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ABSTRACT

The standards presented in this book, for reading, writing, and mathematics, are those that will be initially assessed by Arizona's Instrument To Measure Standards (AIMS). These standards and those for other content areas will be a road map for education in Arizona. A statewide test is being developed for each of these areas to measure student progress and school performance, and it is anticipated that a science test will be added. Each standard defines what students should know and be able to do at various levels of achievement: (1) readiness (kindergarten); (2) foundations (grades 1-3); (3) essentials (grades 4-8); (4) proficiency (grades 9-12); and distinction (Honors). Within each standard is one or more performance objectives that describe the results of learning. The standards are listed for each level, with performance objectives associated with each standard. (SLD)

Arizona Academic Standards

Arizona Student Achievement Program

Arizona Department of Education
Lisa Graham Keegan
Superintendent of Public Instruction

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1998

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Dear Parents, Guardians and Patrons,

The mission of the Arizona Department of Education is to ensure academic excellence. Improving student achievement is our overriding goal. Establishing academic standards—benchmarks for what students should know and be able to do—is crucial to achieving that goal.

Building on the original Arizona Essential Skills, the standards are the result of countless hours of work by commited educators and the community at large, and months of public input. They represent the best of what Arizonans want for their children and their schools. We are incredibly grateful to everyone who participated in their development.

The standards presented in this booklet—for reading, writing and mathematics—are those which will be initially assessed by Arizona's Instrument to Measure Standards (AIMS). We believe these are the educational foundation for all public schools in Arizona. As these standards are put into practice in Arizona schools, students, teachers and parents will clearly understand what is expected of them. We will have a concrete way to measure our successes—and be accountable for student performance.

Our children deserve the best education we can give them. Setting rigorous academic standards is an important first step in that process. We urge everyone who has a stake in the education of our children to use these standards to promote academic success. With clearly defined expectations of our students and teachers, excellence is sure to follow.

Sincerely,

Lisa Graham Keegan
Superintendent of Public Instruction

Kenneth R. Bennett, President
Arizona State Board of Education

Introduction

Experience has shown that setting high expectations for students improves academic achievement. Students excel when challenged.

With this in mind, the Arizona Department of Education, under the direction of the State Board of Education, embarked on an effort in 1995 to produce clear, rigorous academic standards for all students. The goal was to provide parents and teachers with specifics as to what our students should know and be able to do. The standard-setting process involved educators, parents, students and members of the business community, drawing on current research and standards developed nationally and by other states, as well as the Arizona Essential Skills. At every step of the way we asked what it would take to provide Arizona students with a world-class education to prepare them for the 21st century.

The results of this effort, the Arizona Academic Standards, provide a road map for public education in Arizona. They chart a course by which all students can acquire the knowledge and skills they will need to succeed in an increasingly complex world. They are tools students, parents and teachers use to assess academic achievement.

The reading, writing and mathematics standards were deemed the most important by the State Board of Education because they serve as the foundation for all other learning. A statewide test is being developed in these three areas to measure student progress and school performance. The State Board also anticipates adding a test in science subsequent to the implementation of the tests in reading, writing and mathematics. Parents will have a clear idea of how well their children and their schools are doing.

Standards have also been developed for science, the arts, comprehensive health, foreign language, technology, and workplace skills. Social studies standards are under development. These content areas are designed to give schools guidance in setting and assessing rigorous academic goals across all subject areas. Copies of those standards may be obtained at your local school, district office, Arizona Department of Education at 602-542-6236, or through the Internet (www.ade.state.az.us).

Understanding and Using the Standards

Each standard defines what students should know and be able to do at various levels of achievement: readiness (kindergarten), foundations (grades 1-3), essentials (grades 4-8), proficiency (grades 9-12) and distinction (honors). Within each standard is one or more performance objectives. Performance objectives describe the results of learning. They describe what a student would do to show that s/he has achieved desired knowledge and/or skills.

The standards and performance objectives will be used to develop a statewide test. Although the formal test, Arizona's Instrument to Measure Standards (AIMS), will be administered only to students in grades 3, 5, 8 and high school, it is expected that teachers at all grade levels will use the standards and performance objectives to prepare students for their future.

Setting academic standards is a major step toward improving student achievement in Arizona. Many teachers, administrators and committee members are hard at work within their school districts aligning their curriculum, instruction and assessments to the state standards. In setting clear expectations for student performance and informing parents, teachers, and schools of the expectations, our students, teachers, and schools can be more accountable for achieving the academic standards.

While these standards are the foundation for student success, they are only one component of the Arizona Student Achievement Program (ASAP). The following page provides a broad overview of this important program. We are committed to providing all Arizona children access to extraordinary education through this strong focus on academic achievement.

ARIZONA STUDENT ACHIEVEMENT PROGRAM

The Arizona Student Achievement Program (ASAP) is a program created to set new standards for teaching and learning and includes assessment, accountability and reporting of student achievement. Since norm-referenced tests cannot determine whether a student has mastered the ability to perform a specific task, Arizona's Instrument to Measure Standards (AIMS) is being designed to measure a student's performance against a specific set of criteria (i.e., language arts and mathematics standards adopted by the State Board of Education).

COMPONENTS OF THE PROGRAM

Academic Standards

Academic standards have been developed and adopted in language arts, mathematics, science, the arts, comprehensive health, foreign language, technology, and workplace skills.

Social studies standards are in the development process.

Arizona's Instrument to Measure Standards (AIMS)

Tests to measure the standards will be adopted by the State Board of Education and administered to all students in grades 3, 5, 8 and high school in reading, writing and mathematics. For graduation purposes, the grade 12 tests will be available to students starting in grade 10. Students will be given five opportunities to take each standard test. Once a student demonstrates proficiency on a particular standard, the student is finished being tested on that standard. The State Board also anticipates adding a test in science subsequent to the implementation of the reading, writing and mathematics tests.

Statewide testing of all students in high school will begin in the spring of 1999 and in the spring of 2000 for grades 3, 5 and 8. The State Board of Education will set performance standards. Statewide testing will be done annually for students in grades 3, 5, 8 and high school. The high school test will be used as a portion of the graduation requirement, pursuant to A.R.S. 15-701.01 (A) (3), beginning with the graduating class of 2001.

Norm-Referenced Test

The norm-referenced test, Stanford 9, is given to all students annually in grades 2-11, pursuant to A.R.S. 15-741 (A) (3) as amended by Section 11, HB2005 of the 4th Special Session.

District Achievement Plan

All Arizona districts and charter schools are required to teach curriculum aligned to the Arizona Academic Standards and must document this effort. Plans are to be prepared by the school districts and charter schools for aligning curriculum and assessments to the adopted standards. Districts and charter schools are also required to document student progress on the standards through regular assessment to ensure students are given multiple opportunities to become proficient on the standards.

Reports

- School Report Cards (i.e., state, district and school results of the norm-referenced test and AIMS)
- Norm-Referenced Test Pupil Home Reports
- AIMS Pupil Home Reports

Table 1. Language Arts Standards

Language Arts Standards

Reading and Writing

STANDARD 1: Reading

Students learn and effectively apply a variety of reading strategies for comprehending, interpreting and evaluating a wide range of texts including fiction, nonfiction, classic and contemporary works.

STANDARD 2: Writing

Students effectively use written language for a variety of purposes and with a variety of audiences.

LANGUAGE ARTS STANDARDS AND PERFORMANCE OBJECTIVES

Reading and Writing

STANDARD 1: READING (adopted by the State Board of Education 07.08.96)

Students learn and effectively apply a variety of reading strategies for comprehending, interpreting and evaluating a wide range of texts including fiction, nonfiction, classic and contemporary works.

READINESS (Kindergarten)

Students know and are able to do the following:

1. **Identify characters in a story and retell stories in sequence**

   After listening to a selection:
   a. Identify main characters
   b. Retell story line in sequence

2. **Predict elements and events in a story**

   After listening to a selection:
   a. Make predictions based on title, cover, illustrations, text

3. **Identify facts in nonfiction material**

   After listening to a selection:
   a. Identify facts from nonfiction material

4. **Use phonetic skills to decode simple words**

   a. Identify consonant sound/symbol relationships in the context of words

5. **Comprehend the meaning of simple written selections, using prior knowledge, letter/sound relationships and picture clues**

   a. Demonstrate an understanding of print concepts (e.g., directionality, pictures, letters, words, return sweep, book handling skills)
   b. Derive meaning from picture clues
   c. Derive meaning from illustrations/print using prior knowledge/experience
   d. Derive meaning from print using sound/symbol relationships

FOUNDATIONS (Grades 1-3)

Students know and are able to do all of the above and the following:

1. **Use phonetic skills to decode words**

   a. Decode words in context using beginning, middle and final letter/sound relationships

2. **Use word recognition and decoding strategies such as phonetic skills, context clues, picture clues, word order, prefixes and suffixes to comprehend written selections**

   a. Derive meaning from a written selection using reading/decoding strategies
      - phonetic clues
      - context clues
      - picture clues
      - word order
      - structural analysis (e.g., prefixes, suffixes)
      - word recognition

3. **Use reading comprehension strategies such as drawing conclusions, summarizing, making predictions, identifying cause and effect, and differentiating fiction from nonfiction**

   a. Draw conclusions based on the text
   b. Restate information from a reading selection
   c. Predict events, actions and behaviors using prior knowledge and/or details to comprehend a reading selection
   d. Identify cause-and-effect relationships
   e. Differentiate fiction and nonfiction texts

4. **Identify facts and the main idea, sequence events, define and differentiate characters, and determine an author's purpose in a range of traditional and contemporary literature**

   a. Identify the main idea and relevant facts in a reading selection
   b. Sequence a series of events from a reading selection
   c. Compare characters (e.g., traits, roles, similarities, differences) in a reading selection
   d. Identify the author's main purpose (e.g., to inform, to entertain, to persuade, to describe) in a reading selection

5. **Analyze selections of fiction, nonfiction and poetry for their literary elements such as character, setting, plot, sequence of events and organization of text**

   a. Compare characters, plot (including sequence of events), settings across reading selections
   b. Explain whether the events in the reading selection are real or fantasy

c. Describe structural elements of poetry (e.g., rhyme, rhythm, repetition)
d. Describe the literary elements of fiction and nonfiction

6. Read and comprehend consumer information such as forms, newspaper ads, warning labels and safety pamphlets

a. Explain the meaning of specific signs (e.g., traffic, safety, warning)
b. Restate information found in consumer literature (e.g., safety pamphlets, newspapers, catalogs)
c. Compare information in written advertisements
d. Fill out a variety of forms (e.g., contest entry, requests for information)

7. Follow a list of directions and evaluate those directions for clarity

a. Follow a set of written directions
b. Evaluate written directions for sequence and completeness

8. Recognize the historical and cultural perspectives of literary selections

Note: ***For instructional purposes–not for state assessment***

a. Identify similarities and differences relating to theme, plot, setting, character and point of view in literature from different cultures
b. Compare real-life experiences to events, characters and conflicts in literary selections from different cultures
c. Recognize that some words in literary selections come from a variety of cultures

ESSENTIALS (Grades 4-8)

Students know and are able to do <u>all of the above and the following</u>:

1. Use structural analysis skills such as identifying root words, prefixes, suffixes and word origins to decode words unfamiliar in print

(Grades 4-5)

a. Identify root words
b. Infer meanings of words in a selection through knowledge of prefixes and suffixes
c. Confirm meaning of words using context clues

