SC EDUCATION OVERSIGHT COMMITTEE
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AGENDA

Full Education Oversight Committee Meeting
Monday, October 9, 2023
1:00 p.m.
Room 521, Blatt Building

I. Welcome..April Allen

II. Approval of Full EOC Retreat Minutes
for August 6-7, 2023 ....April Allen

III. Presentation and Information Items:
Overview of Coordinating Council for Workforce Development
(CCWD) and the Unified State Plan (USP) ....Charles Appleby
Senior Advisor, CCWD

SC School Accountability and SY 2022-23
Assessment Update.. Dana Yow

Survey Advisory Group Update (SAG)...................................Dr. Jenny May
Director
Qualitative Research & Stakeholder Engagement

IV. Joint Academic Standards & Assessments & Public Awareness
Subcommittees
Action Items:
2023 SC College-and Career-Ready
Mathematics Standards ....Dr. Rainey Knight
Director, Strategic Innovation &
Sandra Ammons
Team Lead & Math Support, SCDE

Process for Approval of Dual Enrollment Courses for CCR......... Dana Yow

Process for Approval of Industry Certifications &
Credentials for CCR.. Dana Yow

V. EIA & Improvement Mechanisms Subcommittee
For Information:
Update on the 2023-24 EIA Reports &
Budget Recommendations ....Dr. Rainey Knight

VI. Executive Director Update

VII. Adjournment

SOUTH CAROLINA EDUCATION OVERSIGHT COMMITTEE

Full Education Oversight Committee Retreat

Minutes of the Meeting

August 6-7, 2023

Members Present (in-person or remote): Rep. Terry Alexander, April Allen, Melanie Barton, Dr. Bob Couch, Dr. Russell Booker, Rep. Neal Collins, Rep. Bill Hager, Barbara Hairfield, Sen. Kevin Johnson, Sidney Locke, Sen. Dwight Loftis, Patty Tate, Sen. Ross Turner, and the Honorable Ellen Weaver

EOC Staff Present: Riley Dixon, Gabrielle Fulton, Dr. Rainey Knight, Dr. Matthew Lavery, Dr. Jenny May, and Dana Yow

Guests Present: Phillip Cease, SCDE; Dr. Lee D'Andrea, EOC Consultant; Matthew Ferguson, SCDE; Dr. Eric Gallien, Charleston County School District; Lisa Jolliff, RFA; Meghan McCraw, Executive Budget Office; Brennan McMahon Parton, Data Quality Campaign; Pierce McNair, House of Representatives; Katie Nilges, SC Senate; Frank Rainwater, RFA; Diane Sigmon, EOC Consultant; Lisa Wren; RFA

August 6, 2023

Chair April Allen welcomed the Committee to Mt. Pleasant and the Ports Authority. As the first order of business, members voted to approve the minutes from the prior Full Committee meeting held on June 12, 2023. The minutes were approved unanimously. Next, Ms. Allen welcomed Brennan Parton from the Data Quality Campaign (DQC).

Ms. Parton thanked the committee before beginning her presentation on the use of data in service of student learning. During the presentation, members engaged in small group discussions about the Committee's vision for data in South Carolina, the role that it plays for students, and the associated challenges and barriers. Following Ms. Parton's presentation, members briefly adjourned.

Next, Dana Yow provided members with an update on the EOC Strategic Plan, highlighting successes, progress, paths forward, and opportunities for improvement. Ms. Yow then introduced Gabrielle Fulton to present an overview of the South Carolina data dashboards that the EOC was newly charged with. These dashboards can be found on DashboardSC.sc.gov.

Following the presentation, Barbara Hairfield introduced Dr. Eric Gallien, Superintendent of the Charleston County School District. Ms. Allen then introduced Superintendent Ellen Weaver for an update on South Carolina Department of Education governance, budget, and progress towards the SCDE Strategic Plan.

August 7, 2023

Ms. Allen welcomed the Committee for the second day and introduced Cami McCoy, from the South Carolina Ports Authority. Ms. McCoy provided the Committee with an overview of the SC Ports Authority's role in commerce and infrastructure, before inviting members on a tour of the SC Ports Authority Wando Terminal.

Following the tour, members reconvened, and Ms. Allen provided members with a brief update before introducing Frank Rainwater, Lisa Jolliff, and Lisa Wren from the SC Revenue and Fiscal Affairs office. Mr. Rainwater provided members with an overview of recent economic changes in South Carolina, along with the impact of SC population changes and projections, noting that while the population is growing overall, that of workforce aged adults is shrinking. Next, Mr. Rainwater demonstrated the upcoming RFA Education Financials Dashboard. Following this, Ms. Allen made closing remarks and with that, the meeting adjourned.

EDUCATION OVERSIGHT COMMITTEE

DATE: October 9, 2023

COMMITTEE:
Education Oversight Committee

ACTION ITEM:
Approval of SC College- and Career-Ready Mathematics Standards

PURPOSE/AUTHORITY
SECTION 59-18-350. Cyclical review of state standards and assessments; analysis of assessment results. (A) The State Board of Education, in consultation with the Education Oversight Committee, shall provide for a cyclical review by academic area of the state standards and assessments to ensure that the standards and assessments are maintaining high expectations for learning and teaching. At a minimum, each academic area should be reviewed and updated every seven years. After each academic area is reviewed, a report on the recommended revisions must be presented to the Education Oversight Committee and the State Board of Education for consideration. The previous content standards shall remain in effect until the recommended revisions are adopted pursuant to Section 59-18-355. As a part of the review, a task force of parents, business and industry persons, community leaders, and educators, to include special education teachers, shall examine the standards and assessment system to determine rigor and relevancy.

CRITICAL FACTS
The South Carolina Department of Education (SCDE) has completed revisions to SC College- and Career-Ready Mathematics Standards. Attached are the SC 2021 South Carolina College and Career Ready Mathematics Standards as revised by the SCDE. These revisions were completed using recommendations which were compiled under the advisement of two review panels convened by the EOC: a national review panel of mathematics educators who have worked with national or other state organizations and a state review panel made up of South Carolina mathematics teachers, parents, business and community leaders and South Carolina teachers of English language learners and exceptional education drawn from various geographic areas in South Carolina.

TIMELINE/REVIEW PROCESS

April-June 2021	EOC conducts state and national review of current SC College- and Career-Ready Math Standards
December 2021	EOC adopts revisions to Mathematics Standards
2022-2023	SCDE Writing Teams consider recommendations made by the EOC, review panels, and Vertical Alignment Team; complete revision for pubic review
September 12, 2023	SC State Board of Education to consider standards for 1st reading
September 18, 2023	Approved by the EOC ASA/PA Subcommittees
October 9, 2023	EOC to consider standards for approval

ECONOMIC IMPACT FOR EOC
none

ACTION REQUEST

☒ **For approval** ☐ **For information**

ACTION TAKEN

☐ **Approved** ☐ **Amended**
☐ **Not Approved** ☐ **Action deferred (explain)**

STATE OF SOUTH CAROLINA

DEPARTMENT OF EDUCATION

ELLEN E. WEAVER
STATE SUPERINTENDENT OF EDUCATION

South Carolina College- and Career-Ready Mathematics Standards

Pursuant to the South Carolina Educational Accountability Act of 1998
(S.C. Code Ann. § 59-18-110)

Presented to the State Board of Education
First Read: September, 2023

Contents

Acknowledgements

South Carolina owes a debt of gratitude to those who collaborated to produce the *2023 South Carolina College- and Career-Ready Mathematics Standards (SC CCR Math Standards)*. For a full list of names of the writing committee, see Appendix B.

Mathematics Standards Review Panel 2021
The review panel recommended revisions to the *2015 South Carolina College- and Career-Ready Standards for Mathematics.*

Standards Writing Committee 2022-2023
The members of the writing committee considered recommendations by the review panel, the Education Oversite Committee, and the vertical alignment team to develop the draft of the revised standards.

Vertical Alignment Team 2023
The vertical alignment team reviewed the first draft of the revised standards and made recommendations to the writing team.

Focus Groups 2023
Stakeholders from across the state, representing educators, parents, businesses, and higher education, reviewed the standards draft and provided recommendations to the writing team.

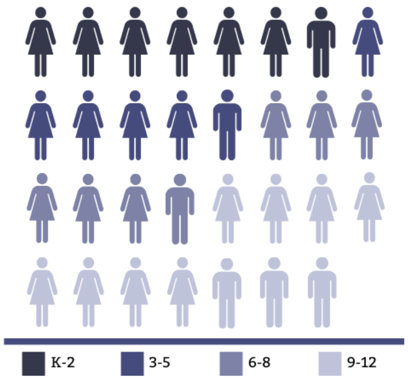
Advisory Team 2022-2023
The advisory team provided support and recommendations to the 2022 writing committee.

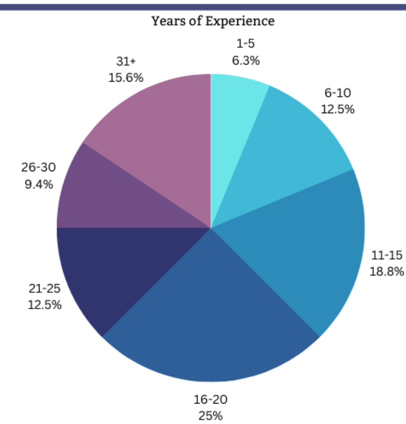
Office of Assessment and Standards Leadership Team and Education Associates
Staff within the Office of Assessment and Standards, Office of Early Learning and Literacy, and Office of Special Education Services worked alongside the review panel, writing committee, and vertical alignment team in support of the work.

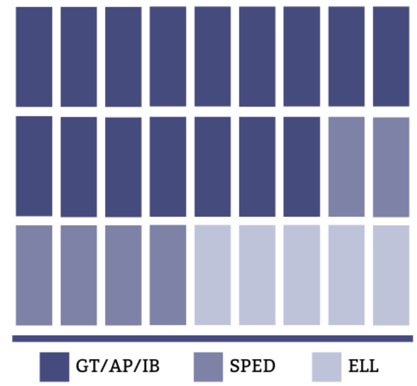
The infographic below illustrates a visual representation of the 2023 Math Standards Writing Committee. Data includes demographic information such as race, gender, and location, as well as years of experience and professional expertise.

