criteria and constraints of a simple decision making problem
- use simple quantitative methods, such as ratios, to compare costs to benefits of a decision problem

INTERMEDIATE

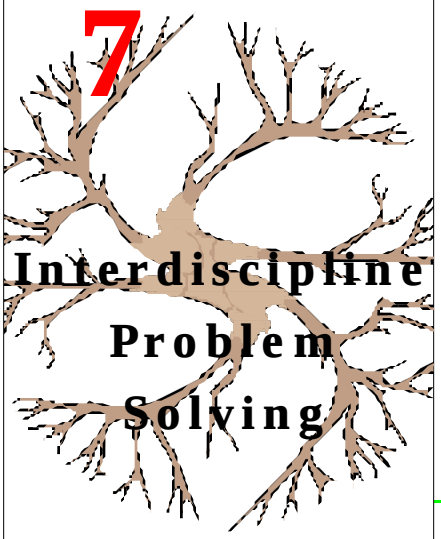
- determine the criteria and constraints and make trade-offs to determine the best decision
- use graphs of information for a decision making problem to determine the optimum solution

COMMENCEMENT

- use optimization techniques, such as linear programming, to determine optimum solutions to problems that can be solved using quantitative methods
- analyze subjective decision making problems to explain the trade-offs that can be made to arrive at the best solution

STANDARD

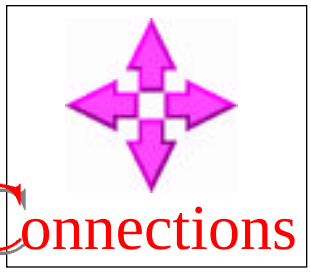
7



Interdiscipline Problem Solving

Mathematics, Science & Technology

Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.



STANDARD 7

Interdisciplinary Problem Solving

Connections

CONNECTIONS

The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomen. **Students will:**

ELEMENTARY

- analyze science/technology/society problems and issues that affect their home, school, orcommunity, and carry out a remedial course of action
- make informed consumer decisions by applying knowledge about the attributes of particular products and making cost/benefit tradeoffs to arrive at an optimal choice
- design solutions to problems involving a familiar and real context, investigate related science concepts to inform the solution, and use mathematics to model, quantify, measure, and compute
- observe phenomena and evaluate them scientifically and mathematically by conducting a fair test of the effect of variables and using mathematical knowledge and technological tools to collect, analyze, and present data and conclusions.

INTERMEDIATE

- analyze science/technology/society problems and issues at the local level and plan and carry out a remedial course of action
- make informed consumer decisions by seeking answers to appropriate questions about products, services, and systems; determining the cost/benefit and risk/benefit tradeoffs; and applying this knowledge to a potential purchase
- design solutions to real-world problems of general social interest related to home, school, or community using scientific experimentation to inform the solution and applying mathematical concepts and reasoning to assist in developing a solution
- describe and explain phenomena by designing and conducting investigations involving systematic observations, accurate measurements, and the identification and control of variables; by inquiring into relevant mathematical ideas; and by using mathematical and technological tools and procedures to assist in the investigation

COMMENCEMENT

- analyze science/technology/society problems and issues on a community, national, or global scale and plan and carry out a remedial course of action
- analyze and quantify consumer product data, understand environmental and economic impacts, develop a method for judging the value and efficacy of competing products, and discuss cost/benefit and risk/benefit tradeoffs made in arriving at the optimal choice
- design solutions to real-world problems on a community, national, or global scale using a technological design process that integrates scientific investigation and rigorous mathematical analysis of the problem and of the solution
- explain and evaluate phenomena mathematically and scientifically by formulating a testable hypothesis, demonstrating the logical connections between the scientific concepts guiding the hypothesis and the design of an experiment, applying and inquiring into the mathematical ideas relating to investigation of phenomena, and using (and if needed, designing) technological tools and procedures to assist in the investigation and in the communication of results

STANDARD 7 Interdisciplinary Problem Solving

STRATEGIES

and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena. **Students will:**

ELEMENTARY—INTERMEDIATE—COMMENCEMENT

Students participate in an extended, culminating mathematics, science, and technology project. The project would require students to:

- work effectively
- gather and process information
- generate and analyze ideas
- observe common themes
- realize ideas
- present results

SKILLS & STRATEGIES FOR INTERDISCIPLINARY PROBLEM SOLVING

ELEMENTARY—INTERMEDIATE—COMMENCEMENT

Working Effectively: Contributing to the work of a brainstorming group, laboratory partnership, cooperative learning group, or project team; planning procedures; identify and managing responsibilities of team members; and staying on task, whether working alone or as part of a group

Gathering and Processing Information: Accessing information from printed media, electronic data bases, and community resources and using the information to develop a definition of the problem and to research possible solutions

Generating and Analyzing Ideas: Developing ideas for proposed solutions, investigating ideas, collecting data, and showing relationships and patterns in the data

Common Themes: Observing examples of common unifying themes, applying them to the problem, and using them to better understand the dimensions of the problem

Realizing Ideas: Constructing components or models, arriving at a solution, and evaluating the result

Presenting Results: Using a variety of media to present the solution and to communicate the results