(Grades 6-8)

a. Identify the effect of prefixes and suffixes on root words
b. Confirm meaning of figurative, idiomatic and technical language using context clues

2. **Use reading strategies such as making inferences and predictions, summarizing, paraphrasing, differentiating fact from opinion, drawing conclusions, and determining the author's purpose and perspective to comprehend written selections**

(Grades 4-5)

a. Identify the main ideas; critical and supporting details; and the author's purpose, feelings and point of view of the text
b. Distinguish fact from opinion
c. Summarize the text in own words **(assessed at district level only)**
d. Compare and contrast the text (e.g., characters, genre, cultural differences, fact, fiction)
e. Determine cause-and-effect relationships
f. Identify the text in chronological, sequential or logical order
g. Make an inference using context clues

(Grades 6-8)

a. Identify the main ideas; critical and supporting details; and the author's purpose, feelings and point of view of the text
b. Distinguish fact from opinion
c. Summarize the text in own words **(assessed at district level only)**
d. Compare and contrast the text (e.g., characters, genre, cultural differences, fact, fiction)
e. Determine cause-and-effect relationships
f. Summarize the text in chronological, sequential or logical order
g. Predict outcome of text

3. **Analyze selections of fiction, nonfiction and poetry by identifying the plot line (i.e., beginning, conflict, rising action, climax and resolution); distinguishing the main character from minor ones; describing the relationships between and motivations of characters; and making inferences about the events, setting, style, tone, mood and meaning of the selection**

(Grades 4-5)

a. Distinguish the main characters from the minor characters
b. Summarize the plot line to include cause and effect
c. Explain the interaction of major and minor characters in a selection
d. Draw defensible conclusions based on events and settings
e. Differentiate fiction, nonfiction and poetry based on their attributes
f. Explain cause and effect within the plot

(Grades 6-8)

a. Describe the setting and its relationship to the selection
b. Describe the motivation of major and minor characters in a selection
c. Draw defensible conclusions, based on stated and implied information according to style, meaning and mood
d. Differentiate fiction, nonfiction or poetry based on their attributes
e. Identify the theme

4. Identify the author's purpose, position, bias and strategies in a persuasive selection

(Grades 4-5)

a. Identify the author's purpose and use of details to support the purpose
b. Describe the author's use of strategies to convince or persuade
   - bandwagon
   - peer pressure
   - "loaded" words
c. Identify the author's bias

(Grades 6-8)

a. Identify the author's purpose and use of details to support the purpose
b. Describe the author's use of strategies to convince or persuade
   - bandwagon
   - peer pressure
   - "loaded" words
c. Identify the author's bias

5. Evaluate an instructional manual such as assembly directions or user's guide for clarity and completeness

Note: ***Can be used for 5th and 8th grades, depending on difficulty of manual used for the assessment***

a. Identify the components of an instructional manual (e.g., directions, tools required, parts needed, illustrations, diagram sequence, bold face for relevant steps)
b. Incorporate information from the illustrations
c. Locate support help in manual or from manufacturer
d. Identify the sequence of activities needed to carry out a procedure
e. Identify information that is either extraneous or missing (e.g., directions, tools required, parts needed, illustrations, diagram sequence, bold face for relevant steps)

6. Compare and contrast the historical and cultural perspectives of literary selections

Note: ***For instructional purposes–not for state assessment***

(Grades 4-5)

a. Compare one author's perspective of a historical character, setting or event with another historical or contemporary literary selection (e.g., essays, autobiographies, fiction, nonfiction)
b. Compare the lives and experiences of characters in history to present-day individuals who have similar goals or face similar challenges
c. Compare versions of traditional or contemporary literature from different cultures for similarities and differences related to theme, plot, character, setting and point of view

(Grades 6-8)

a. Compare one author's perspective of a historical character, setting or event with another historical or contemporary literary selection (e.g., essays, autobiographies, fiction, nonfiction)
b. Compare the lives and experiences of characters in history to present-day individuals who have similar goals or face similar challenges
c. Compare versions of traditional or contemporary literature from different cultures for similarities and differences related to theme, plot, character, setting and point of view

PROFICIENCY (Grades 9-12)

Students know and are able to do all of the above and the following:

1. **Apply reading strategies such as extracting, summarizing, clarifying and interpreting information; predicting events and extending the ideas presented; relating new information to prior knowledge; supporting assertions with evidence; and making useful connections to other topics to comprehend works of literature and documents**

   a. Extract critical details or elements of literature
   b. Summarize the main points
   c. Make predictions based on evidence presented
   d. Extend ideas presented in the text
   e. Connect prior knowledge to information available

2. **Recognize, analyze and evaluate an author's use of literary elements such as mood, tone, theme, point of view, diction, dialog and figurative language (e.g., metaphors, allusions, symbolism, similes) in selections of challenging fiction, nonfiction and poetry**

   a. Identify the author's use of literary elements (e.g., theme, point of view, diction, dialog, character, setting, plot and figurative language)
   b. Analyze the author's use of literary elements and figurative language
   c. Support a judgment of the effectiveness of the author's use of literary elements and figurative language

3. **Evaluate the author's persuasive techniques in written selections such as editorials, essays, reviews and critiques**

   a. Distinguish use of fact and opinion
   b. Identify purpose (thesis, point of view, stand) of a selection and the response desired from the reader
   c. Evaluate the author's bias and use of persuasive strategies to accomplish a purpose
      - faulty logic
      - word choice
      - sentence structure

- propaganda techniques
- organizational pattern

4. **Evaluate technical journals or workplace documents for purpose, organizational pattern, clarity, reliability and accuracy, and relevancy of information**

   a. Critique consistency and clarity of purpose
   b. Critique effectiveness of organizational pattern (e.g., logic, focus, consistency, visual appeal)
   c. Evaluate information for
      - relevance
      - clarity
      - understandability
      - logic
      - reliability and accuracy (e.g., expertise of author, appropriate use of statistics, diagrams, charts)

5. **Analyze classic and contemporary literature selections, drawn from American and world literature, for the universality of themes such as the individual's role in society, interdependence, and the interaction between man and nature**

   a. Draw a logical inference about the theme and support the inference with evidence from the selection (e.g., symbolism, setting, characterization, irony, conflict)
   b. Compare and/or contrast universality of themes with real-life experiences and/or other works of literature

DISTINCTION (Honors)

Students know and are able to do <u>all of the above and the following</u>:

1. **Analyze complex texts drawn from American and world literature in several historical periods and movements to discern the universality of themes such as the individual's role in society, interdependence, and the interaction between man and nature; and the author's use of literary elements and styles**

2. **Use a full range of strategies to judge the reliability, accuracy, effectiveness, and persuasiveness of literary criticism and analysis, professional and technical journals, and professional-level reading materials**

3. **Develop and support a theme or thesis about the craft and significance of a body of literature, both classic and contemporary, from a diverse selection of writers**

STANDARD 2: WRITING (adopted by the State Board of Education 08.07.96)

Students effectively use written language for a variety of purposes and with a variety of audiences.

READINESS (Kindergarten)

Students know and are able to do the following:

1. **Relate a narrative, creative story or other communication by drawing, telling and writing**
   a. Create a narrative by drawing, telling and/or emergent writing
   b. Create a story by drawing, telling and/or emergent writing
   c. Create a message by drawing, telling and/or emergent writing

2. **Spell simple words**
   a. Apply letter/sound relationships as emergent writers

3. **Write the 26 letters of the alphabet**
   a. Copy the 26 letters of the alphabet

FOUNDATIONS (Grades 1-3)

Students know and are able to do all of the above and the following:

1. **Use the writing process, including generating topics, drafting, revising ideas and editing, to complete effectively a variety of writing tasks**

   a. Generate topics through prewriting activities (e.g., brainstorming, webbing, mapping, drawing, writer's notebook, K-W-L charts, scaffolds, group discussion)
   b. Align purpose (e.g., to entertain, to inform, to communicate) with audience
   c. Write a first draft with the necessary components for a specific genre
   d. Revise draft content (e.g., organization, relevant details, clarity)
   e. Edit revised draft using resources (e.g., dictionary, word lists and banks, thesaurus, spell checker, glossary, style manual, grammar and usage reference)
   f. Proofread revised draft
   g. Present final copy according to purpose (e.g., read aloud, display, publish, mail, send, perform)

2. **Use correct spelling, punctuation, capitalization, grammar and word usage, and good penmanship to complete effectively a variety of writing tasks**

   In final copy of student's own writing tasks:

a. Spell high frequency words correctly
b. Punctuate endings of sentences
c. Capitalize sentence beginnings and proper nouns
d. Use standard, age-appropriate grammar and word usage (e.g., basic subject-verb agreement, complete simple sentences, appropriate verb tense, regular plurals)
e. Write legibly

3. **Write a personal experience narrative or a creative story that has a beginning, middle, and end and uses descriptive words or phrases to develop ideas and advance the characters, plot and setting**

a. Write a narrative
   - establish a beginning, middle and end
   - use sensory details to describe

-OR-

b. Write a story
   - use sensory details to describe setting and characters
   - develop a story line with a problem and events leading to a solution

4. **Gather, organize and accurately, clearly and sequentially report information gained from personal observations and experiences such as science experiments, field trips and classroom visitors**

a. Record observations (e.g., logs, lists, graphs, charts, tables, illustrations)
b. Write an introductory statement
c. Report events sequentially
d. Write a concluding statement

5. **Locate, acknowledge and use several sources to write an informational report in their own words**

a. Use resources (e.g., video tapes, magazines, informational books, reference materials, interviews, guest speakers, Internet) and report information in their own words
b. Write an introductory statement, followed by details to support the main idea
c. List resources used by title

6. **Write well-organized communications, such as friendly letters, memos and invitations, for a specific audience and with a clear purpose**

a. Organize content, including necessary components of the selected format, for a specified audience
b. Place commas correctly in components (e.g., heading, greeting, closing, address) unique to letters, memos, invitations

ESSENTIALS (Grades 4-8)

Students know and are able to do all of the above and the following:

Note: ***In developing the Essentials Level concepts, students should use the writing process, including generating topics, drafting, revising ideas and editing, to complete effectively a variety of writing tasks (see Foundations Level 1a-g, page 9)***

1. Use correct spelling, punctuation, capitalization, grammar and usage, along with varied sentence structure and paragraph organization, to complete effectively a variety of writing tasks

(Grades 4-5)

a. Spell correctly
b. Punctuate correctly (e.g., sentence endings, commas in a friendly letter's greeting and closing, commas in a series, abbreviations, quotations in dialog, apostrophes)
c. Apply rules of capitalization (e.g., sentence beginnings, titles, abbreviations, proper nouns)
d. Apply standard grammar and usage (e.g., subject-verb agreement, simple and compound sentences, appropriate verb tense, plurals)
e. Organize paragraphs with a variety of sentence structures (e.g., simple, compound)

(Grades 6-8)

a. Spell correctly
b. Punctuate correctly (e.g., sentence endings, commas in a series, commas in compound sentences, abbreviations, quotation marks, colon in a business letter greeting, apostrophes)
c. Apply rules of capitalization (e.g., sentence beginnings, titles, abbreviations, proper nouns, direct quotations)
d. Apply standard grammar and usage (e.g., subject-verb agreement; simple, compound and complex sentences; appropriate verb tense; plurals; prepositions)
e. Organize paragraphs with a variety of sentence structures (e.g., simple, compound, complex)