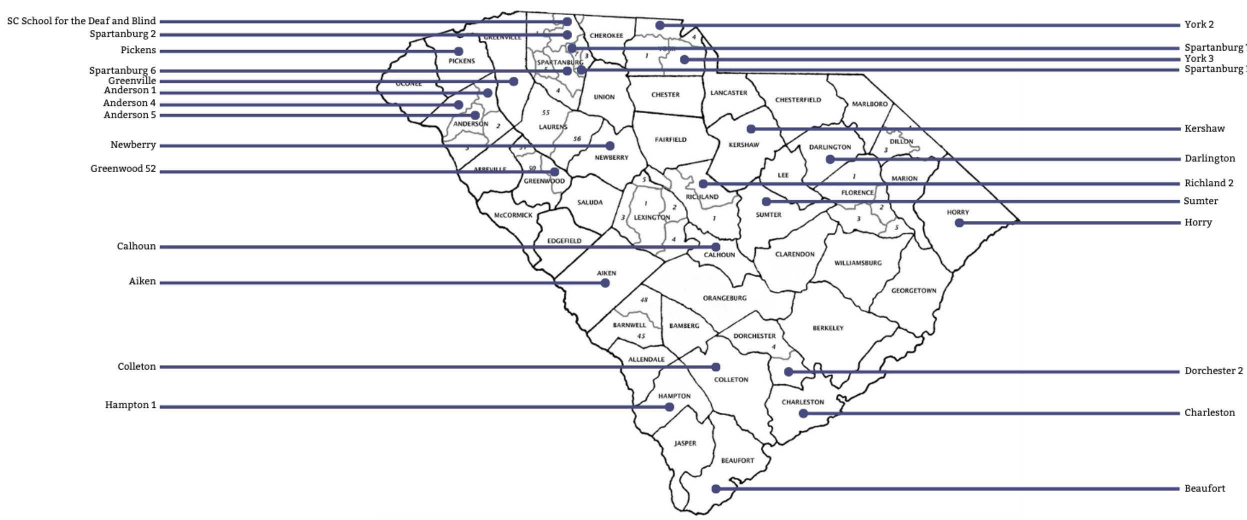
2022 Math Standards Writing Committee Participants

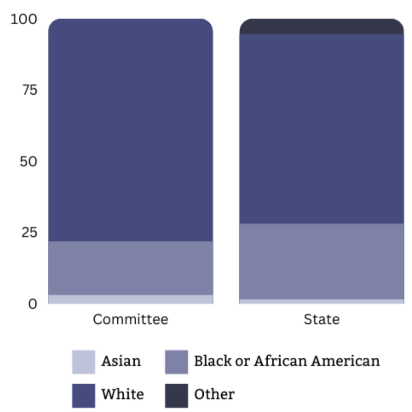
Selected participants were representative of the demographic characteristics of South Carolina in terms of gender, race and ethnicity, and region (education districts) as well as a range of years of experience and a variety of areas of expertise.

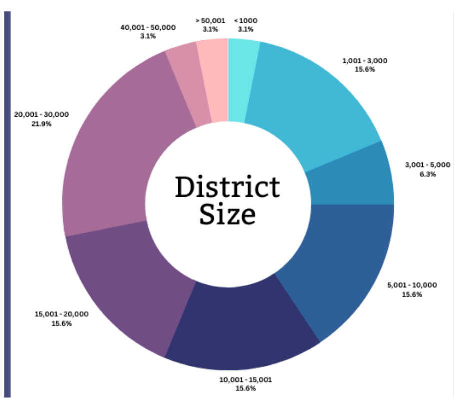


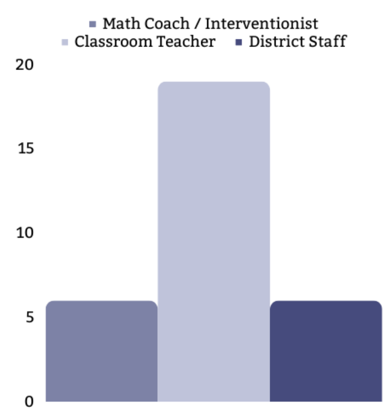












South Carolina's Standards Revision Process

According to the South Carolina Educational Accountability Act of 1998 (S.C. Code Ann. § 59-18- 110), the purpose of academic standards is to provide the basis for the development of local curricula and statewide assessments. The *2023 SC CCR Math Standards* were written in accordance with the cyclical review process as set by the South Carolina Department of Education and the Education Oversight Committee. The writing team was carefully selected from a pool of interested applicants and included South Carolina classroom teachers, instructional coaches, district leaders, and educators who specialize in working with multilingual learners, gifted learners, students with IEPs, career and technology education, and assessment. The team of writers was representative of South Carolina, and every effort was made to ensure districts of varying sizes and regions were represented. In addition, the *2023 SC CCR Math Standards* were developed under and supported by the leadership of numerous South Carolina Department of Education staff and offices from across the agency.

Prior to the math writing team revising the math standards, it considered feedback provided in the cyclical reviews from the State Department of Education and the Education Oversight Committees. The writing committee also referenced the *2005 National Adult Education Program (NAEP) Mathematics Framework*, the *2021 Program for International Student Assessment (PISA) Mathematics Framework*, and recommendations from *the National Council of Teachers of Mathematics' (NCTM) Catalyzing Change* resources for elementary, middle, and high school students. The NCTM highlights the importance of preparing all students for college mathematics and careers and ensuring that high school Math courses do not limit a student's ability to pursue postsecondary goals.

The purpose of the standards revision process was to design college- and career-ready standards that would ensure that students who complete high school in South Carolina are ready for college, career, and community. The *Profile of the South Carolina Graduate*, adopted by The State Board of Education and The Education Oversight Committee, was a touchstone during the revision of the standards. The process was designed to create Math standards that are clear, concise, aligned, and accessible to all students and educators in the state.

SECTION 59-18-350 of South Carolina states the following regarding state standards and assessments:

(A) The State Board of Education, in consultation with the Education Oversight Committee, shall provide for a cyclical review by academic area of the state standards and assessments to ensure that the standards and assessments are maintaining high expectations for learning and teaching. At a minimum, each academic area should be reviewed and updated every seven years. After each academic area is reviewed, a report on the recommended revisions must be presented to the Education Oversight Committee and the State Board of Education for consideration. The previous content standards shall remain in effect until the recommended revisions are adopted pursuant to Section 59-18-355. As a part of the review, a task force of parents, business and industry persons, community leaders, and educators, to include special education teachers, shall examine the standards and assessment system to determine rigor and relevance.

(B) For the purpose of developing new college and career readiness English/language arts and mathematics state content standards, a cyclical review must be performed pursuant to subsection (A) for English/language arts and mathematics state content standards not developed by the South Carolina Department of Education. The review must begin on or before January 1, 2015, and the new college and career readiness state content standards must be implemented for the 2015-2016 school year.

(C) The State Department of Education annually shall convene a team of curriculum experts to analyze the results of the assessments, including performance item by item. This analysis must yield a plan for disseminating additional information about the assessment results and instruction and the information must be disseminated to districts not later than January fifteenth of the subsequent year.

HISTORY: 1998 Act No. 400, Section 2; 2008 Act No. 282, Section 1, eff June 5, 2008; 2014
After each academic area is reviewed, a report on the recommended revisions must be presented to the State Board of Education and the Education Oversight Committee for approval. The mathematics standards development process was designed to develop clear, rigorous, and coherent standards for mathematics that will prepare students for success in college and/or careers. The South Carolina Profile of a College and Career-Ready Mathematics Student and the Profile of the South Carolina Graduate, served as the foundation that guided the mathematics writing team's determination of the components of South Carolina College- and Career-Ready Standards for Mathematics.

How to Read This Document

Overall Document Organization

The standards document is divided into four major strands: Numerical Reasoning (NR), Patterns, Algebra, and Functional Reasoning (PAFR), Data, Probability, and Statistical Reasoning (DPSR), and Measurement, Geometry, and Spatial Reasoning (MGSR). Neither the order of the strands nor the indicators within each strand are intended to prescribe an instructional sequence. Within each strand is a number of standards for the grade level. Each standard contains one or more vertically articulated grade-level indicators. The grade-level indicators set the end-of-year learning expectations, not instructional sequence. In most cases, the indicators progress from kindergarten through the completion of Geometry, Algebra 1, and Algebra 2 in high school. Upon completion of high school courses in Geometry and Algebra 1, students will have choices in math sequence based upon their college and career goals. The K-8 strands are presented in this document by grade level including the standards, indicators, and instructional insights. Each high school course is aligned to the appropriate strand and includes standards, indicators, and instructional considerations.

Coding

The coding of the *SC CCR Math Standards* is presented in a format showing the content area, grade/course level, strand code, standard number, and indicator number. A visual layout of the coding and a table including the strand codes are presented below.

Example: 6.NR.1.1
(Grade 6, Numerical Reasoning Strand, Standard 1, Indicator 1)

Strand	Abbreviation
Mathematical Process Standards	MPS
Data, Probability, and Statistical Reasoning	DPSR
Measurement, Geometry, and Spatial Reasoning	MGSR
Numerical Reasoning	NR
Patterns, Algebra, and Functional Reasoning	PAFR

High School Course	Abbreviation
Geometry with Statistics	GS
Algebra 1	A1
Algebra 2 with Probability	A2P
Pre-Calculus	PC
Calculus	C
Reasoning in Mathematics	RM
Applications and Modeling	AM
Statistical Modeling	SM
Discrete Mathematics	DM

Key Features

Grade-Level/Course Entrance Statements
Each grade level of standards is introduced with an entrance statement that outlines the general skills appropriate for students at that grade. Any major shifts are also included.

Mathematical Process Standards
Each set of grade level standards starts with the Mathematical Process Standards. Just as in content, the Mathematical Process Standards progress in complexity through the grade bands. The Indicator Insights for the Mathematical Process Standards contain descriptions of what the standards should look like in that specific grade band. The grade bands are K-2, 3-5, 6-8, and 9-12.

Standards and Indicators
According to the *Procedures for Cyclical Review of South Carolina Academic Standards*, "academic standards are statements of the most important, consensually determined expectations for student learning in a particular discipline. Each of the newly revised South Carolina standards statements will be supported by specific instructional objectives called indicators" (2016).

Each standard contains one or more vertically articulated grade-level indicators. The grade-level indicators set the end-of-year learning expectation. The order of indicators does not specify the order of instruction.

Indicator Insights
Indicator Insights provide an understanding of the indicator for the classroom teacher. These insights provide teachers with clarifying information about the expectations of the indicator and/or the content of the indicator. Some insights may provide connections to indicators in other standards or strands.

Appendices
- A- High School Math Course Pathways Graphic: This section provides insight into the possible pathways for students.
- B- Acknowledgments: This section details the members involved in the development of the SC CCR Math Standards.

South Carolina College- and Career-Ready Mathematics Standards K-12 Overview

SC CCR Math Standards are divided into four strands: Numerical Reasoning (NR); Patterns, Algebra, and Functional Reasoning (PAFR); Data, Probability, and Statistical Reasoning (DPSR), and Measurement, Geometry, and Spatial Reasoning (MGSR). Within each strand, there are grade level standards that students should know and be able to do upon the completion of the strand. Each standard contains indicators that have been vertically aligned from high school to kindergarten. These standards and indicators represent a balance of conceptual and procedural knowledge and specify the mathematics that students will master in each grade level and in each high school course.

SC CCR Mathematical Process Standards

The SC CCR Mathematical Process Standards demonstrate the ways in which students develop conceptual understanding of mathematical content and apply mathematical skills. As a result, the SC CCR Mathematical Process Standards should be integrated within the SC CCR Mathematics Standards for each grade level and course. Since the process standards drive the pedagogical component of teaching and serve as the means by which students should demonstrate understanding of the content standards, the process standards must be incorporated as an integral part of overall student expectations when assessing content understanding. Students who are college- and career-ready should take a productive and confident approach to mathematics. They can recognize that mathematics is achievable, sensible, useful, doable, and worthwhile. They also perceive themselves as effective learners and practitioners of mathematics and understand that a consistent effort in learning mathematics is beneficial. Since manipulatives and technology are integral to the development of mathematical understanding in all grade levels and courses, curriculum should support, and instructional approaches should include the use of a variety of concrete materials and technological tools to help students explore connections, make conjectures, formulate generalizations, draw conclusions, and discover new mathematical ideas. The Program for International Student Assessment (PISA) defines mathematical literacy as "an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged, and reflective citizens" (Organization for Economic Cooperation and Development, 2012).

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Students understand there are multiple entry points that can identify and explain a problem. Using prior knowledge, a variety of methods, and continual self-reflection, students can check for reasonable solutions. Students can monitor progress and confidently change course if necessary to plan a solution pathway.
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Students can consider the available and relevant tools that are helpful to explore, model, and deepen their understanding of concepts. They can use precise mathematical language to model, explain, and justify valid solutions. Students can engage in constructive dialogue individually and collaboratively through writing, speaking, and listening.
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Students can make connections between different areas of mathematics, other content areas, and real-world context. They can identify applicable quantities, interpret mathematical models, and describe their relationships in the context of relevant situations.
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Students can construct arguments using multiple representations (objects, symbols, drawings, and actions). They can recognize and explain bias and errors in an argument. Mathematical students can listen and read the arguments of others to critique whether they make sense and ask questions for clarification. Students can use reasoning to make and explore the truth of conjectures.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Students can make and test conjectures, express regularities as generalizations about relationships then use the generalizations to solve problems. They can recognize complex mathematical objects and situations as being composed of multiple parts.

New Elements

Informed by current, theoretical research and commitment to preparing all students in South Carolina to be college and/or career ready, the new standards include the following elements:

1. **The progression of math courses includes offering Geometry prior to Algebra 1**. This progression enables the standards for Geometry to be used as a concrete and pictorial representation for developing the concepts of the algebraic principles before moving to the abstract representations in Algebra 1, allowing students to be more successful in Algebra 1. Algebra 1 will remain the gateway course which will include the End of Course Assessment at the conclusion of the course. Foundations and Intermediate Algebra will no longer be available courses for students. The new Geometry course will provide students with the foundational skills necessary to be successful in Algebra 1. (See Appendix A)

2. The mathematical strands include a **focus on data, probability, and statistics in all grade levels,** ensuring that South Carolina graduates are prepared for real-world experiences. Probability and Statistics is not a stand-alone course; instead, the standards and indicators are a specific strand in grades K-12, and they are interwoven into high school courses to allow all students the opportunity to learn these important real-world skills prior to graduation.

3. **Standards and indicators have been written for all high school courses in the progression**, and, as appropriate, the courses are aligned to the four strands: Numerical Reasoning (NR), Patterns, Algebra, and Functional Reasoning (PAFR), Measurement, Geometry, and Spatial Reasoning (MGSR), and Data, Probability, and Statistical Reasoning (DPSR). Students have the opportunity to access numerous courses on the progression, and the courses contain the rigor necessary for all students to be successful in college and/or careers.

Alignment to the *Profile of the South Carolina Graduate*

South Carolina students will achieve readiness for college, career, and lifelong learning through the integration of various higher order thinking and mathematical skills. Those skills will be supported by standards, curriculum, instruction, local and state assessments, and by employing inquiry-based learning and encouraging student choice, to inspire creativity, innovation, and problem-solving ability. Knowledge and skills such as these are representative of the expectations of the *SC CCR Math Standards.*


PROFILE OF THE
South Carolina Graduate
WORLD-CLASS KNOWLEDGE
Rigorous standards in language arts and math for career and college readiness
Multiple languages, science, technology, engineering, mathematics (STEM), arts and social sciences
WORLD-CLASS SKILLS
Creativity and innovation
Critical thinking and problem solving
Collaboration and teamwork
Communication, information, media and technology
Knowing how to learn
LIFE AND CAREER CHARACTERISTICS
Integrity • Self-direction • Global perspective • Perseverance • Work ethic • Interpersonal skills
© SCASA Superintendents' Roundtable
Adopted by: SC Arts in Basic Curriculum Steering Committee, SCASCD, SC Chamber of Commerce, SC Council on Competitiveness, SC Education Oversight Committee, SC State Board of Education, SC State Department of Education, TransformSC Schools and Districts.
transformSC
tomorrow won't wait for our students
AN INITIATIVE OF
SOUTH CAROLINA COUNCIL ON COMPETITIVENESS

Kindergarten Math Standards

The standards are designed to provide students with knowledge and skills to solve problems using critically important skills for college and career readiness. The focus in kindergarten is concentrated within the strands of Numerical Reasoning; Patterns, Algebra, and Functional Reasoning; Data, Probability, and Statistical Reasoning; and Measurement, Geometry, and Spatial Reasoning.

For Numerical Reasoning, a major emphasis is given to building number sense for numbers zero to twenty. Kindergarten will focus on developing an understanding of counting to represent the total number of objects in a set. Additionally, students will use concrete representations to compare the quantity of two sets of objects. Opportunities should be given to use concrete objects to demonstrate that whole numbers can be composed and decomposed in a variety of ways. A major focus for students in kindergarten will be subitizing quantities to ten. This ability to subitize is crucial for students as it allows them to understand how whole numbers can be composed in numerous ways.

For Patterns, Algebra, and Functional Reasoning, kindergarteners will use multiple representations to reason and solve problems involving addition and subtraction. Students will use a variety of strategies for addition and subtraction within 10. A major focus for students in kindergarten will include building a strong conceptual foundation of addition and subtraction by exploring the relationship between these operations. Multiple opportunities with concrete and pictorial models should be embedded in this strand and students should be able to apply the concepts to mathematical and real-world situations. In this grade, students will also use reasoning to extend and continue patterns.

For Data, Probability, and Statistical Reasoning this grade will collect, sort, analyze, and communicate data through various charts and graphs.

For Measurement, Geometry, and Spatial Reasoning, kindergarteners will identify coins and compare objects using measurement vocabulary. Students will also identify, describe, compare, and analyze two-dimensional and three-dimensional shapes based on their attributes.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Make meaning of a problem and use prior knowledge as an entry point to begin, plan, and choose a solution pathway including acting out, making a model, or using reasoning strategies. Look for another solution strategy when the solution approach tried does not make sense or does not result in a reasonable answer. Make sense of the world by comparing and ordering objects by their attributes. Use concrete objects or pictures to show the actions or relationships in a problem such as counting, joining, separating, and comparing sets. Connect these actions to the meanings of the operations.
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse and actions to explain reasoning and select multiple representations that are helpful to explore, model, and deepen understanding of mathematical concepts. Draw pictures, construct models, share verbal mathematical reasoning, and include numerals to represent quantities and equations in a variety of formats, compare whole numbers, and use shapes and spatial reasoning to model and explore geometric objects in their environments.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying counting and use the equal sign consistently and appropriately with real-world contexts. Explain how the number reached when counting on is a relationship between the quantity started from and the quantity added. Use precise language to describe why one quantity is fewer than, is more than, or is equal to (the same as) another and sort three-dimensional solid objects and two-dimensional shapes by different attributes (such as size or number of sides) and describe the attributes, using precise mathematical language.
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Listen to or read the explanations and logical arguments of others, decide whether they make sense, and ask questions to clarify or revise the arguments. Construct arguments using objects, drawings, diagrams, and actions. Make sense of correct solutions, even though solutions are not generalized or made formal. Investigate questions, gather, display, and/or identify similarities and differences in categorical data.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects (including multi-digit numbers and shapes) and situations as being composed of multiple parts. Apply counting on, counting back, skip counting, and simple grouping strategies to combine or partition whole numbers. Continue shape patterns and number patterns based on ones, twos, fives, and tens.

Data, Probability, and Statistical Reasoning

K.DPSR.1. Collect and organize data and communicate through multiple representations.

Indicator	***Indicator Insight***
K.DPSR.1.1 Sort pictures or objects into at least two categories. Count to determine how many are in each category. Limit to 20 pictures or objects.	Provide opportunities to sort data given the categories. In addition, classify data by having students create categories and describe how the items in each category were sorted. Categories may include shape, color, size, or type (animals, food, etc.). Identify any objects that do not belong to a particular group and explain the reasoning used.
K.DPSR.1.2 Answer questions about data organized in a t-chart, object graph, or picture graph.	Data is collected and organized by the teacher. Real objects, such as teddy bear counters, should be used when creating an object graph. Students are not expected to organize the data. Ask questions that require students to count the quantity in each category or compare the quantities.