2. Write a personal experience narrative or creative story that includes a plot and shows the reader what happens through well-developed characters, setting, dialog, and themes and uses figurative language, descriptive words and phrases

(Grades 4-5)

a. Write a personal experience narrative
   - develop a story line in a sequence that is clear
   - use descriptive words and phrases

-OR-

b. Write a story
   - develop a story line in a sequence that is clear
   - develop the characters
   - describe the setting
   - use dialog when appropriate
   - use descriptive words and phrases

(Grades 6-8)

a. Write a personal experience narrative
   - develop a story line in a sequence that is clear
   - use figurative language or descriptive words and phrases

-OR-

b. Write a story
   - develop a story line in a sequence that is clear
   - develop the characters
   - describe the setting
   - use dialog when appropriate
   - use simile, metaphor or descriptive words and phrases

3. Write a summary that presents information clearly and accurately, contains the most significant details and preserves the position of the author

(Grades 4-5)

Note: ***For instructional purposes--not for state assessment***

(Grades 6-8)

a. Use own words except for material quoted
b. Preserve the author's perspective and voice
c. Contain main ideas of event/article/story plus the most significant details
d. Present clearly written and organized information

4. Write an expository essay that contains effective introductory and summary statements and fully develops the ideas with details, facts, examples and descriptions

(Grades 4-5)

Note: ***For instructional purposes--not for state assessment***

(Grades 6-8)

a. Write an expository essay that begins by stating the thesis (purpose) with an effective introductory statement or paragraph; provides smooth transitions; and ends with either a paragraph concluding the development of the thesis, a summary or a clincher statement
b. Use own words (except for quoted material) to develop ideas accurately and clearly with supporting details, facts, examples or descriptions
c. Use personal interpretation, analysis, evaluation or reflection to evidence understanding of subject

5. **Write a report that conveys a point of view and develops a topic with appropriate facts, details, examples and descriptions from a variety of cited sources**

(Grades 4-5)

a. Write a report in own words that states, develops and provides a concluding statement for a point of view (perspective) about a topic that is narrow enough to be adequately covered
b. Use logical sequence (including transitional words and phrases such as *first, next, then*)
c. Provide support through facts, details, examples or descriptions that are appropriate, directly related to the topic and from a variety of cited sources

(Grades 6-8)

a. Write a report in own words (except for quoted material) that states, develops and provides a concluding statement for a point of view (perspective) about a topic that is narrow enough to be adequately covered
b. Organize a report with a clear beginning, middle and end including use of smooth transitions
c. Provide support through facts, details, examples or descriptions that are appropriate, directly related to the topic, and from a variety of cited sources
d. Use personal interpretation, analysis, evaluation or reflection to evidence understanding of subject

6. **Write formal communications, such as personal or business letters, messages, directions and applications, in an appropriate format and for a specific audience and purpose**

(Grades 4-5)

a. Write a formal communication in an appropriate format for a specific audience and purpose
b. Organize ideas in a meaningful sequence using transitional words or phrases (e.g., *first, next, then*)
c. Express ideas that are clear and directly related to the topic

(Grades 6-8)

a. Write a formal communication in an appropriate format for a specific audience and purpose
b. Organize ideas in a meaningful sequence using smooth transitions
c. Express ideas that are clear and directly related to the topic

7. **Write a response to a literary selection by supporting their ideas with references to the text, other works or experiences**

(Grades 4-5)

a. Write a clear response supported with examples from the text, other works or experiences
b. Relate own ideas to supporting details in a clear manner
c. Organize response with a clear beginning, middle and end

(Grades 6-8)

a. State clearly a position that is interpretive, analytic, evaluative or reflective
b. Support inferences and conclusions with examples from the text, personal experience, references to other works or reference to non-print media
c. Relate own ideas to supporting details in a clear and logical manner
d. Provide support adequate to the literary selection (e.g., short poem *vs.* novel)

8. Demonstrate research skills using reference materials such as a dictionary, encyclopedia and thesaurus to complete effectively a variety of writing tasks

(Grades 4-5)

a. Implement a research strategy that includes
   - selecting an appropriate source for a specific research purpose
   - utilizing reference materials (e.g., dictionary, thesaurus, encyclopedia, informational trade books, multimedia sources, Internet)
   - writing a paraphrase of information from a source
   - recording relevant information (e.g., notes, graphs, tables) taken from a research source
   - organizing notes and integrating notes into a finished product
   - incorporating notes into a finished product

(Grades 6-8)

a. Implement a research strategy that includes
   - selecting the best source for specific research purpose
   - taking notes that summarize and paraphrase information relevant to the topic
   - incorporating notes into a finished product

PROFICIENCY (Grades 9-12)

Students know and are able to do <u>all of the above and the following</u>:

Note: ***In developing the Proficiency Level concepts, students should use the writing process, including generating topics, drafting, revising ideas and editing, to complete effectively a variety of writing task (see Foundations Level 1a-g, page 9)***

1. Use transitional devices; varied sentence structures; the active voice; parallel structures; supporting details, phrases and clauses; and correct spelling, punctuation, capitalization, grammar and usage to sharpen the focus and clarify the meaning of their writings

a. Use transitions (e.g., conjunctive adverbs, coordinating conjunctions, subordinating conjunctions) where appropriate
b. Vary sentence structure (e.g., compound, complex, compound-complex)
c. Use active voice as appropriate to purpose (e.g., creative writing, expository writing)

d. Use parallel structure appropriately
e. Sharpen the focus and clarify the meaning of their writing through the appropriate use of
   - capitalization
   - standard grammar and usage (e.g., subject-verb agreement, pronoun agreement and consistency of verb tense)
   - spelling, with the use of a dictionary/thesaurus (as needed)
   - punctuation (e.g., comma, ellipsis, apostrophe, semicolon, colon)

2. **Write a persuasive essay (e.g., an editorial, a review, an essay, a critique) that contains effective introductory and summary statements; arranges the arguments effectively; and fully develops the ideas with convincing proof, details, facts, examples and descriptions**

   a. Write a thesis statement to convey a point of view about a subject
   b. Develop the point of view with ample and convincing support (e.g., details, facts, reasons, examples and descriptions) appropriate to audience and purpose
   c. Create an organizational structure that includes an effective beginning, middle and end
   d. Use persuasive word choice and sentence structure (e.g., connotation, strong verbs, repetition and parallelism)

3. **Write an analysis of an author's use of literary elements such as character, setting, theme, plot, figurative language and point of view**

   a. Develop a thesis that states a position about the author's use of literary elements
   b. Support the thesis with relevant examples from the selection
   c. Analyze the author's use of literary elements (e.g., character, setting and theme)
   d. Organize the analysis with a clear beginning, middle and end

4. **Craft a cohesive research document that develops a logical argument or thesis; contains comprehensive, supporting information from a variety of credible and cited resources; and conforms to a style manual**

   a. State a point of view, position or argument about the subject
   b. Organize with a beginning that states the thesis, a middle that develops the thesis, and an end
   c. Support a point of view, position or argument, utilizing facts, examples, details and/or quotes from credible, accurate sources
   d. Follow the guidelines of a selected style manual consistently

5. **Write formal communications, such as a résumé, manuals and letters of application, in appropriate formats, for a definite audience and with a clear purpose**

   a. Establish a clear purpose for a specific audience
   b. Use a clear and appropriate organizational pattern following a standard format for the assigned communication

c. Include only relevant information
d. Use language with an appropriate degree of formality

6. **Write a narrative or story that develops complex characters, plot structure, point of view and setting; organizes ideas in meaningful sequence; and includes sensory details and concrete language to advance the story line**

   a. Write a first- or third-person narrative or story
      - develop a point of view
      - present events in a logical order
      - develop events that convey a unifying theme or tone
      - include sensory details, concrete language and/or dialog
      - use literary elements (e.g., plot, setting, character, theme)

DISTINCTION (Honors)

Students know and are able to do all of the above and the following:

1. **Expand writing experiences by experimenting with language, form and genres (e.g., poetry, screen plays and public policy documents)**

2. **Reflect the subtleties of language and polished literary style in their writings including the power of imagery and precise word choice, and the use of such literary devices as foreshadowing, flashbacks, metaphors, similes, symbolism and idioms**

3. **Analyze, synthesize, evaluate and apply principles of formal logic in expository writing tasks**

Language Arts Glossary

acknowledge To cite the source of information in a written piece.

address To speak to, to deal with.

adequate Sufficient, competent, satisfactory.

advance To put forward, propose.

allusion An indirect reference to something assumed to be familiar.

analytic Noting relationships, reasoning from the interrelations of a subject.

anticipate To foresee, to realize beforehand.

appropriate Consistent with accepted standards, suited to an end or purpose.

cluster A group of the same or similar elements.

cohesive Consistent, tending to unify.

complex Composite, intricate, complicated.

concrete Precise, specific.

contain To have within, to include, to have as component parts.

contemporary In existence now, present, current, present-day.

convey To communicate or make known.

craft To construct, create.

create To produce through artistic or imaginative effort.

creative Original, inventive, innovative.

credible Worthy of belief because of precision; valid, convincing, true.

credit To acknowledge work done, to cite.

effective Producing a desired effect, efficient.

exclude To reject, to prevent from being included or considered.

expository Explanatory, interpretive.

figurative language Use of figures of speech, symbolic language.

genre Type or class, classification of literature.

good penmanship Readable formation of letters, the art of handwriting.

high frequency word A word that appears many more times than others in ordinary reading material.

idiomatic Pertaining to expressions of language that do not mean what they literally say.

interpretive Serving to explain, explanatory.

K-W-L A reading comprehension strategy to determine what a student knows, wants to know and has learned.

list To itemize, to make a list of.

maintain To support, sustain.

meaningful Effectively conveying meaning, feeling or mood; important, significant.

metaphor A figure of speech in which a comparison is implied by analogy but not stated.

paraphrase To restate text or passage in another form or words.

personal experience First-hand experience.

perspective View, outlook.

preserve To keep or maintain intact.

reflective Characterized by or disposed to serious thought; contemplative, deliberative.

relate To give account of, describe, report.

relevant Having a bearing on or connection with the matter at hand.

résumé A brief written account of personal, educational and professional qualifications and experience.

scaffold To build one idea upon another.

sensory Pertaining to the senses.

simile A figure of speech in which two essentially unlike things are compared.

skim To look through reading matter casually.

symbolism Attributing symbolic meanings or significance to objects, events or relationships.

traditional Conventional.

Table 1. Mathematics Standards

Mathematics Standards

STANDARD 1: Number Sense

Students develop number sense and use numbers and number relationships to acquire basic facts, to solve a wide variety of real-world problems, and to determine the reasonableness of results.

STANDARD 2: Data Analysis and Probability

Students use data collection and analysis, statistics, and probability to make valid inferences, decisions and arguments and to solve a variety of real-world problems.

STANDARD 3: Patterns, Algebra and Functions

Students use algebraic methods to explore, model and describe patterns, relationships and functions involving numbers, shapes, data and graphs within a variety of real-world problem-solving situations.

STANDARD 4: Geometry

Students use geometric methods, properties and relationships as a means to recognize, draw, describe, connect, and analyze shapes and representations in the physical world.

STANDARD 5: Measurement and Discrete Mathematics

Students make and use direct and indirect measurement, metric and U.S. customary, to describe and compare the real world and to prepare for the study of discrete functions, fractals and chaos which have evolved out of the age of technology.

STANDARD 6: Mathematical Structure/Logic

Students use both inductive and deductive reasoning as they make conjectures and test the validity of arguments.