Measurement, Geometry, and Spatial Reasoning

K.MGSR.1. Identify units of currency and compare the length or height of objects.

Indicator	***Indicator Insight***
K.MGSR.1.1 Identify a penny, nickel, dime, and quarter.	Focus on the identification from visual characteristics. Mention the values to prepare for future experience with money but do not assess students on it.
K.MGSR.1.2 Directly compare two objects using words including *shorter, longer, taller, lighter, and heavier*.	Students are introduced to attributes that can be measured. Provide opportunities for students to explore and discuss these attributes.

K.MGSR.2. Analyze and describe shapes to make sense of their relationships in mathematical and real-world situations.

Indicator	*Indicator Insight*
K.MGSR.2.1 Identify and describe the attributes of triangles, squares, rectangles, circles, cubes, and spheres to include everyday situations.	The teacher should use correct mathematical vocabulary when describing the attributes of triangles, squares, rectangles, and circles. Show several types of triangles, not just equilateral. Show shapes in different orientations. Provide students with experiences to draw or make two-dimensional shapes and discuss the attributes.
K.MGSR.2.2 Describe relative positions of objects by appropriately using terms including *below, above, beside, between, inside, outside, in front of, or behind*.	Have students manipulate the objects in different ways to describe the objects' position.

Numerical Reasoning

K.NR.1. Represent multi-digit numbers in a variety of ways to build the foundation for place value understanding.

Indicator	*Indicator Insight*
K.NR.1.1 Read, write, and represent the numerals 0 to 20 and represent the written numeral with concrete models.	Think of the term "written numeral" as standard form. Prior to students being able to write the numeral, they could match a numeral card to the quantity.
K.NR.1.2 Compose and decompose numbers from 11-19 into tens and ones by using concrete objects, pictorial models, or drawings to demonstrate understanding that the teen numbers are composed of one set of ten ones and a few more ones.	Exploration of considering ten as a unit in place value is further developed in first grade. Base ten blocks should not be used. Instead, students may use ten frames, linking cubes, and math racks.

K.NR.2. Demonstrate and explain the relationship between numbers and quantities.

Indicator	*Indicator Insight*
K.NR.2.1 Count forward by ones and tens to 100 and backward from 10 by ones.	This is rote counting. Counting forward is a foundational skill for addition, and counting backward is a foundational skill for subtraction. Count forward by ones beginning from any number less than 100, making accurate decade transitions.

Indicator	Indicator Insight
K.NR.2.2 Subitize a quantity of up to 10 objects in an organized arrangement without counting, explaining how one grouped the objects within the set to determine the total quantity.	Conceptual subitizing is foundational for composing and decomposing as well as part-part-whole. Organized arrangements might include five frames, ten frames, math racks, and dot images.
K.NR.2.3 Given a group of up to 20 objects, count the number of objects in that group and represent the number of objects with a written numeral. State the number of objects in a rearrangement of that group without recounting.	Counting should be done using one-to-one correspondence, matching number names to individual items (rational counting). Provide opportunities to explain the number of objects is the same regardless of their arrangement, if they are moved around, or the order in which they are counted changes (conservation of number)
K.NR.2.4 Given a number from 0 to 20, count out that many objects.	Instruction includes giving a number verbally or with a written numeral. Provide students with more objects than the number you are asking them to count out. For example, give the student 20 objects and ask them to count out 12.

K.NR.3. Demonstrate the ability to compare quantities of objects and numerals representing quantities of objects.

Indicator	*Indicator Insight*
K.NR.3.1 Compare up to 10 objects in one set to another set of up to 10 objects using the phrases *more than, fewer than, or the same as.*	Use one-to-one matching and counting strategies with concrete objects, pictorial representations, or number paths. They may be able to visually see which set is more than, fewer than, or the same as. Generally, "fewer than" and "more than" are used with countable nouns, such as teddy bear counters. Example: There are more red teddy bear counters. There are fewer yellow teddy bear counters.

Patterns, Algebra, and Functional Reasoning

K.PAFR.1 Develop an understanding of addition and subtraction operations with one-digit whole numbers and represent and solve addition problems with sums between 0 and 10 and subtraction problems using related facts.

Indicator	*Indicator Insight*
K.PAFR.1.1 Add and subtract number combinations within 5.	Use visuals and concrete models, and five frames to help provide structure for students.

Indicator	*Indicator Insight*
K.PAFR.1.2 Create a sum of 10 using objects and drawings when given one of two addends 0-9, to include real-world situations.	Teachers may record the equation to expose students to the concept for future learning but should not assess the writing of the equation.
K.PAFR.1.3 Compose and decompose numbers up to 10 in different ways. Record using objects or drawings.	Use objects, linking cubes, ten frames, math racks, and drawings. Teachers may record the equation to expose students to the concept for future learning, but the expectation is not that students write the equation. The sum or difference can be represented on either side of the equal sign.
K.PAFR.1.4 Solve add-to/joining, take-from/separating, part-part-whole (total unknown), part-part-whole (both addends unknown) in real-world situations to find sums and differences within 10.	Situations should be modeled using concrete objects, ten frames, fingers, math racks, number paths, acting out, drawings, mental images, or verbal explanations. Teachers may record the equation to expose students, but the expectation is not that the student writes the equation.

K.PAFR.2. Recognize, describe, extend, and create patterns.

Indicator	*Indicator Insight*
K.PAFR.2.1 Describe, extend, and create (to the next term) simple repeating patterns in the form of AB, AAB, ABB, and ABC.	Letter patterns are only for teacher use to strategically represent a variety of patterns with students. Provide opportunities to name the objects in patterns using concrete objects and drawings.

First Grade Math Standards

The standards are designed to provide students with knowledge and skills to solve problems using critically important skills for college and career readiness. The focus in first grade is concentrated within the strands of Numerical Reasoning; Patterns, Algebra, and Functional Reasoning; Data, Probability, and Statistical Reasoning; and Measurement, Geometry, and Spatial Reasoning.

For Numerical Reasoning, a major emphasis is given to building number sense and place value understanding for numbers zero to 100. Students will continue to count, combining items into groups of ten to demonstrate place value structure. Additionally, students will use various representations to compare two numbers. Opportunities should be given to use concrete objects, drawings, and equations to demonstrate that whole numbers can be composed and decomposed in a variety of ways. Experiences should be given to allow students to partition shapes into equal parts as a building block for fractional understanding.

For Patterns, Algebra, and Functional Reasoning, first graders will use multiple representations to reason and solve problems involving addition and subtraction. Students will use a variety of strategies for addition and subtraction within 100. A major focus for students in first grade will include understanding the equal sign and building a strong conceptual foundation for addition and subtraction by exploring the relationship between these operations. Multiple opportunities with concrete and pictorial models should be embedded in this strand and students should be able to apply the concepts to mathematical and real-world situations. In this grade, students will also use reasoning to create, describe, and extend patterns.

For Data, Probability, and Statistical Reasoning, students will create an investigative question, for which they will then collect data. Students will then sort, analyze, and communicate this data through various charts and graphs.

For Measurement, Geometry, and Spatial Reasoning, first graders will identify coins and bills by name and value. Additionally, students will count collections of like coins not to exceed a dollar. Students will begin telling time to the hour on analog and digital clocks. Students will also identify, describe, classify, construct, compare, and analyze two-dimensional and three-dimensional shapes based on their attributes.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Make meaning of a problem and use prior knowledge as an entry point to begin, plan, and choose a solution pathway including acting out, making a model, or using reasoning strategies. Look for another solution strategy when the solution approach tried does not make sense or does not result in a reasonable answer. Make sense of the world by comparing and ordering objects by their attributes. Use concrete objects or pictures to show the actions or relationships in a problem such as counting, joining, separating, and comparing sets. Connect these actions to the meanings of the operations.
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse and actions to explain reasoning and select multiple representations that are helpful to explore, model, and deepen understanding of mathematical concepts. Draw pictures, construct models, share verbal mathematical reasoning, and include numerals to represent quantities and equations in a variety of formats, compare whole numbers, and use shapes and spatial reasoning to model and explore geometric objects in their environments.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying counting and use the equal sign consistently and appropriately with real-world contexts. Explain how the number reached when counting on is a relationship between the quantity started from and the quantity added. Use precise language to describe why one quantity is fewer than, is more than, or is equal to (the same as) another and sort three-dimensional solid objects and two-dimensional shapes by different attributes (such as size or number of sides) and describe the attributes, using precise mathematical language.
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Listen to or read the explanations and logical arguments of others, decide whether they make sense, and ask questions to clarify or revise the arguments. Construct arguments using objects, drawings, diagrams, and actions. Make sense of correct solutions, even though solutions are not generalized or made formal. Investigate questions, gather, display, and/or identify similarities and differences in categorical data.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects (including multi-digit numbers and shapes) and situations as being composed of multiple parts. Apply counting on, counting back, skip counting, and simple grouping strategies to combine or partition whole numbers. Continue shape patterns and number patterns based on ones, twos, fives, and tens.

Data, Probability, and Statistical Reasoning

1.DPSR.1. Create and answer survey questions, collect and analyze data, and communicate through multiple representations.

Indicator	*Indicator Insight*
1.DPSR.1.1 Sort pictures or objects into at least three categories (not to exceed ten items in each category).	Provide opportunities to sort pictures or objects into given categories. In addition, students should classify by creating their own categories.
1.DPSR.1.2 Create a survey question and collect data with up to three categories. Create tally charts, object graphs, and picture graphs with a single-unit scale to display the data. Use the graph to answer questions and draw conclusions. Limit to one-step add-to, take-from, and part-part-whole questions.	Provide opportunities to create a survey question, then decide what data to collect, and from whom to collect it. Answer the following questions: Who? What? When? Where? Why? How? Tally charts, object graphs, and picture graphs are appropriate for first grade. Provide experiences with both horizontal and vertical graphs.

Measurement, Geometry, and Spatial Reasoning

1.MGSR.1. Describe, estimate, measure, and compare objects in real-world situations using units of length, weight, money, and time.

Indicator	*Indicator Insight*
1.MGSR.1.1 Order three objects by length from shortest to longest and longest to shortest using direct comparison.	Use actual objects that can be aligned with a common starting point to compare.
1.MGSR.1.2 Use nonstandard physical objects to estimate and then measure the length of an item as the number of same size units of length with no gaps or overlaps.	Prior to measuring with nonstandard objects, have students make an estimate. Nonstandard units can include paper clips, popsicle sticks, pencils, etc.
1.MGSR.1.3 Use analog and digital clocks to tell and record time to the hour and half hour.	Teachers can begin to note and record AM and PM; however, this is not an expectation. Additionally, teachers can connect the idea of half of a circle to half an hour.
1.MGSR.1.4 Identify and write the values of a coin or a bill using a ¢ symbol for coin values or $ symbol for bills. Limited to penny, nickel, dime, quarter, one dollar bill, five-dollar bill, and ten-dollar bill.	Identify how different coins' values relate to each other.
1.MGSR.1.5 Count a collection of like coins to determine the total value of the set. Limit to pennies, nickels, and dimes with values not to exceed a dollar.	Relate to patterns of counting by ones, fives, and tens.

1.MGSR.2. Analyze, describe, and manipulate shapes to make sense of their relationships in mathematical and real-world situations.

Indicator	***Indicator Insight***
1.MGSR.2.1 Sort a mixed set of polygons and describe the reasoning used while sorting the polygons.	The intent is not for students to sort into a group of regular polygons and a second group of irregular polygons. The intent is to expose students to a wide variety of regular and irregular polygons of assorted sizes and orientations rather than just prototypical regular polygons. Provide opportunities for students to describe how they used one of more common attributes to group each set of shapes.
1.MGSR.2.2 Identify and describe the attributes of two-dimensional shapes and three-dimensional shapes. Limit to triangle, square, rectangle, rhombus, hexagon, circle, cone, cube, cylinder, square pyramid, and sphere.	Describe the attributes of the shape prior to providing the name. The teacher should use correct mathematical vocabulary, including *sides/edges, faces, flat, straight, and corners/vertex/vertices,* when describing the attributes. Provide opportunities to draw or make the shapes.
1.MGSR.2.3 Identify and describe a given shape in everyday situations to include two-dimensional shapes and three-dimensional shapes. Limit to triangle, square, rectangle, rhombus, hexagon, circle, cone, cube, cylinder, square pyramid, and sphere.	Reinforce mathematical language. For example: Use cube rather than box and sphere rather than ball, knowing that a representation of each in the real-world could be a box or a ball. Analyze and compare a pair of two-dimensional shapes or a pair of three-dimensional shapes of assorted sizes and orientations using formal mathematical language. Provide opportunities to compare a pair of shapes, using terms such as *sides/edges, faces, flat, straight, and corners/vertex/vertices*.
1.MGSR.2.4 Classify shapes as two-dimensional/flat or three-dimensional/solid and explain the reasoning using formal mathematical language. Limit to triangle, square, rectangle, rhombus, hexagon, circle, cone, cube, cylinder, square pyramid, and sphere.	The intent of this indicator is to have students articulate the reasoning behind the classification of a figure as two-dimensional or three-dimensional.

Indicator	*Indicator Insight*
1.MGSR.2.5 Analyze and compare a pair of two-dimensional shapes or a pair of three-dimensional shapes of assorted sizes and orientations using formal mathematical language. Limit to triangle, square, rectangle, rhombus, hexagon, circle, cone, cube, cylinder, square pyramid, and sphere.	Provide opportunities to compare a pair of shapes, using terms such as *sides/edges, faces, flat, straight, and corners/vertex/vertices*.

Numerical Reasoning

1.NR.1. Represent multi-digit numbers in a variety of ways to build place value understanding.

Indicator	*Indicator Insight*
1.NR.1.1 Read, write, and represent numbers to 100 using concrete models, drawings, standard form, base ten language, and equations in expanded form.	Base ten language refers to identifying the number of tens and ones in a numeral. For example: 6 tens 3 ones. Base ten blocks should not be used at this level due to their inability to be broken apart into individual units.
1.NR.1.2 Represent and explain that whole numbers 1 through 99 are organized into groups of tens and ones, and a digit has a different value depending on its placement.	Provide experiences using concrete materials, such as popsicle sticks, straws, etc. to make a bundle of ten. Given a collection of objects, students can count the objects and group them by tens.
1.NR.1.3 Compose and decompose whole numbers from 1 through 99 in more than one way using tens and ones. Explain and demonstrate each composition or decomposition with the use of concrete models, drawings, and/or equations.	The focus of this indicator is on developing place value concepts. This indicator serves as a prerequisite for regrouping when adding and subtracting with two-digit numbers. Base ten blocks should not be used at this level due to their inability to be broken apart into individual units. Instead, provide experiences bundling and unbundling groups of ten objects to compose and decompose numbers in multiple ways. Objects such as coffee stirrers, straws, popsicle sticks, etc. could be used.
1.NR.1.4 Apply place value reasoning to identify the number that is one more and one less, ten more, and ten less than a given number with up to two digits.	Hundred charts to include the bottom-up chart, 100-bead math racks, and connecting cubes can be used to develop conceptual understanding. It is important for mathematicians to discover the pattern on a hundred chart by using concrete models and connecting to the chart.

1.NR.2. Represent partitioned shapes in multiple ways using part-whole relationships.

Indicator	***Indicator Insight***
1.NR.2.1 Partition in multiple ways squares, rectangles, and circles into two or four equal-sized parts. Name the pieces as halves and fourths.	This indicator is foundational for fraction work in third grade. It is imperative that students look at equal-sized parts. Do not use "quarters" to name the pieces.

1.NR.3. Explain the relationship between numbers and quantities.

Indicator	***Indicator Insight***
1.NR.3.1 Count by ones forward or backward starting at any number up to 120 making accurate decade transitions.	Make connections between counting on and counting back. When doing choral counting, the teacher could also record the count for students so that they can look for and describe patterns.
1.NR.3.2 Skip count by fives and tens from any multiple of five to 100, identifying place value patterns in the sequence.	Record counts on the board, chart paper, hundred chart, etc. Have students identify the patterns that they notice.

1.NR.4. Demonstrate the ability to compare quantities of objects and numerals representing quantities of objects.

Indicator	***Indicator Insight***
1.NR.4.1 Compare representations of two numbers up to 100 using the phrases *is greater than, is less than, or is equal to (the same value as)*.	It is especially important to use mathematical phrases with students. Teach reading the number sentence from left to right. Use concrete objects or pictorial representations to compare sets prior to comparing just numerals. A number path or hundred chart can also be used to locate and compare numbers. Representations can include concrete models, drawings, number lines or number paths, hundred charts, and different number forms (standard, base ten, or expanded form).

Patterns, Algebra, and Functional Reasoning

1.PAFR.1. Understand and apply properties of operations and the relationship between addition and subtraction to solve problems.

Indicator	***Indicator Insight***
1.PAFR.1.1 Determine and explain if an equation within 10 is true using a variety of equation formats.	Encourage the use of concrete objects or drawings while students are explaining whether the equation is true or balanced. It is especially important to develop an understanding of the meaning of the equal sign. Provide opportunities to see equations formatted in a variety of ways. This includes equations with the addends to the left of the equal sign, the right of the equal sign, and two addition and/or subtraction sentences on both sides of the equal sign. Both sides of the equal sign may contain two addends. The = symbol should be read as "has the same value as" or "is equal to."
1.PAFR.1.2 Compose and decompose numbers less than or equal to 20 in more than one way. Record each composition or decomposition as an equation.	Initially, visuals, concrete objects, or drawings should be used as a tool for conceptual understanding. Eventually, students should be able to mentally compose and decompose flexibly. For example, 13 can be decomposed as $13 = 7 + 6$ or as $13 = 8 + 5$.
1.PAFR.1.3 Solve add-to, take-from, and part-part-whole real-world situations to find sums and differences within 20. Situations should include result or change unknown, both addends unknown, and total or one part unknown.	Use Numberless Word Problems and ask students to justify why they are using a certain operation. Use concrete objects or drawings. Write the equations that go with each problem, with students writing them when they can do so. Provide opportunities for students to create their own real-world situation to represent a given equation or expression involving addition and subtraction within 20.
1.PAFR.1.4 Add and subtract number combinations flexibly and accurately within 10.	Provide opportunities to think flexibly to add and subtract. Fluency can be described as knowing how a number can be composed and decomposed to solve problems accurately, efficiently, and flexibly.

Indicator	*Indicator Insight*
1.PAFR.1.5 Apply and explain the *Commutative Property of Addition* to find the sum (through 20) of two addends and explain that the value does not change when the order of the two numbers changes.	Provide opportunities for students to use concrete manipulatives. Encourage students to explain what they notice to enable their discoveries. The expectation is to apply the property, not to name the property; however, use the term *Commutative Property* so that students are used to hearing it and begin to use it on their own.
1.PAFR.1.6 Determine an unknown number in addition and subtraction equations within 10.	Representations should include using concrete objects, models, and/or drawings. Mental math, such as think addition, could also be a strategy.

1.PAFR.2. Represent and solve multi-digit addition and subtraction problems using additive reasoning.

Indicator	*Indicator Insight*
1.PAFR.2.1 Find the sum of a two-digit number and a one-digit number or a two-digit number and a multiple of 10 (1-99) using concrete models, drawing and strategies that reflect place value understanding, the inverse relationship of addition and subtraction, and the properties of the operations to justify the sum.	Justification strategies should include the use of concrete models, drawings, and oral explanations. Students do not need to know the names of the properties of operations but should be able to apply them when needed.
1.PAFR.2.2 Find the difference between two numbers that are multiples of 10 both in the range 10 to 90 and write the corresponding equation. Explain the reasoning used.	Include concrete models, drawings, or reasoning strategies based on place value.

1.PAFR.3. Recognize, describe, extend, and create patterns.

Indicator	*Indicator Insight*
1.PAFR.3.1 Create, describe, and extend (to the next term) a growing shape pattern.	Use concrete objects or drawings, not numbers or letters. The shape pattern can include concrete objects or drawings, but not numbers. Students will need practice with describing and extending given shape patterns before they are asked to create their own.

Indicator	***Indicator Insight***
1.PAFR.3.2 Create, describe, and extend (to three terms within a sequence) repeating patterns using *AB, AAB, ABB, and ABC* type patterns.	Use concrete objects or drawings. Letter patterns are only for teacher use to strategically represent a variety of patterns with students. Name the objects in patterns using concrete objects and drawings. Teachers might consider using ordinal numbers to describe the elements. Provide practice with describing and extending given patterns before they are asked to create their own.