MATHEMATICS STANDARDS AND PERFORMANCE OBJECTIVES

(adopted by the State Board of Education 08.26.96)

Throughout all of the following six standards, students will use reasoning, communication skills, and appropriate manipulatives (concrete materials) and technology within real-world problem-solving situations to make connections within mathematics and between mathematics and other disciplines.

STANDARD 1: NUMBER SENSE

Students develop number sense and use numbers and number relationships to acquire basic facts, to solve a wide variety of real-world problems, and to determine the reasonableness of results.

Students know and are able to do the following:

READINESS (Kindergarten)

1. **Develop an understanding of number meanings and relationships**

2. **Demonstrate one-to-one correspondence between elements in collections (sets) (e.g., nine blocks is as many as nine ducks)**

3. **Use manipulatives (concrete materials) to count, order and group**

4. **Recognize relationships between concrete representations, number names, and symbolic representations of numbers (e.g., understand that three rocks can be represented as three circles, the numeral *3* and the word *three*)**

FOUNDATIONS (Grades 1-3)

1. **Represent and use numbers in equivalent forms through the use of physical models, drawings, word names and symbols (e.g., using concrete materials and fraction equivalents to represent and compare halves, thirds, fourths, eighths and tenths)**

    a. Make a model to represent a given whole number
    b. Identify a whole number represented by a model with a word name and symbol
    c. Construct equivalent forms of whole numbers (e.g., 15 + 5 = 10 + 10)
    d. Make a model to represent a given fraction (e.g., geometric model–shading a picture, set model–part of an egg carton) (halves, thirds and fourths)
    e. Identify the fraction represented by a model with a word name and symbol (halves, thirds and fourths)
    f. Identify a given model that is divided into equal fractional parts (halves, thirds and fourths)

2. **Relate counting, grouping and place-value concepts to whole numbers (e.g., reading and writing the number represented when objects are grouped by thousands, hundreds, tens and ones)**

   a. Read whole numbers up to one thousand
   b. Write whole numbers up to one thousand
   c. Order whole numbers (e.g., smallest to largest, largest to smallest) up to one thousand
   d. Construct a model to represent place value concepts
   e. Write a whole number in expanded notation (e.g., 531 = 500 + 30 + 1)
   f. Read aloud a whole number with correct place value words (e.g., a student will read 5 2 1 as "five hundred twenty-one")
   g. Count money to $5.00 using bills and coins

3. **Understand the meaning for and application of the operations of addition, subtraction, multiplication and division**

   a. Demonstrate with models to show the process used in addition (joins things together, increases)
   b. Demonstrate with models to show the process used in subtraction (takes away, compares, finds the difference, decreases)
   c. Demonstrate with models to show the process used in multiplication (uses repeated addition, counts by multiples, combines things that come in groups of equal size, makes arrays, uses area models)
   d. Demonstrate with models to show the process used in division (puts things into groups of equal size, shares equally, uses repeated subtraction)
   e. Demonstrate with models the operations of addition and subtraction up to two three-digit whole numbers
   f. Select appropriate operations to solve word problems
   g. Solve word problems using the appropriate operations
   h. Apply mathematical operations in everyday situations

4. **Demonstrate proficiency with the operations of addition and subtraction of whole numbers**

   Note: ***Proficiency—accurate and consistent solving of computational problems in a reasonable time, using self-checking skills***

   a. Demonstrate proficiency with basic facts up to 20
   b. Add and subtract two three-digit whole numbers
   c. Solve problems using a variety of mental computations and estimation

5. **Demonstrate proficiency with the operations of multiplication and division of single-digit numbers**

   a. Demonstrate proficiency with basic facts up to the fives
   b. Solve problems using a variety of mental computations and estimation

6. **Add and subtract commonly used fractions and decimals**

   a. Demonstrate with models addition and subtraction of fractions with common denominators (halves, thirds and fourths)
   b. Add and subtract money up to $5.00

7. **Select and use appropriate techniques to facilitate computation (e.g., mental, estimation, paper-and-pencil, calculator and computer methods) while solving problems and determining the reasonableness of results**

   a. Select a computational technique to solve a problem
   b. Solve a problem using the appropriate computational techniques
   c. Evaluate the reasonableness of results using a variety of mental computation and estimation techniques (e.g., compatible numbers, front-end, chunking)
   d. Use technology (e.g., calculators, computers, multimedia) to solve problems containing larger numbers

ESSENTIALS (Grades 4-8)

1. **Read, write and order integers, whole numbers and rational numbers**

   a. Compare and order using concrete or illustrated models
      1) whole numbers (to millions) ***(Grades 4-5)***
      2) common fractions (halves, thirds, fourths, eighths) ***(Grades 4-5)***
      3) decimals (thousandths) ***(Grades 4-5)***
      4) rational numbers (e.g., -5, 1.2, 1 3/4, square root of 16) ***(Grades 6-8)***
   b. Represent place value using concrete or illustrated models
      1) whole numbers (millions), decimals (thousandths) ***(Grades 4-5)***
      2) rational numbers (millions to millionths) ***(Grades 6-8)***
   c. Read and write whole numbers, integers, common fractions and decimals using real-world situations
      1) whole number (millions), decimals (thousandths), fractions (halves, thirds, fourths, eighths) ***(Grades 4-5)***
      2) rational numbers (millions to millionths) ***(Grades 6-8)***

2. **Relate the basic arithmetic operations to one another (e.g., multiplication and division are inverse operations)**

   a. Represent the process of multiplication as repeated addition, using **concrete or illustrative models**
      1) whole numbers ***(Grades 4-5)***
      2) fractions and decimals ***(Grades 6-8)***
   b. Represent the process of division as repeated subtraction, partitioning a group and partitioning a whole, using **concrete or illustrative models**
      1) whole numbers ***(Grades 4-5)***

2) fractions and decimals *(Grades 6-8)*

c. Write the family of equations using inverse operations for a given set of numbers
   1) whole numbers with addition/subtraction [(4 + 5 = 9, 5 + 4 = 9, 9 – 4 = 5, 9 – 5 = 4) and multiplication/division] *(Grades 4-5)*
   2) positive fractions and decimals, integers with addition/subtraction and multiplication/division *(Grades 6-8)*

3. Demonstrate proficiency with the operations of multiplication and division of whole numbers

a. Calculate multiplication/division
   1) three-digit by two-digit to find the product *(Grades 4-5)*
   2) facts through 12 *(Grades 4-5)*
   3) mental math and estimation with multiples of 10 *(Grades 4-5)*
   4) one-digit divisor to find quotient with remainder *(Grades 4-5)*
   5) two-digit divisor, with remainders and rounding in context (e.g., percentages and money) *(Grades 6-8)*

b. Calculate multiplication and division problems using contextual situations *(Grades 4-5, 6-8)*

4. Develop and apply number theory concepts (e.g., primes, factors and multiples) to represent numbers in various ways

a. State the factors for a given whole number *(Grades 4-5)*
b. Factor a whole number into a product of its primes (prime factorization) *(Grades 6-8)*
c. Identify greatest common factor and least common multiples for a set of whole numbers *(Grades 6-8)*
d. Sort numbers by their properties
   1) odd, even *(Grades 4-5)*
   2) prime, composite, square, square root *(Grades 6-8)*
e. Simplify numerical expressions using order of operations *(Grades 6-8)*

5. Represent and use numbers in equivalent forms (integers, fractions, percent, decimals, exponents, scientific notation and square roots)

a. Add, subtract, multiply and divide integers, positive fractions and decimals *(Grades 6-8)*
b. Demonstrate the relationship and equivalency among
   1) decimals, fractions and percents (e.g.,1/2 = .5 = 50% with halves, fourths and tenths) *(Grades 4-5)*
   2) decimals, fractions, ratios, percents *(Grades 6-8)*
c. Factor numbers into prime form and express in exponential form *(Grades 6-8)*
d. Convert standard notation to scientific notation and vice versa with positive exponents *(Grades 6-8)*
e. Determine the square root of a perfect square *(Grades 6-8)*

6. **Recognize that the degree of precision needed in calculating a number depends on how the results will be used and the instruments used to generate the measurements**

   a. Express answers to the appropriate place or degree of precision (e.g., time, money, pi) ***(Grades 6-8)***
   b. Apply the appropriate strategy (e.g., estimation, approximation, rounding or exact numbers) when calculating to solve problems ***(Grades 4-5, 6-8)***
   c. Demonstrate/describe the magnitude of
      1) whole numbers (e.g., "How many apples in the orchard?") ***(Grades 4-5)***
      2) rational numbers (e.g., "How small is a bacterium?") ***(Grades 6-8)***

   Note: ***We recommend that this be assessed at the district level.***

   d. Interpret calculations and calculator results within a contextual situation ***(Grades 4-5, 6-8)***

PROFICIENCY (Grades 9-12)

1. **Compare and contrast the real number system and its various subsystems with regard to their structural characteristics**

   a. Classify numbers as members of the sets (natural, whole, integers, rationals and irrationals)
   b. Compare subsets of the real number system with regard to their properties (commutative, associative, distributive, identity, inverse and closure properties)
   c. Compare subsets of the real numbers by determining which characteristics they have in common
   d. Identify whether a given set of numbers is finite or infinite

2. **Construct, interpret and demonstrate meaning for real numbers and absolute value in problem-solving situations**

   a. Determine a rational estimate of an irrational number
   b. Define *absolute value* as the distance from the origin
   c. Solve real-world distance problems using absolute value
   d. Determine, among the solutions to a real-world problem, which, if any, is reasonable
   e. Define *pi* as the irrational ratio of circumference to diameter
   f. Choose the appropriate signed real number to represent a real-world value
   g. Use the appropriate form of a real number to express a real-world situation (e.g., choosing between a radical expression or rational approximation)
   h. Convert standard notation to scientific notation, including negative exponents, and vice versa

DISTINCTION (Honors)

1. **Develop conceptual understanding of the complex number system**

2. **Demonstrate facility with operations in the complex number system**

STANDARD 2: DATA ANALYSIS AND PROBABILITY

Students use data collection and analysis, statistics, and probability to make valid inferences, decisions and arguments and to solve a variety of real-world problems.