Second Grade Math Standards

The standards are designed to provide students with knowledge and skills to solve problems using critically important skills for college and career readiness. The focus in Second Grade is concentrated within the strands of Numerical Reasoning; Patterns, Algebra, and Functional Reasoning; Data, Probability, and Statistical Reasoning; and Measurement, Geometry, and Spatial Reasoning.

For Numerical Reasoning, a major emphasis is given to building number sense and place value understanding for numbers zero to 999. Students will continue to count to combine items into groups of ten or 100 to demonstrate place value structure. Additionally, students will use various representations to compare two numbers. Opportunities should be given to use concrete objects, drawings, and equations to demonstrate that whole numbers can be composed and decomposed in a variety of ways. Experiences should be given to allow students to use multiple ways to partition shapes into halves and fourths as a building block for fractional understanding. As a precursor to rounding, when given a two-digit number, students should identify to which multiple of ten the number is closer.

For Patterns, Algebra, and Functional Reasoning, second graders will use multiple representations to reason and solve problems involving addition and subtraction. Students will use a variety of strategies for addition and subtraction within 999. A major focus for students in second grade will include understanding the equal sign and building a strong conceptual foundation of addition and subtraction by exploring the relationship between these operations. Multiple opportunities with concrete and pictorial models should be embedded in this strand and students should be able to apply the concepts to mathematical and real-world situations. Students will begin using arrays as an early connection between addition and multiplication. In this grade, students will also use reasoning to recognize, describe, extend, and create patterns.

For Data, Probability, and Statistical Reasoning, students will create an investigative question for which they will then collect data. Students will then sort, analyze, communicate, and represent this data through various charts and graphs.

For Measurement, Geometry, and Spatial Reasoning second graders will identify and write the values of coins and bills. Additionally, students will count collections of mixed coins not to exceed one dollar while collections of mixed bills should also be counted with the total value not to exceed 100 dollars. Students will use analog and digital clocks to tell and record time in five-minute intervals. In addition, second graders will experiment with the length of objects using appropriate tools. Students will also identify, describe, classify, construct, compare, and analyze two-dimensional and three-dimensional shapes based on their attributes.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Make meaning of a problem and use prior knowledge as an entry point to begin, plan, and choose a solution pathway including acting out, making a model, or using reasoning strategies. Look for another solution strategy when the solution approach tried does not make sense or does not result in a reasonable answer. Make sense of the world by comparing and ordering objects by their attributes. Use concrete objects or pictures to show the actions or relationships in a problem such as counting, joining, separating, and comparing sets. Connect these actions to the meanings of the operations.
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse and actions to explain reasoning and select multiple representations that are helpful to explore, model, and deepen understanding of mathematical concepts. Draw pictures, construct models, share verbal mathematical reasoning, and include numerals to represent quantities and equations in a variety of formats, compare whole numbers, and use shapes and spatial reasoning to model and explore geometric objects in their environments.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying counting and use the equal sign consistently and appropriately with real-world contexts. Explain how the number reached when counting on is a relationship between the quantity started from and the quantity added. Use precise language to describe why one quantity is fewer than, is more than, or is equal to (the same as) another and sort three-dimensional solid objects and two-dimensional shapes by different attributes (such as size or number of sides) and describe the attributes, using precise mathematical language.
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Listen to or read the explanations and logical arguments of others, decide whether they make sense, and ask questions to clarify or revise the arguments. Construct arguments using objects, drawings, diagrams, and actions. Make sense of correct solutions, even though solutions are not generalized or made formal. Investigate questions, gather, display, and/or identify similarities and differences in categorical data.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects (including multi-digit numbers and shapes) and situations as being composed of multiple parts. Apply counting on, counting back, skip counting, and simple grouping strategies to combine or partition whole numbers. Continue shape patterns and number patterns based on ones, twos, fives, and tens.

Data, Probability, and Statistical Reasoning

2.DPSR.1. Create and answer survey questions, collect and analyze data, and communicate through multiple representations.

Indicator	***Indicator Insight***
2.DPSR.1.1 Create a survey question and collect data with up to four categories. Create tally charts, picture graphs, dot plots, and bar graphs with a single-unit scale to read the graph, answer questions, and draw conclusions. Limit to one-step add-to, take-from, part-part-whole, and comparison questions.	Provide opportunities to create a survey question, then decide what data to collect, and from whom to collect it. Answer the following questions: Who? What? When? Where? Why? How? Provide experiences with both horizontal and vertical graphs. Compare different data collected in the categories. Categories are identified by names or descriptions and amounts are numerical. Appropriate questions should not ask students to add or subtract data from more than two categories.

Measurement, Geometry, and Spatial Reasoning

2.MGSR.1. Describe, estimate, measure, and compare objects in real-world situations using units of length, weight, currency, and time.

Indicator	***Indicator Insight***
2.MGSR.1.1 Select and use appropriate tools to estimate and measure length of an object or distance to the nearest customary unit. Limit to inches, feet, and yards.	Explore length as an attribute of an object found by locating two endpoints and finding how far it is between those two points. Talk about how to use a ruler. Link rulers to number lines (continuous units).
2.MGSR.1.2 Use analog and digital clocks to tell and record time in five-minute intervals, identifying AM and PM.	Point out that the numbers on a clock are made of two different circular number lines, one going from 1 to 12 and the other going from 0 to 60.
2.MGSR.1.3 Determine the value of mixed sets of coins or bills in mathematical and real-world situations and record the value using a ¢ or $ symbol. Limit to pennies, nickels, dimes, and quarters up to a dollar; one-dollar bills, five-dollar bills, ten-dollar bills, and twenty-dollar bills up to $100, and add-to or take-from problem types.	Coins and bills are not counted together in this indicator.

2.MGSR.2. Analyze, describe, and manipulate shapes to make sense of their relationships in mathematical and real-world situations.

Indicator	*Indicator Insight*
2.MGSR.2.1 Identify and describe a given shape in everyday situations to include two-dimensional shapes and three-dimensional shapes. Limit to triangle, quadrilateral, pentagon, hexagon, octagon, circle, cone, cube, cylinder, rectangular prism, square pyramid, and sphere.	Reinforce mathematical language. For example: use cube rather than box and sphere rather than ball, knowing that a representation of each in the real-world could be a box or a ball. Provide opportunities to explore the faces and the shape of each face.
2.MGSR.2.2 Classify shapes as polygons or non-polygons and defend that determination based on their attributes.	Provide experiences with a variety of straight-edged and curved and closed and open two-dimensional figures. Defining attributes include the number of sides and vertices.
2.MGSR.2.3 Classify two-dimensional shapes as triangles or quadrilaterals and justify each classification.	Students need to see and classify a wide variety of triangles and quadrilaterals, not just the standard triangles and quadrilaterals, as well as a variety of orientations.

Numerical Reasoning

2.NR.1. Represent multi-digit numbers in a variety of ways to build place value understanding.

Indicator	*Indicator Insight*
2.NR.1.1 Read, write, and represent numbers up to 999 using concrete models, drawings, standard form, base ten language, and equations in expanded form.	Represent numbers with proportional materials such as base ten blocks, sketches, or numerical notation. Provide experiences with placing numbers on an open number line. Base ten language refers to identifying the number of hundreds, tens, and ones in a numeral. For example: 4 hundreds 9 tens 6 ones.
2.NR.1.2 Represent and explain that whole numbers 1 through 999 are organized into groups of hundreds, tens, and ones, and a digit has a different value depending on its placement.	The focus of this indicator is on developing place value concepts. Provide experiences with concrete materials, such as base ten blocks, popsicle sticks, straws, etc. to represent the value of each digit and show that 100 is a bundle of 10 tens and 1 ten is a bundle of 10 ones. Given a collection of objects, students can count the objects and group them by hundreds, tens, and ones.

Indicator	*Indicator Insight*
2.NR.1.3 Compose and decompose whole numbers from 1 through 999 in more than one way using hundreds, tens, and ones. Explain and demonstrate each composition or decomposition with the use of concrete models, drawings, and equations.	The focus of this indicator is on place value. This indicator serves as a prerequisite for regrouping when adding and subtracting with three-digit numbers. Provide experiences with bundling and unbundling groups of objects, including but not limited to popsicle sticks, straws, etc.
2.NR.1.4 Apply place value reasoning to identify the number that is 10 more, 10 less, 100 more, and 100 less than a given three-digit number through 999.	Students need experience with concrete models and drawings before moving to the abstract. Ask students what patterns they notice in the place values as they are adding or subtracting tens and hundreds.

2.NR.2. Represent and compare partitioned shapes in multiple ways using part-whole relationships.

Indicator	*Indicator Insight*
2.NR.2.1 Partition in multiple ways squares, rectangles, and circles into two or four equal-sized parts, and describe the parts using the words *halves, fourths, a half of, and a fourth of (not quarters).*	This indicator is foundational for fraction work in third grade. Although students are not expected to use formal fraction notation, expose students to fraction notation. When writing fractions, they should be written with a horizontal bar (vinculum), not slanted. The expectation is not that students write the fraction. Name the whole as two halves, or four fourths.
2.NR.2.2 Explain that when partitioning a square, rectangle, or circle into two or four equal parts, the parts become smaller as the number of parts increases.	This indicator is foundational for fraction work in third grade.

2.NR.3. Explain the relationship between numbers and quantities.

Indicator	*Indicator Insight*
2.NR.3.1 Count forward and backward by ones, tens, and hundreds from any number within 999 and identify patterns in the sequence.	Provide counting experiences on a regular basis When doing choral counting, the teacher should also record the count for students so that they can look for and describe patterns.

2.NR.4. Demonstrate the ability to compare quantities of objects and numerals representing quantities of objects.

Indicator	***Indicator Insight***
2.NR.4.1 Compare representations of whole numbers up to 999 and write a comparison statement using words and symbols. Limit to *is equal to (=), is less than (<),* and/or *is greater than (>).*	It is especially important to use mathematical phrases with students and to make sure that students can read the symbols correctly. Representations can include concrete models, drawings, number lines, and different number forms (standard, base ten, or expanded form). Locate whole numbers on a number line to compare them. Expose students to both vertical and horizontal number lines. Emphasize the understanding that numbers to the right or above a number on a number line are greater and numbers to the left or below are less.
2.NR.4.2 When given a two-digit number, identify to which multiple of ten the number is closest.	Use number lines and concrete base ten models. Second grade transitions from a number path to the use of a number line. If the number has a 5 in the one's place, the accepted convention of going to the higher multiple of 10 should be shared. This is a precursor to rounding.

Patterns, Algebra, and Functional Reasoning

2.PAFR.1. Represent and solve multi-digit addition and subtraction problems using additive reasoning.

Indicator	***Indicator Insight***
2.PAFR.1.1 Use a strategy to accurately find sums and differences of two-digit numbers within 100 and justify the sum or difference.	Provide opportunities to select a strategy to calculate. Use concrete base ten materials, number lines, drawings, place value understanding, and properties of the operations. This indicator is about building conceptual understanding, not about practicing a standard algorithm.

2.PAFR.2. Understand and apply properties of operations and the relationship between addition and subtraction to solve problems.

Indicator	*Indicator Insight*
2.PAFR.2.1 Determine and explain if an equation (within 20) is true using a variety of equation formats.	Apply understanding of the equal sign as a symbol of equality. Recognize that the solution (sum or difference) can be located on either side of the equal sign. For example, equations can be formatted in the following ways: 6 = 2 + 4 3 + 3 = 1 + 5 9 - 3 = 6 6 = 6
2.PAFR.2.2 Solve one-step add-to, take-from, part-part-whole, and additive comparison real-world situations through 99 with the unknown in any position.	Students may use concrete models, drawings, verbal explanations, expressions, and equations. Provide opportunities for students to create their own real-world situation to represent a given equation or expression involving addition and subtraction through 99. Provide contexts that include measurement situations with inches, feet, and yards.
2.PAFR.2.3 For any number from 0 to 99, find the number that makes 100 when added to the given number.	Find and record the answer using concrete materials, a number line, drawing, or equation. Concrete materials could include items such as 100-bead math racks, connecting cubes, base ten blocks, and ten frames,
2.PAFR.2.4 Add and subtract number combinations flexibly and accurately within 20.	Provide opportunities to think flexibly to add and subtract. Fluency can be described as knowing how a number can be composed and decomposed to solve problems accurately, efficiently, and flexibly. Provide experiences with concrete models, such as ten frames, double ten frames, and math racks, and visuals. This is necessary for students to develop derived facts (doubles plus one, make ten, etc.).

Indicator	*Indicator Insight*
2.PAFR.2.5 Apply the *Associative Property of Addition* to find the sum (through 20) of three addends and explain that the value can be found using various grouping strategies.	During this first exposure to the *Associative Property*, the intent is for students to see that numbers can be decomposed and then recomposed to help make addition more efficient and flexible. For example, if given the numbers 4, 7, and 3 a student could combine the 7 and 3 to first make a ten or combine the 4 and 3 to help make doubles. The expectation is to apply the property, not to name the property or use parentheses; however, the teacher should use the term *Associative Property* so that students are used to hearing it.
2.PAFR.2.6 Determine the unknown number in addition and subtraction equations within 20, with the unknown in any position.	Representations should include using concrete objects, models, or drawings. Unknowns should be represented by an empty box or a question mark, not a blank space. Students may restate a subtraction problem as a missing addend problem (think addition) using the inverse relationship between addition and subtraction.
2.PAFR.2.7 Sort a collection of 20 or fewer objects into two groups to determine if the number of objects is even or odd.	Students may use a pairing strategy to identify whether a number is odd or even.
2.PAFR.2.8 Find the total number of objects arranged in equal groups or in a rectangular array and write an addition equation to express the total as a sum (up to 25) of equal addends.	Repeated addition is an early connection between addition and multiplication but should not be focused on as a solution strategy for multiplication problems. Instead, the focus should be on equal groups or rows and columns.

2.PAFR.3. Recognize, describe, extend, and create patterns.

Indicator	*Indicator Insight*
2.PAFR.3.1 Describe, extend, and create a growing shape pattern with up to three terms within a sequence.	The shape pattern can include concrete objects or drawings, but not numbers. Provide practice with describing and extending given shape patterns before they are asked to create their own.
2.PAFR.3.2 Create, describe, and extend an appropriate one-step rule for number patterns using addition and subtraction within 100.	Provide practice with describing and extending given number patterns before they are asked to create their own.

Third Grade Math Standards

The standards are designed to provide students with knowledge and skills to solve problems using critically important skills for college and career readiness. The focus in third grade is concentrated within the strands of Numerical Reasoning; Patterns, Algebra, and Functional Reasoning; Data, Probability, and Statistical Reasoning; and Measurement, Geometric and Spatial Reasoning.

For Numerical Reasoning, this grade will continue to represent and compare whole numbers using relationships within the base ten number system. A major focus for students in third grade will include building a strong conceptual foundation of fractions. They will represent and compare fractions based upon part-whole relationships using concrete, area, and linear models.

For Patterns, Algebra, and Functional Reasoning, third grade will use multiple representations to reason and solve problems involving operational properties of whole numbers. Students will continue using a variety of strategies for addition and subtraction which have been previously introduced in earlier grades. A major focus for students in third grade will include building a strong conceptual foundation of multiplication and division by exploring the relationship between these operations. The extension of knowledge will lead to the ability to solve multi-digit problems in fourth and fifth grades. Multiple opportunities with concrete and pictorial models should be embedded in this strand and students should be able to apply the concepts to mathematical and real-world situations. In third grade, students will use reasoning to represent and solve algebraic and numerical situations involving unknowns and patterns.

For Data, Probability, and Statistical Reasoning, third graders will collect and analyze data and communicate through various tables, charts, and graphs. In this grade, students extend their analysis from content in second grade to scaled graphs. Probability is introduced for the first time as students will represent the likelihood of a simple event occurring. This understanding will extend in fourth and fifth grades as students collect data from a probability experiment and record it as fractions.

For Measurement, Geometry, and Spatial Reasoning, third grade will solve area and perimeter problems in real-world and mathematical situations. This is the first time students will be introduced to area and perimeter in addition to distinguishing when to use these measurements in real-world situations. A focus should include connecting area and multiplication. When determining the area, students will use squares and rectangles. When determining perimeter, students will use triangles and quadrilaterals. Students will measure customary and metric units of length. In previous grades, students have been telling time and this learning will now focus on third grade students determining elapsed time to the half hour and using analog and digital clocks to tell and record time in one-minute intervals. In third grade, students will continue to determine the value of collections of money greater than $1 using coins and bills with the amount now recorded using decimal notation.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Make meaning of a problem and use prior knowledge as an entry point to begin, plan, and choose a solution pathway. Look for another solution strategy when the solution approach tried does not make sense or does not result in a reasonable answer. Use concrete objects, pictures, or equations to explain conjectures and solve problems. Compare strategies to understand different approaches to solve relevant problems that involve multiple steps using operations with rational numbers. Use mathematical modeling to represent, analyze, and make predictions using data.
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in mathematical discourse to justify a conjecture. Be specific with explanations by using objects, pictures, and symbols when describing the relationship between the operations. Use properties of operations to justify equivalence of fractions and different expressions. Provide manipulatives to encourage concrete understanding. Represent rational numbers in a variety of forms. Name and categorize shapes and use appropriate tools and units of measurement for the quantities given.
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying number sense with real-world context. Describe fractions and decimals both as parts of other numbers and analyze visual representations that support understanding of fractions. Make sense of missing numbers in equations by using the relationships between addition, subtraction, multiplication, and division.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Critique the arguments of others, decide whether they make sense, and ask questions to clarify or revise the arguments. Construct arguments using objects, concrete materials, drawings, diagrams, actions, and mathematical symbols. Make sense and confirm correct answers, even though solutions are not generalized or made formal. Reason inductively about data, making reasonable arguments that consider the context from which the data arose. Critique when making comparisons with fractions that refer to different wholes.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects, including multi-digit numbers and shapes, and situations as being composed of multiple parts. Apply basic addition and subtraction facts, simple multiplication facts, and knowledge of place value and related division facts to combine or partition whole numbers, find fractions of sets, shapes, and quantities, and recognize area and perimeter formulas. Create and continue spatial and number patterns based on addition, subtraction, or simple multiplication.

Data, Probability, and Statistical Reasoning

3.DPSR.1. Collect and analyze data and communicate through multiple representations.

Indicator	*Indicator Insight*
3.DPSR.1.1 Collect and organize categorical and numerical data based on observations, surveys, experiments, and investigations with whole number values using tables, scaled picture graphs, scaled bar graphs, or dot plots. Use titles and labels. Limit scales to 1, 2, 5, and 10.	Categorical data can be represented using bar graphs and picture graphs that are displayed horizontally or vertically. Numerical data can be represented using dot plots and bar graphs. Use data from science and social studies content.

Indicator	*Indicator Insight*
3.DPSR.1.2 Solve one-step, real-world problems using whole number data represented in tables, scaled picture graphs, scaled bar graphs, or dot plots. Limit scales to 1, 2, 5, 10.	Do not use data with outliers.

3.DPSR.2. Represent the probability of simple events by conducting experiments to determine possible outcomes.

Indicator	*Indicator Insight*
3.DPSR.2.1 Identify the possible outcomes of a simple event.	For example: when rolling a die, the possible outcomes are 1, 2, 3, 4, 5, or 6. Rolling a 9 is not a possible outcome. This is the first time that probability is introduced as a simple event. A simple event could include but is not limited to spinning a spinner, tossing a die, drawing one card, or flipping a coin.

Measurement, Geometry, and Spatial Reasoning

3.MGSR.1. Solve area and perimeter problems in real-world and mathematical situations.

Indicator	*Indicator Insight*
3.MGSR.1.1 Determine the area of squares and rectangles presented in relevant problems by covering the space with square units and counting the total number of units needed.	Explore area as an attribute that involves the covering of two-dimensional space. When tiling, there should be no gaps or overlaps. Provide opportunities for students to use square tiles, grid paper, and/or dot paper. Use square units to label area measurements. To make connections to multiplication, it is important for students to discover the relationship between the two side lengths of the rectangle and the area.
3.MGSR.1.2 Determine the perimeter of regular and irregular triangles and quadrilaterals with known side lengths.	Explore perimeter as the length/distance around the sides of a two-dimensional shape. Provide exposure to finding the perimeter of other polygons, but the emphasis should be on regular and irregular triangles and quadrilaterals. Composite quadrilaterals are not an expectation.
3.MGSR.1.3 Determine if a real-world situation is an example of the need for finding the area or the perimeter of a figure.	Understand the difference between a measure of length (perimeter) and a measure of covering space (area). Students would not be expected to solve for perimeter or area for this indicator.