Students know and are able to do the following:

READINESS (Kindergarten)

1. **Compare and sort objects by their physical attributes**

2. **Collect, organize and describe simple data**

3. **Construct concrete displays of data; read and interpret elementary tables, graphs and charts**

FOUNDATIONS (Grades 1-3)

1. **Collect and analyze data using the concepts of largest, smallest, most often, least often and middle**

    a. Collect and record data from surveys (e.g., favorite color or food, height, ages) or experiments
    b. Organize (e.g., sorting, sequencing, tallying) information from surveys or experiments
    c. Identify largest, smallest, most often recorded (i.e., mode), least often and middle (i.e., median) using sorted data
    d. Formulate questions from organized data

2. **Construct, read and interpret displays of data to make valid decisions, inferences and predictions**

    a. Make and label a graph (horizontal bar, vertical bar, picture graph or tally chart) from organized data
    b. Answer questions about a circle graph (i.e., pie graph) divided into halves and fourths
    c. Answer questions about a pictograph where each symbol represents multiple units
    d. Write a title representing the main idea of a graph
    e. Locate points on a line graph (grid) using ordered pairs
    f. Draw conclusions (e.g., valid decisions, conjectures and predictions) from graphed data
    g. Formulate questions from graphs, charts and tables
    h. Solve problems using graphs, charts and tables (e.g., given a bar graph on preferred flavors of ice cream, students have to decide what flavors of ice cream to order)

3. **Predict and measure the likelihood of events and recognize that the results of an experiment may not match predicted outcomes**

    Note: ***Probability experiments are simple one-step activities, e.g., tossing a two-colored counter***

a. Collect and record data from a probability experiment
b. Organize (e.g., sorting, sequencing, tallying) data from a probability experiment
c. Name the possible outcomes of the probability experiment
d. Predict the most likely or least likely outcome in probability experiments
e. Compare the outcome of the experiment to the predictions

4. **Understand the concept of sample (i.e., that a larger sample of observed outcomes leads to more reliable information)**

   a. Compare data from probability experiments in which the experiments are performed a different number of times with the given expected outcomes (e.g., toss a two-colored counter 10 times and record the data; toss the counter 20 times and record the data; compare the results to the expected outcome [1 out of 2])

ESSENTIALS (Grades 4-8)

1. **Construct, read, analyze and interpret tables, charts, graphs and data plots (e.g., box-and-whisker, stem-and-leaf, and scatter plots)**

   a. Construct
      1) bar graphs, line graphs, frequency tables and Venn diagrams ***(Grades 4-5)***
      2) histograms, stem-and-leaf plots, scatter plots, circle graphs and flow charts ***(Grades 6-8)***
   b. Interpret and analyze data from graphical representations and draw simple conclusions
      1) bar graphs, line graphs, circle graphs, frequency tables and Venn diagrams ***(Grades 4-5)***
      2) histograms, stem-and-leaf plots, scatter plots, circle graphs and flow charts ***(Grades 6-8)***
   c. Choose an appropriate graphical format to organize and represent data ***(Grades 6-8)***

2. **Make valid inferences, predictions and arguments based on statistical analysis**

   a. Formulate predictions from a given set of data and justify predictions ***(Grades 4-5, 6-8)***
   b. Compare a given prediction with the results of an investigation ***(Grades 4-5, 6-8)***
   c. Critique the conclusions and recommendations of others' statistics ***(Grades 6-8)***
   d. Consider the effects of missing or incorrect information ***(Grades 6-8)***

3. **Display and use measures of range and central tendency (i.e., mean, median and mode)**

   a. Find the mean, median, mode and range of data using **concrete and illustrative models** ***(Grades 4-5)***
   b. Find the mean, median, mode and range of a data set ***(Grades 6-8)***
   c. Choose appropriate measures of central tendencies to describe given or derived data ***(Grades 6-8)***

4. **Use counting strategies to determine all the possible outcomes of a particular event (e.g., the number of ways students can line up to have their pictures taken)**

   a. Find all possible outcome sets involving
      1) two sets of objects (e.g., shirts and pants) ***(Grades 4-5)***
      2) two or more sets of objects ***(Grades 6-8)***
   b. Find all possible arrangements given a set (e.g., "How many ways can you arrange a set of books on a shelf?") ***(Grades 6-8)***

5. **Determine probabilities through experiments and/or simulations and compare the results with the mathematical expectation**

   a. Make predictions from the results of a student-generated experiment (empirical probability)
      1) single events (e.g., spinners) ***(Grades 4-5)***
      2) two-stage events (e.g., two spinners) ***(Grades 6-8)***
   b. Determine and compare experimental (empirical) and mathematical (theoretical) probabilities (e.g., flipping two-colored counters) ***(Grades 6-8)***
   c. Describe events that are certain or impossible ***(Grades 4-5)***
   d. Express probability as a fraction, zero or one ***(Grades 6-8)***
   e. Identify outcomes that are more likely, less likely or equally likely to occur ***(Grades 4-5)***

PROFICIENCY (Grades 9-12)

1. **Construct and draw inferences, including measures of central tendency, from charts, tables, graphs and data plots that summarize data from real-world situations**

   a. Organize collections of data into frequency charts, stem-and-leaf plots, scatter plots and matrices
   b. Construct histograms, line graphs, circle graphs and box-and-whisker plots
   c. Draw inferences from collections of data
   d. Evaluate the reasonableness of conclusions drawn from data analysis
   e. Use mean, median, mode, quartiles and range as a means for effective decision making in analyzing the data and the outliers
   f. Explain graphic misrepresentations and distortions of sets of data

2. **Use appropriate technology (e.g., graphing calculators, computer software) to display and analyze data**

   a. Use appropriate technology to display data as lists, tables, matrices and plots
   b. Use appropriate technology to calculate mean, median, mode, minimum and maximum
   c. Use appropriate technology to predict patterns in sets of data (e.g., "Does a scatter plot appear to be linear?")

3. **Apply curve fitting to make predictions from data**

   a. Draw a line or a curve which closely fits a scatter plot
   b. Make a prediction from a pattern in plots of data

4. **Explain the effects of sampling on statistical claims and recognize misuses of statistics**

   a. Differentiate between sampling and census
   b. Differentiate between a biased and an unbiased sample
   c. Recognize the impact of interpreting data from a biased sample
   d. Distinguish the effects of using statistical measures obtained from a sample *vs.* those obtained from a census
   e. Recognize the misinterpretations of data from different representations of those same data
   f. Determine the validity of sampling methods in studies

5. **Design and conduct a statistical experiment to study a problem and interpret and communicate the outcomes**

   a. Design a statistical experiment based on a given hypothesis
   b. Create an appropriate data-gathering instrument (e.g., biased *vs.* unbiased questions, multiple choice *vs.* open-ended)
   c. Organize collected data into an appropriate graphical representation
   d. Draw and support inferences that are based on data analysis

6. **Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty**

   a. Recognize whether experimental or theoretical methods were used to calculate a particular probability
   b. Use experimental observations to estimate probabilities of entire populations
   c. Distinguish between independent and dependent events
   d. Solve probability problems involving *and* and *or* statements, with and without replacement

7. **Use simulations to estimate probabilities**

   a. Design appropriate simulations to estimate probabilities of real-world situations (e.g., disk toss, cube toss, technological simulations)
   b. Use simulations to estimate probabilities of real-world situations

8. **Solve real-world problems by using combinations and permutations**

   a. Use a tree diagram and a chart of possible outcomes to count probable outcomes of an event
   b. Determine when to use combinations in counting objects
   c. Determine when to use permutations in counting objects

d. Use combinations and permutations to solve real-world problems not requiring the use of formulas

9. Describe, in general terms, the normal curve and use its properties to answer questions about sets of data that are assumed to be normally distributed

a. Determine if data gathered from a real-world situation fits a normal curve
b. Describe the central tendency characteristics of the normal curve
c. Make simple predictions from data represented on a given normal curve

10. Explain the concept of a random variable

a. Distinguish situations where a random variable is needed or used
b. Use a random number table or technology to generate random numbers in modeling real-life situations (e.g., select randomly who belongs in what group)

11. Apply measures of central tendency, variability and correlation

a. Apply the concepts of mean, median, mode and range to draw conclusions about data
b. Draw conclusions about the "spread" of data given the variance and standard deviation (e.g., compare sets of data with the same central tendency, but with different variance)
c. Determine, from a given plot of data, whether it has strong or weak, positive or negative correlation

DISTINCTION (Honors)

1. Transform data to aid in data interpretation and prediction

2. Test hypotheses using appropriate statistics

3. Explain the concept of a random variable to generate and interpret probability distributions including binomial, uniform and normal

4. Apply the concept of a random variable to generate and interpret probability distributions including binomial, uniform and normal

5. Apply curve fitting to determine the strength of the relationship between two data sets and to make predictions from data

STANDARD 3: PATTERNS, ALGEBRA AND FUNCTIONS

Students use algebraic methods to explore, model and describe patterns, relationships and functions involving numbers, shapes, data and graphs within a variety of real-world problem-solving situations.

Students know and are able to do the following:

READINESS (Kindergarten)

1. **Create, describe and extend a variety of patterns, using concrete objects**

2. **Recognize that the same patterns can emerge from a variety of manipulatives and real-world situations**

FOUNDATIONS (Grades 1-3)

1. **Create, describe and extend a variety of patterns using shapes, events, designs and numbers**

   Note: ***Types of patterns: manipulatives, symbols, words, numbers and pictures***

   a. Create a pattern using a model (e.g., symbolically: numbers or letters; visually: shapes, designs, numbers or pictures; auditorially: clapping, singing or listening; and kinesthetically: dancing, movement or tactile)
   b. Communicate orally or in written form the repetition of objects in a pattern
   c. Communicate orally or in written form a given pattern occurring in a sequence of numbers (e.g., counting by 10's, 5's, 3's, 2's, odd, even, forward and backward)
   d. Extend patterns using a model
   e. Extend a given pattern occurring in a sequence of numbers

2. **Formulate generalizations about patterns (e.g., color, shape, size, direction, orientation) to make predictions**

   a. Make predictions based on a given pattern

3. **Represent and describe how changing the value of one variable results in a change in another**

   a. Describe in a given situation how a change in one variable results in the change of another (e.g., if you have to share a batch of cookies with friends, the more friends you have, the fewer cookies you'll each get)

4. **Represent and describe mathematical relationships such as order, grouping, etc. (e.g., given a string of numbers, describe the pattern, define the relationship between the numbers and determine the next number in line)**

   a. Identify the pattern in skip counting

b. Determine the next number in a skip counting pattern

5. **Recognize the symbols of equality and inequality**

   a. Use the symbols <, >, = to compare whole numbers

6. **Find missing elements in number sentences**

   a. Find the missing number in addition and subtraction number sentences

ESSENTIALS (Grades 4-8)

1. **Use algebraic methods (write number sentences in the form of expressions and equations) to explore, model, and describe patterns and functions involving numbers, shapes, data, graphs and data plots**

   a. Extend simple geometric and number patterns (e.g., 1, 1, 2, 1, 1, 3, 1, 1, 4 . . .) ***(Grades 4-5)***
   b. Create simple geometric and number patterns ***(Grades 4-5)***
   c. Describe a rule for a simple pattern (e.g., 5, 10, 15, 20 . . . rule = add five or count by fives) ***(Grades 4-5)***
   d. Generate patterns using algebraic expressions ***(Grades 6-8)***

2. **Describe, represent and analyze patterns and relationships using shapes, tables, graphs, data plots, verbal rules and standard algebraic notation** (see Essentials Level 1a-d and 4a-d)

3. **Describe the concepts of variables, expressions, equations and inequalities**

   a. Describe and use variables in a contextual situation ***(Grades 6-8)***
   b. Evaluate an expression using substitution with four basic operations on whole numbers ***(Grades 6-8)***
   c. Translate a written phrase to an algebraic expression and vice versa (words to symbols and symbols to words) (e.g., the quotient of x and y) ***(Grades 6-8)***
   d. Express a simple inequality from a contextual situation (e.g., Joe earns more than $5.00 an hour; therefore, $x > 5$.) ***(Grades 6-8)***

4. **Analyze functional relationships to explain how a change in one variable results in a change in another**

   a. Describe a real-life situation in which a change in one variable results in a change in another (e.g., the temperature in the classroom goes up and the amount of clothing goes down) ***(Grades 4-5)***

b. Produce the rule (function) that explains the relationship (pattern) between the numbers when a change in the first variable affects the second variable (T-chart, two-row table, or input/output machine) ***(Grades 6-8)***
c. Compute an "output" for a given "input" in a function ***(Grades 4-5)***
d. Complete a T-chart for a given rule ***(Grades 6-8)***

5. Use patterns and functions to represent and solve problems both formally and informally (e.g., measuring the height a ball bounces by dropping different balls from different starting heights)

a. Solve a problem, given a pattern, both formally and informally (e.g., "In a patterned necklace, how many red and green beads do you need for a 20-inch necklace?") ***(Grades 6-8)***

6. Distinguish between linear and nonlinear functions through investigations

a. Distinguish between linear and nonlinear functions, given graphic examples ***(Grades 6-8)***

7. Solve simple linear equations and inequalities using a variety of methods (e.g., informal, formal, graphical) and a variety of manipulatives

a. Solve equations using
   1) whole numbers with one variable-one step ***(Grades 4-5)***
   2) whole numbers with one variable-multiple steps ***(Grades 6-8)***
b. Solve linear (first degree) equations using models/manipulatives, symbols and/or graphing in a one-step equation ***(Grades 6-8)***
c. Graph given data points to represent a linear equation
   1) on a coordinate grid with whole numbers ***(Grades 4-5)***
   2) in (x, y) form using all four quadrants of a coordinate grid ***(Grades 6-8)***

8. Develop, analyze and explain methods for solving proportions

a. Describe how to solve a problem in context using a proportion ***(Grades 6-8)***
b. Compare quantities using ratios ***(Grades 6-8)***
c. Solve proportions using formal (e.g., cross product) or informal methods (e.g., diagrams, geometric models) ***(Grades 6-8)***

PROFICIENCY (Grades 9-12)

1. Model real-world phenomena (e.g., compound interest or the flight of a ball) using functions and relations (e.g., linear, quadratic, sine and cosine, and exponential)

a. Identify the independent and dependent variables from a real-world situation
b. Describe a real-world situation that is depicted by a given graph
c. Sketch a graph that models a given real-world situation

2. **Represent and analyze relationships using written and verbal explanations, tables, equations, graphs and matrices and describe the connections among those representations**

   a. Express the relationship between two variables using a table, equation, graph and matrix
   b. Describe the relationship suggested by two or more graphs of related real-world situations
   c. Determine whether a relation is a function, given the graphical representation

3. **Analyze the effects of parameter changes on functions (e.g., linear, quadratic and trigonometric) using calculators and/or computers**

   a. Use technology to determine changes in the shape and behavior of polynomial functions (of degree 2 or less) when constants and coefficients are varied

4. **Interpret algebraic equations and inequalities geometrically and describe geometric relationships algebraically**

   a. Graph a linear equation in two variables
   b. Graph a linear inequality in two variables
   c. Determine slope and intercepts of a linear equation
   d. Write an equation of the line that passes through two given points
   e. Determine from two linear equations whether the lines are parallel, are perpendicular or coincide

5. **Apply trigonometry to real-life problem situations (e.g., investigate how to find the distance across a river using similar triangles and trigonometric ratios; compare the sine and cosine curves to the curves of sound waves and tide variations)**

   a. Use the definitions of trigonometric functions to find the sine, cosine and tangent of the acute angles of a right triangle
   b. Solve simple right-triangle trigonometric equations involving sine, cosine and tangent
   c. Use an appropriate right-triangle trigonometric model to solve a real-life problem

6. **Perform mathematical operations on expressions and matrices, and solve equations and inequalities**

   a. Simplify numerical expressions using the order of operations, including exponents
   b. Evaluate algebraic expressions using substitution
   c. Simplify algebraic expressions using distributive property
   d. Simplify square roots and cube roots with monomial radicands that are perfect squares or perfect cubes
   e. Calculate powers and roots of real numbers, both rational and irrational, using technology
   f. Evaluate numerical and algebraic absolute value expressions

g. Multiply and divide monomial expressions with integer exponents
h. Add, subtract and perform scalar multiplication with matrices
i. Solve linear equations and inequalities in one variable
j. Solve formulas for specified variables
k. Solve quadratic equations
l. Solve radical equations involving one radical (restrict to square roots)
m. Solve proportions which generate linear or quadratic equations
n. Solve absolute value equations containing a single absolute value expression
o. Solve systems of linear equations in two variables

7. Translate among tabular, symbolic and graphical representations of functions

a. Create a linear equation from a table of values
b. Create a graph from a table of values
c. Determine the solution to a system of equations in two variables, from a given graph
d. Determine the solution to a system of inequalities in two variables, from a given graph (e.g., "Which of the shaded regions represents the solution to the system?")

8. Use the power of mathematical abstraction and algebraic symbolism to represent various situations

a. Translate verbal expressions and sentences to mathematical expressions and sentences
b. Generate an algebraic sentence to model real-life situations, given a data set (limited to linear relationships)

9. Determine maximum and minimum points of a graph and interpret results in problem situations

a. Identify the maximum or minimum point from the graph of a quadratic function
b. Determine domain and range of a relation, given the graph or a set of points
c. Determine the solution to a real-world maximum/minimum problem, given the graphical representation (e.g., given the graph of the path of a ball, determine its maximum height, when it will reach its maximum height, when it will reach ground level)

10. Investigate the limiting process by examining infinite sequences and series and areas under curves

a. Compare the estimates of the area under a curve over a bounded interval, using progressively smaller rectangles (not using calculus)
b. Estimate the limit of a given infinite sequence (e.g., given the sequence $1/n$, as n gets larger) (not using calculus)

DISTINCTION (Honors)

1. Use matrices to solve linear systems

2. Demonstrate technical facility with algebraic transformations, including techniques based on the theory of equations

3. Understand operations on, and the general principles and behavior of, classes of functions (including logarithmic functions)

4. Apply general graphing techniques to trigonometric functions

5. Solve trigonometric equations and verify trigonometric identities

6. Understand the connections between trigonometric functions and polar coordinates, complex numbers and series

7. Understand the conceptual foundations of limits, the area under a curve, the rate of change, and the slope of a tangent line, and their applications in other disciplines

8. Analyze the graphs of polynomial, rational, radical and transcendental functions

STANDARD 4: GEOMETRY

Students use geometric methods, properties and relationships as a means to recognize, draw, describe, connect, and analyze shapes and representations in the physical world.

Students know and are able to do the following:

READINESS (Kindergarten)

1. **Identify, compare, classify, draw and make models of shapes**

2. **Recognize geometry in their surroundings**

FOUNDATIONS (Grades 1-3)

1. **Relate geometric concepts to number and measurement ideas (e.g., dividing a rectangle into parts to represent multiplication)**

   Note: ***- two-dimensional shapes: square, rectangle, triangle, circle***
   - three-dimensional figures: sphere, cube, rectangular prism (box), cone, pyramid
   - attributes: size; shape; the number of sides, corners and faces

   a. Identify two-dimensional shapes by name and attribute
   b. Draw two-dimensional shapes
   c. Identify three-dimensional figures by name and/or attribute
   d. Compare attributes of two-dimensional shapes
   e. Compare attributes of three-dimensional figures
   f. Use a rectangular array to represent a multiplication fact (e.g., put 12 tiles in a rectangular array; make a 3 x 4, 6 x 2, and 12 x 1 array)

2. **Predict how shapes can be changed by combining or dividing them**

   a. Build geometric shapes with other common shapes (e.g., tangrams, pattern blocks, geoboards)

ESSENTIALS (Grades 4-8)

1. **Visualize and draw two- and three-dimensional geometric figures with special attention to analyzing and reasoning informally about their properties (e.g., parallelism, perpendicularity and congruence)**

   a. Classify two-dimensional shapes and three-dimensional figures by their properties
      1) by sight ***(Grades 4-5)***
      2) by properties ***(Grades 6-8)***

b. Identify the properties of geometric figures using appropriate terminology and vocabulary (e.g., parallelism, perpendicularity and congruency)
   1) two-dimensional shapes (three- and four-sided polygons) ***(Grades 4-5)***
   2) three-dimensional figures (prisms) ***(Grades 6-8)***
c. Draw or build two-dimensional shapes ***(Grades 4-5)*** and three-dimensional figures ***(Grades 6-8)*** by applying significant properties of each (e.g., draw a rectangle with two sets of parallel sides and four right angles)

2. Apply geometric properties and relationships such as congruence, similarity, angle measure, parallelism and perpendicularity to real-world situations

a. Design or draw a model (e.g., designing a playhouse, garden) that demonstrates basic geometric relationships, such as
   1) parallelism, perpendicularity, similarity ***(Grades 4-5)***
   2) all of the above and proportionality and congruency ***(Grades 6-8)***
b. Classify triangles by their angles and sides (e.g., equilateral, acute, isosceles . . .) ***(Grades 4-5)***
c. Label corresponding, supplementary and complementary angles ***(Grades 6-8)***
d. Measure and label specified angles (e.g., alternate interior, obtuse, acute, right, corresponding . . .) ***(Grades 6-8)***
e. Identify lines that are parallel and perpendicular ***(Grades 4-5)***
f. Distinguish shapes that are congruent ***(Grades 4-5)***

3. Perform elementary transformations (e.g., tessellations, flips, slides, rotations)

a. Demonstrate slide, flip or turn using concrete geometric figures ***(Grades 4-5)***
b. Illustrate, using concrete or pictorial models,
   1) slide, flip or turn (e.g., quilts) ***(Grades 4-5)***
   2) reflections, rotations and translations (e.g., tessellations) ***(Grades 6-8)***
c. Draw or build a shape that
   1) has symmetry ***(Grades 4-5)***
   2) has two or more lines of symmetry ***(Grades 6-8)***

4. Represent and solve problems relating to size, shape, area and volume using geometric models

a. Solve problems using **given** formulas for
   1) simple area and perimeter ***(Grades 4-5)***
   2) area, perimeter/circumference of various circles/polygons ***(Grades 6-8)***
   3) volume of prisms ***(Grades 6-8)***
b. Identify a variety of shapes having the same perimeter and area ***(Grades 4-5)***
c. Draw or build a variety of shapes having the same perimeter and area ***(Grades 6-8)***

PROFICIENCY (Grades 9-12)

1. Interpret and draw three-dimensional objects

a. Sketch prisms, pyramids, cones, cylinders and spheres
b. Classify prisms, pyramids, cones, cylinders and spheres by base shape, lateral surface shape, related surface area and volume formulas
c. Recognize the three-dimensional figure represented by a two-dimensional drawing (e.g., "What figures are represented by given nets, sketches, photographs?")

2. Represent problem situations with geometric models and apply properties of figures

a. Calculate surface areas and volumes of three-dimensional geometric figures, given the required formulas
b. Solve applied problems using angle, side length, and triangle inequality relationships
c. Solve applied problems using the Pythagorean theorem (e.g., determine whether a wall is square)
d. Solve applied problems using congruence and similarity relationships of triangles (e.g., estimate the height of a building, using shadows)
e. Make a model of a three-dimensional figure from a two-dimensional drawing and make a two-dimensional representation of a three-dimensional object (models and representations include scale drawings, perspective drawings, blueprints or computer simulations)
f. Calculate distance and midpoint between points within a coordinate system representative of a practical application
g. Find the area of a geometric figure composed of a combination of two or more geometric figures, given an appropriate real-world situation and the formulas
h. Solve problems involving complementary, supplementary and congruent angles

3. Deduce properties of figures using transformations in coordinate systems, identifying congruency and similarity

a. Determine whether a figure is symmetric with respect to a line or a point
b. Give the new coordinates of a transformed geometric figure
c. Determine the effects of a transformation on linear and area measurements of the original figure
d. Sketch the figure that is the result of a given transformation

4. Deduce properties of, and relationships between, figures from given assumptions

a. Find similarities and differences among geometric shapes and designs using a given attribute (e.g., height, area, perimeter, diagonals, angle measurements)
b. Identify arcs, chords, tangents and secants of a circle
c. State valid conclusions using given definitions, postulates and theorems

5. **Translate between synthetic and coordinate representations (e.g., a straight line is represented by the algebraic equation $Ax + By = C$)**

   a. Determine the relative placement of two lines on a coordinate plane by examining the algebraic equations representing them
   b. Verify characteristics of a given geometric figure using coordinate formulas such as distance, midpoint, and slope to confirm parallelism, perpendicularity and congruency

6. **Recognize and analyze Euclidean transformations (e.g., reflections, rotations, dilations and translations)**

   a. Classify transformations based on whether they produce congruent or similar non-congruent figures
   b. Determine whether a given pair of figures on a coordinate plane represents a translation, reflection, rotation and/or dilation
   c. Apply transformational principles to practical situations (e.g., enlarge a photograph)

DISTINCTION (Honors)

1. **Deduce properties of figures using vectors**

2. **Apply transformations, coordinates and vectors in problem solving**

STANDARD 5: MEASUREMENT AND DISCRETE MATHEMATICS

Students make and use direct and indirect measurement, metric and U.S. customary, to describe and compare the real world and to prepare for the study of discrete functions, fractals and chaos which have evolved out of the age of technology.

Students know and are able to do the following:

READINESS (Kindergarten)

1. **Recognize that a single object has different attributes (e.g., length, color, size, texture) that can be measured in different ways**

2. **Compare and order objects according to observable attributes**

3. **Use a variety of puzzles and games involving counting problems**

FOUNDATIONS (Grades 1-3)

1. **Demonstrate that a single object has different attributes that can be measured in different ways (e.g., length, mass/weight, time, temperature, area and volume)**

   a. Determine the characteristics (attributes) of an object that are measurable (e.g., length and weight are measurable; color and texture are not measurable)
   b. Identify the type of measure (e.g., weight, height, volume) for each attribute

2. **Explain the concepts related to units of measure and demonstrate the process of measurement with non-standard (e.g., using paper clip lengths), U.S. customary and metric units**

   a. Select the appropriate unit of measure for a given characteristic of an object

length -	inches, feet and yards;
	centimeters and meters
capacity/volume -	cups, gallons and liters
mass/weight -	ounces, pounds, grams and kilograms

   b. Select the appropriate tool (e.g., ruler, thermometer, measuring cup, scale) to measure the given characteristic of an object
   c. Measure a given characteristic of an object using non-standard units of measure
   d. Measure a given characteristic of an object using standard units of measure
   e. Tell time to the nearest minute on digital and traditional (analog) clocks
   f. Determine the passage of time (i.e., units of days, months and years) using a calendar
   g. Compare units of measure to determine *more* or *less* relationships

length -	inches and feet
	feet and yards
	centimeters and meters

capacity -	cups and gallons
mass -	ounces and pounds
	grams and kilograms
time -	minutes and hours
	hours and days
	days and weeks
	months and years
money -	pennies, nickels, dimes,
	quarters and dollars

h. Compare units of measure to determine equivalent relationships

length -	inches to feet
time -	minutes to hours
	days to weeks
	months to years
money -	pennies, nickels, dimes,
	quarters to dollars

i. Read a thermometer in Celsius and Fahrenheit to the nearest degree

3. Make estimates of measurement

a. Estimate a measurement
b. Compare the estimation to actual measure
c. Evaluate the reasonableness of the estimation

4. Use discrete mathematical models for graphs to represent everyday situations (e.g., determine how many ways to move from point A to point B on a grid)

a. Make a diagram to represent the number of combinations between two sets (e.g., "How many outfits can one make with three different colors of shirts and two different pairs of pants?")

ESSENTIALS (Grades 4-8)

1. Estimate, make and use measurements (U.S. customary and metric) to describe and make comparisons

a. Measure length, volume and weight in both U.S. customary and metric units ***(Grades 4-5)***
b. Convert measurement units to equivalent units **within** a given system (customary and metric) (e.g., 12 inches = 1 foot, 10 decimeters = 1 meter) ***(Grades 4-5)***
c. Estimate measurements for both U.S. customary and metric units within either system ***(Grades 4-5, 6-8)***
d. Compare estimated measurements **between** U.S. customary and metric systems (e.g., a yard is about a meter) ***(Grades 6-8)***

2. **Select and use appropriate units and tools to measure to the degree of accuracy required in a particular problem-solving situation**

   a. State the appropriate tool to measure in a particular situation (e.g., "What tool would you use to measure the top of your desk?") ***(Grades 4-5)***
   b. State the appropriate unit of measurement in a particular situation (e.g., "What unit of measurement would you use to measure the top of your desk?") ***(Grades 4-5)***
   c. Measure to the appropriate degree of accuracy to solve problems (e.g., measuring to the nearest sixteenth of an inch or using ounces, measuring to the nearest millimeter or using liters) ***(Grades 4-5, 6-8)***

3. **Estimate, use and describe measures of distance, perimeter, area, volume, capacity, weight, mass and angles**

   a. Differentiate between perimeter and area of quadrilaterals using concrete and illustrative models ***(Grades 4-5)***
   b. Record estimates and measurements for
      1) distance ***(Grades 4-5)***
      2) distance in scale drawings ***(Grades 6-8)***
      3) perimeter ***(Grades 4-5)***
      4) circumference ***(Grades 6-8)***
      5) area ***(Grades 4-5, 6-8)***
      6) volume ***(Grades 6-8)***
      7) weight ***(Grades 4-5)***
      8) mass ***(Grades 6-8)***
      9) degrees of angles ***(Grades 6-8)***
      10) capacity ***(Grades 6-8)***
   c. Compare weight to mass and capacity to volume ***(Grades 6-8)***

4. **Develop and use formulas and procedures to solve problems involving measurement**

   a. Develop a procedure or formula to calculate
      1) area and perimeter of simple polygons ***(Grades 4-5)***
      2) area of polygons and circles ***(Grades 6-8)***
      3) surface area of rectangular prisms ***(Grades 6-8)***
      4) volume of rectangular prisms ***(Grades 6-8)***
   b. Use **given** formulas to find
      1) area and perimeter of simple polygons ***(Grades 4-5)***
      2) circumference of a circle ***(Grades 6-8)***
      3) area of polygons and circles ***(Grades 6-8)***
      4) surface area of rectangular prisms ***(Grades 6-8)***
      5) volume of prisms ***(Grades 6-8)***

5. **Describe how a change in the linear dimension of an object affects its perimeter, area and volume**

   a. Describe the change in perimeter and area when one dimension of an object is altered *(Grades 4-5)*
   b. Describe the effect on perimeter, area and volume when one dimension of an object is altered *(Grades 6-8)*

6. **Use calculators and computers to perform basic recursive and iterative processes**

   a. Solve a problem using the iterative process
      1) doubling (e.g., "If you get paid 1 cent the first day, 2 cents the second day, each day doubling the previous day's pay, how much would you get paid on the 20th day?") *(Grades 4-5)*
      2) designing a simple geometric pattern (e.g., design a basic quilt block; use it to generate the whole quilt) *(Grades 6-8)*
   b. Generate the interative sequence for the next six terms when given the first four terms (e.g., 4, 7, 10, 13, . . .) *(Grades 4-5)*
   c. Complete the interative sequence (e.g., given these terms and assuming a constant difference 21, -, -, -, -, -, 63, -, -, -!) *(Grades 6-8)*
   d. Generate subsequent terms of a recursive sequence (e.g., 3, 3, 6, 9, 15, . . .) *(Grades 6-8)*

PROFICIENCY (Grades 9-12)

1. **Represent problem situations using discrete structures such as finite graphs, matrices, sequences and recurrence relations**

   a. Use matrices and finite graphs to display data
   b. Find a specified n^{th} term of a simple arithmetic or geometric sequence, where the common difference or common ratio is an integer and $n > 100$
   c. Use simple or basic recursion formulas to solve real-life problems (e.g., compound interest)

2. **Represent and analyze finite graphs using matrices**

   a. Interpret data using matrices and finite graphs (e.g., networks, street diagrams, tournament schedules, production schedules)
   b. Determine when a finite graph gives an accurate picture of a data set
   c. Translate a finite graph into a matrix and vice versa

3. **Develop and analyze algorithms**

   a. Write an algorithm that explains a particular mathematical process (e.g., tell a younger child how to find the average of two numbers)
   b. Determine the purpose of a given algorithm
   c. Determine whether given algorithms are equivalent

4. **Solve enumeration and finite probability problems**

   a. Find the outcome set of a situation
   b. Describe how likely it is that a specific event will happen
   c. Determine theoretical geometrical probabilities, given necessary formulas (e.g., "Given a circular target on a square base, what is the probability of hitting the circle with a dart, providing the dart goes inside the square?")
   d. Determine the number of possible outcomes in a real-world situation using the counting principle and tree diagrams
   e. Use critical path methods in problem solving (e.g., students can represent connections between cities, or some other objects, with graphs and illustrate the number of ways of moving from one vertex to another under various rules for movement [touch each vertex only once, touch each edge only once, begin and end at the same vertex, . . .])

DISTINCTION (Honors)

1. **Represent and solve problems using linear programming and difference equations**

2. **Investigate problem situations that arise in connection with computer validation and the application of algorithms**

3. **Describe, analyze and extend patterns produced by processes of geometric change such as fractals**

STANDARD 6: MATHEMATICAL STRUCTURE/LOGIC

Students use both inductive and deductive reasoning as they make conjectures and test the validity of arguments.

Students know and are able to do the following:

READINESS (Kindergarten)

1. **Sort and classify objects according to observable attributes**

2. **Justify their answers and reasoning processes**

FOUNDATIONS (Grades 1-3)

1. **Recognize that numbers are used for different purposes in the world and a variety of mathematical notations represent these situations**

   a. Formulate mathematical problems from everyday situations

2. **Draw inductive and deductive conclusions about mathematics**

   a. Extend a pattern using inductive reasoning (e.g., "What is the next number after 2, 4, 6, 8?")
   b. Make a prediction based on existing information (e.g., "All the students in a 3rd grade class are under 10 years old. How old will the next new student probably be?")

3. **Distinguish between relevant and irrelevant information**

   a. Select the information necessary to solve a given problem

4. **Interpret statements made with precise language of logic (e.g., *all*, *every*, *none*, *some*, *or*, *many*)**

   a. Use words such as *all*, *every*, *none*, *some* and *many* to make reasonable conclusions about situations

ESSENTIALS (Grades 4-8)

1. **Use models to explain how ratios, proportions and percents can be used to solve problems and apply reasoning processes, such as spatial reasoning and reasoning with proportions and graphs**

   a. Communicate how to solve problems involving ratios, proportions and percents using concrete and illustrative models ***(Grades 6-8)***

2. **Construct, use and explain algorithmic procedures for computing and estimating with whole numbers, fractions, decimals and integers**

   a. Design a method with a series of defined steps for solving a problem; justify the method
      1) whole numbers ***(Grades 4-5)***
      2) fractions, decimals and integers ***(Grades 6-8)***

3. **Use *if . . . then* statements to construct simple valid arguments**

   a. Construct simple valid arguments using *if . . . then* statements based on
      1) graphic organizers (e.g., Venn diagrams and pictures . . .) ***(Grades 4-5)***
      2) geometric shapes ***(Grades 4-5, 6-8)***
      3) proportional reasoning in probability ***(Grades 6-8)***
      4) syllogism ***(Grades 6-8)***
   b. Solve problems using deductive reasoning ***(Grades 6-8)***

PROFICIENCY (Grades 9-12)

1. **Use inductive and deductive logic to construct simple valid arguments**

   a. Construct a simple informal deductive proof (e.g., write a proof of the statement: "You can fly from Bombay to Mexico City, given an airline schedule.")
   b. Produce a valid conjecture using inductive reasoning by generalizing from a pattern of observations (e.g., if $10^1 = 10$, $10^2 = 100$, $10^3 = 1000$, make a conjecture)

2. **Determine the validity of arguments**

   a. Determine if the converse of a given statement is true or false
   b. Draw a simple valid conclusion from a given *if . . . then* statement and a minor premise
   c. Distinguish valid arguments from invalid arguments
   d. List related *if . . . then* statements in logical order
   e. Use Venn diagrams to determine the validity of an argument
   f. Analyze assertions about everyday life by using principles of logic (e.g., examine the fallacies of advertising)
   g. Recognize the difference between a statement verified by mathematical proof (i.e., a theorem) and one verified by empirical data (e.g., women score higher than men on vocabulary tests)

3. **Formulate counterexamples and use indirect proof**

   a. Construct a counterexample to show that a given invalid conjecture is false (e.g., Nina makes a conjecture that $x^3 > x^2$ for all values of x. Find a counterexample.)

4. Make and test conjectures

a. Write an appropriate conjecture given a certain set of circumstances
b. Test a conjecture by constructing a logical argument or a counterexample

5. Understand the logic of algebraic procedures

a. Determine whether a given algebraic expression and a possible simplified form are equivalent (e.g., show that $(x + y)^2 = x^2 + y^2$ is invalid)
b. Determine whether a given procedure for solving an equation is valid

DISTINCTION (Honors)

1. Prove elementary theorems within various mathematical structures

2. Develop an understanding of the nature and purpose of axiomatic systems

3. Construct proofs for mathematical assertions, including indirect proofs and proofs by mathematical induction

Mathematics Glossary

absolute value A number's distance from zero on a number line. The absolute value of –4 is 4; the absolute value of 4 is 4.

algebraic methods The use of symbols to represent quantities and signs to represent their relationships.

algebraic sentence A general term for equations and inequalities.

algorithm A mechanical procedure for performing a given calculation or solving a problem through step-by-step procedures such as those used in long division.

angle measure The measure of the space between two lines that meet in a point. Angles are measured in degrees or radians.

axiomatic systems Systems that include self-evident truths; truths without proof and from which further statements, or theorems, can be derived.

binomial In algebra, an expression consisting of two terms connected by a plus or minus sign, such as $4a + 6$.

box-and-whisker plot A graphic method for showing a summary of data using median, quartiles and extremes of data. A box plot shows where the data are spread out and where they are concentrated.

census The count of a population.

combinations Subsets of a larger number of items (e.g., the number of different teams of three that can be chosen from a group of 21).

computational techniques Operations or tools–number lines, calculators.

complex numbers Numbers that have the form a + bi where a and b are real numbers and i is an imaginary number.

congruence The state of having the same size and shape.

conjecture An inference drawn from observed patterns in several examples.

contextual situation Relating mathematical problems to real, modeled or illustrated circumstance.

coordinate system Any set of two or more magnitudes used to locate points, lines or curves. Commonly placed by using a horizontal axis (x-axis) and vertical axis (y-axis).

correlation coefficient A statistical measure that relates how well a set of data points can be modeled by a line.

cosine The trigonometric function that is defined as the ratio of the leg adjacent to an angle to the hypotenuse of its right triangle.

counterexample An example of a conditional statement in which the hypothesis is true and the conclusion is false.

curve fitting Plotting data and observing the pattern to predict trends.

deductive reasoning A series of logical steps in which a conclusion is drawn directly from a set of statements that are known or assumed to be true.

dilation A transformation that either enlarges or reduces a geometric figure proportionately.

direct proof A conclusion proved through deductive reasoning.

discrete mathematics The study of mathematical properties of sets and systems that have only a specific number of elements. For example, the results of tossing dice form a discrete set of events, since a die has to land on one of its six faces.

empirical Relating to the collection of actual data.

equation A mathematical statement in which one expression is equal to another.

Euclidean transformations In geometry, the process of changing one configuration into another, including slides, rotations and reflections.

exponent Tells how many times a number or variable is used as a factor. For example, 6 with an exponent of 3 (6^3) indicates that 6 is a factor 3 times (6 x 6 x 6).

exponential function A function commonly used to study growth and decay. It has a form $y = a^x$.

expression A mathematical phrase with no equal sign, such as $3x$, y, $2n + 3m$.

factors Any of two or more quantities that are multiplied together.

finite graph A structure consisting of vertices and edges, where the edges indicate a mapping among the vertices (e.g., the vertices may represent players in a tournament, and the edges indicate who plays whom).

flip A transformation, also called a reflection, that produces a mirror image of a geometric figure.

fractal An algebraically generated complex geometric shape having the property of being endlessly self-similar under magnification. Some computer screen savers utilize fractals.

function A dependent relationship between two sets of numbers in which a value in the first set has only one defined element in the second set.

identify To state, match, select, write.

imaginary numbers The square root of a negative number usually expressed using i, e.g., $(\sqrt{-9}) = 3i$.

indirect proof A deductive proof using contradiction or elimination to rule out all except the desired conclusion.

inductive reasoning A form of reasoning from individual cases to general ones or from observed instances to unobserved ones.

inequalities Statements indicating that two quantities are not equal, utilizing symbols > (greater than) or < (less than) and ≠.

integers A set of numbers consisting of the whole numbers and their opposites {. . . -2, -1, 0, 1, 2 . . .}.

inverse A related but opposite process or number such as multiplication being the inverse of division and 2/1 being the inverse of 1/2.

irrational numbers A set of numbers that cannot be represented as an exact ratio of two integers (e.g., the square root of 2).

iterative processes In discrete mathematics, a method of calculating an amount by using an initial value and applying a function repeatedly.

linear function A function that has a constant rate of change and can be modeled by a straight line.

logarithm An alternative notation for expressing an exponent.

logic A system of reasoning used to validate arguments.

magnitude Size or quantity.

manipulatives A wide variety of physical materials and supplies that students use to foster the learning of abstract ideas in mathematics.

matrices A rectangular array of numbers or letters arranged in rows and columns.

mean In statistics, the average obtained by dividing the sum of two or more quantities by the number of these quantities.

measures of central tendency Numbers that communicate the "center" or "middle" of a set of data. The mean, median and mode are statistical measures of central tendency.

median In statistics, the quantity designating the middle value in a set of numbers.

mode In statistics, the value that occurs most frequently in a given series of numbers.

model (noun) A display of concrete materials, objects or drawings.

model (verb) Use of concrete materials; symbolic.

monomial In algebra, an expression consisting of a single term such as 5*y*.

multiple A number into which another number may be divided with no remainder.

nonstandard measurement Measurement expressed in terms of objects such as paper clips, sticks of gum, shoes, etc.

normal curve In statistics, the distribution of data along a bell-shaped curve that reaches its maximum height at the mean.

open sentence A statement that contains at least one unknown (e.g., $6 + x = 14$).

parallelism The state of being parallel; not intersecting.

parameter A quantity whose value varies with the circumstances of its application, such as the radius of a group of circles.

permutations Ordered arrangements of a given number of items in a set.

polynomial In algebra, an expression consisting of two or more terms such as $x^2 - 2xy + y^2$.

primes Counting numbers that can only be evenly divided by two numbers which are the number itself and 1 (e.g., the numbers 2, 3, 5, 7).

proportion An equality between ratios (e.g., 2/6 = 3/9).

quadratic function A function that has an equation of the form $y = Ax^2 + Bx + C$ where A does not equal 0.

radian The size of the central angle of a circle when the arc length equals the radius.

random variable A quantity that can take any one of a number of unpredicted values.

range In statistics, the difference between the greatest and smallest values in a set of data.

ratio A comparison expressed as indicated division. For example, there is a ratio of three boys to two girls in our class (3/2, 3:2).

rational numbers Numbers that can be expressed as an exact ratio of two integers.

real numbers All rational and irrational numbers.

rectangular array An organized arrangement of square units (tiles).

recurrence relations In discrete mathematics, a value in a series is derived by applying a formula to the previous value.

recursive sequence In discrete mathematics, a series of numbers in which values are derived by applying a formula to the previous value.

reflection In geometry, a transformation, also called a flip, that produces a mirror image of a geometric figure.

rotation In geometry, a transformation that turns a figure about a point.

sample A part of the total population. Used in statistics to make predictions about the characteristics of the entire group.

scatter plot A graph of the points representing a collection of data.

scientific notation A shorthand way of writing very large or very small numbers. A number expressed in scientific notation is expressed as a decimal number between 1 and 10 multiplied by a power of 10.

similarity In geometry, objects or figures that are the same shape but not necessarily the same size.

sine A trigonometric function that is defined as the ratio of the leg opposite the angle to the hypotenuse of its right triangle.

skip counting Counting by equal intervals.

slides In geometry, a transformation where a figure moves in a given direction.

square root Two equal factors of a number. For example, 4 is the square root of 16.

standard deviation A statistic that measures the dispersion of a sample.

stem-and-leaf plot A table utilizing digit(s) of a number as stems and the other digit(s) as leaves. For example, 5 | 7, 8 shows 57 and 58.

survey Interview, questionnaire and/or polling.

symmetry A correspondence in size, form and arrangement of parts on opposite sides of a plane, line or point. For example, a figure that has line symmetry has two halves that coincide if folded along its line of symmetry.

synthetic representation The geometric form as opposed to the algebraic representation of a figure.

tangent A trigonometric function of an angle which is defined as the ratio of the lengths of the leg opposite to the leg adjacent to an angle in its right triangle. Also a line having one point in common with a curve.

tessellations A mosaic formed by repetitions of a single shape.

theoretical (mathematical) Relating to the probability of a given event, using mathematical relationships (e.g., the chance of a red side coming up on the flip of a two-colored counter is one in two or 1/2).

transformation A geometric process for changing one figure into another.

trigonometric ratios The ratios of the lengths of pairs of sides in a right triangle, i.e., sine, cosine and tangent.

trigonometry The branch of mathematics involving triangles that combines arithmetic, algebra and geometry. Trigonometry is used in surveying, navigation and physics.

validity An argument that is correctly inferred or deduced from a premise.

variability Numbers that describe how spread out a set of data is (e.g., range and quartile).

variable A place holder in algebraic expressions. In $3x + y = 23$, x and y are variables.

vector Quantity that has magnitude (length) and direction. It may be represented as a directed line segment ($\rightarrow$).

whole numbers The counting numbers and zero {0, 1, 2, 3 . . .}.

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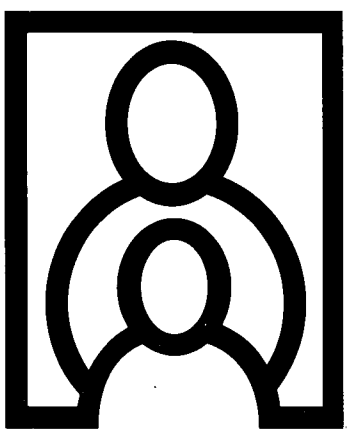

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