3.MGSR.2. Estimate and measure using units of length, liquid volume, currency, and intervals of time.

Indicator	*Indicator Insight*
3.MGSR.2.1 Determine the value of any collection of coins not to exceed $5. Write the amount in the form of dollars and cents using the decimal notation. Limit to penny, nickel, dime, and quarter.	Provide experiences with collections with front and back sides of coins.
3.MGSR.2.2 Use analog and digital clocks to tell and record time to one-minute intervals, identifying AM and PM.	In second grade, students used analog and digital clocks to tell and record time to 5-minute intervals.
3.MGSR.2.3 Solve problems involving addition and subtraction of time intervals to determine elapsed time to the nearest half hour.	Use a number line to represent adding or subtracting hours and/or half hours. The expectation is not to add or subtract times that cross noon or midnight. Start times should begin on the hour or half hour.
3.MGSR.2.4 Estimate and measure length/distance to the nearest half inch and nearest whole centimeter.	Connect the ruler to the number line. Centimeter is the first mention of the metric system.
3.MGSR.2.5 Determine which unit of liquid volume is most appropriate to measure in real-world situations. Limited to fluid ounces, cup, pint, quart, gallon, milliliter, and liter.	Show containers that will represent each of the measures. Work within one system of measurement at a time.

3.MGSR.3. Extend geometric reasoning to attributes of polygons and polyhedrons.

Indicator	*Indicator Insight*
3.MGSR.3.1 Describe and draw right, acute, obtuse, and straight angles. Identify these angle types in two-dimensional figures including triangles and quadrilaterals.	Recognize angles as attributes of geometric shapes formed when two rays share a common endpoint and create a space between the rays. An acute angle has rays that are closer together. An obtuse angle has rays that are farther apart. Use everyday objects with a square corner, such as index cards, sticky notes, and notebook paper, as a reference or benchmark for a right angle. Use the straight edge of a sheet of paper as a benchmark for 180 degrees (straight angle). The expectation is not to measure angles with a protractor.
3.MGSR.3.2 Identify, describe, and draw points, lines, line segments, rays, intersecting lines, perpendicular lines, and parallel lines. Identify these in two-dimensional figures.	Clarify lines versus line segments in two-dimensional figures.

Numerical Reasoning

3.NR.1. Represent and compare whole numbers using relationships within the base ten number system.

Indicator	***Indicator Insight***
3.NR.1.1 Read, write, and represent whole numbers through the thousands period (0 to 999,999) on a number line and in standard, base ten language, word, and equations in expanded form.	Use a scaled number line and have students position numbers. Base ten language refers to identifying the number of hundred thousands, ten thousands, thousands, hundreds, tens, and ones in a numeral. For example: 6 hundred thousands, 4 ten thousands, 7 thousands, 2 hundreds, 9 tens, 5 ones. Number lines should not be limited to starting at 0 and should include different ranges like 1000 - 5000.
3.NR.1.2 Compose and decompose 4-digit whole numbers in multiple ways using thousands, hundreds, tens, and ones.	Explain and demonstrate each composition or decomposition with the use of concrete objects, drawings, expressions, and equations.
3.NR.1.3 Compare two whole numbers up to 999,999 based on the place value of the digits using the symbols *is equal to (=), is less than (<) or is greater than (>).*	Compare the quantities using place value.
3.NR.1.4 Round whole numbers from 0 to 1,000 to the nearest 10 or 100.	Use both vertical and horizontal number lines, and place benchmark and midpoint numbers. Doing so allows mathematicians to conceptually understand to which multiple of 10 or multiple of 100 a number rounds. Use the convention that if there is a 5 in the ones or tens place the number is rounded to the next 10 or 100 depending on the unit requested. Avoid the use of rhymes and tricks for rounding.

3.NR.2. Represent and compare fractions in multiple ways using part-whole relationships.

Indicator	***Indicator Insight***
3.NR.2.1 Identify unit fractions as the quantity formed by one part when a whole is partitioned into 2, 3, 4, 6, or 8 equal-sized parts. Express each part as a unit fraction of the whole.	Provide opportunities to partition circles, equilateral triangles, squares, rectangles, hexagons, and octagons. Explore many ways to partition these shapes into equal-sized parts. This indicator is the foundation for unit fractions being represented by visual representations. A fraction $\frac{a}{b}$ is the quantity formed by a part of size $\frac{1}{b}$. For example, $\frac{3}{4}$ is formed by three one fourths.
3.NR.2.2 Represent fractions from 0-1 using concrete, set, area, and linear models, and write them in standard form and word form. Limit denominators to 2, 3, 4, 6, and 8.	This is students' first experience with concrete, set, area, and linear models. Linear models could include number lines and fraction tiles. In second grade, students partitioned circles, squares, and rectangles into halves and fourths. This is also the first time students have seen a fraction written as a number. Concrete and hands-on opportunities should be embedded throughout the fraction unit. Continue to build student understanding of quantity and size of unit fractions when representing fractions 0-1.
3.NR.2.3 Express whole numbers as fractions and identify fractions that are equivalent to whole numbers.	Area and linear models should be used.
3.NR.2.4 Compose fractions between the whole numbers 0 and 5 using unit fractions. Record the composition as a mixed number or fraction greater than one. Limit denominators to 2, 3, 4, 6, and 8.	Concrete, area, and linear models should be used. Represent and interpret the fraction greater than one in the form of $\frac{a}{b}$ when the unit fraction $\frac{1}{b}$ is added *a* times. Provide experiences counting by a unit fraction beyond one whole. Provide opportunities to build the model and name the value both as a fraction greater than one and a mixed number to notice the relationship between the two representations. Fractions greater than one have been referred to as improper fractions in the past.

Indicator	*Indicator Insight*
3.NR.2.5 Recognize two fractions are equivalent based on the same size whole. Limit denominators to 2, 3, 4, 6, and 8, and fractions should be limited to fractions between 0 and 1.	Use concrete, area, and linear models. Use visual fraction models (area) of the same whole to identify equivalencies. Corresponding number lines should represent equivalent fractions.
3.NR.2.6 Compare two fractions with the same numerator or same denominator based on the same size whole by reasoning about their size. Use the symbols *is equal to (=), is less than (<) or is greater than (>).* Limit denominators to 2, 3, 4, 6, and 8, and fractions should be limited to fractions between 0 and 1.	Use concrete, area, and linear models. When referring to a fraction (numerator and denominator), avoid using language such as "top number," "bottom number," and "out of." Locate fractions on a number line to compare.

Patterns, Algebra, and Functional Reasoning

3.PAFR.1. Use multiple representations to reason and solve problems involving operational properties of whole numbers.

Indicator	*Indicator Insight*
3.PAFR.1.1 Use a strategy to compute sums and differences up to 1,000.	This indicator is about building conceptual understanding, not about practicing a standard algorithm. Strategies should include using concrete models, open number lines, or drawings and strategies based on place value, properties of operations, partial sums, or the inverse relationship between addition and subtraction. Provide opportunities to select a strategy that best fits the problem.

Indicator	*Indicator Insight*
3.PAFR.1.2 Multiply whole numbers (factors 0-10) and divide whole numbers (divisors 1-10) using a model and write a corresponding equation.	The purpose of this indicator is to build conceptual understanding of multiplication and division. To develop the relationship between multiplication and division, these concepts should be taught at the same time. When modeling multiplication, present the related division fact. Connect the equation to the model. When modeling division, present the related multiplication fact. Connect the equation to the model. Representations should include concrete models, equal groups, arrays (rows x columns), and linear models. When reading a multiplication equation, the multiplication symbol should be read as “groups of.” This reinforces the meaning of multiplication. When models are shown the convention is that 3 X 3 is three groups of three. It is also an array with three rows and three in each row. When using arrays, explore the *Commutative Property* for multiplication by rotating their model to discover that the product is still the same even though the order of the factors changed. Using the *Commutative Property* allows students to learn two facts simultaneously. *The Associative and Distributive Properties* should be explored for multiplication and division. Ensure connections are made when decomposing arrays and concrete objects. Parentheses can be used as grouping symbols when recording the decomposition.
3.PAFR.1.3 Multiply two whole numbers from 0 to 10 and divide using related facts flexibly and accurately.	Decompose a factor or dividend/divisor into a fact they do know. They may also use a known fact to determine the unknown fact. Both strategies can be done efficiently and accurately. Using visuals will help students develop flexibility. Parentheses will be used as grouping symbols. State a division problem as a missing factor problem.

3.PAFR.2. Use reasoning to represent and solve algebraic and numerical situations.

Indicator	*Indicator Insight*
3.PAFR.2.1 Determine the unknown whole number in a multiplication or division real-world situation relating three whole numbers when the unknown is a missing factor, product, dividend, divisor, or quotient.	The unknown can be represented by an open box, question mark, symbol, or a letter.
3.PAFR.2.2 Solve one-and two-step real-world problems using addition and subtraction up to 1,000.	Represent the problem situation using an equation with a symbol for the unknown. Provide contexts that include measurement situations with metric and customary units.
3.PAFR.2.3 Identify, create, and extend numerical patterns to determine the next three terms in an addition or subtraction sequence.	Use ordinal numbers such as *first, second,* and so on to describe the number in the sequence.
3.PAFR.2.4 Recognize that a whole number is a multiple of each of its factors 1-10.	Multiples can be determined by skip counting and should be limited to basic facts. Explore patterns in the multiplication table.

Fourth Grade Math Standards

The standards are designed to provide students with knowledge and skills to solve problems using critically important skills for college and career readiness. The focus in fourth grade is concentrated within the strands of Numerical Reasoning; Patterns, Algebra, and Functional Reasoning; Data, Probability, and Statistical Reasoning; and Measurement, Geometry, and Spatial Reasoning.

For Numerical Reasoning, this grade will use relationships within the base ten number system to represent, compare, and order whole numbers, fractions, and decimals. A major focus for students in fourth grade will be to continue building a strong conceptual understanding of fractions and part-whole relationships, using models, reasoning strategies, and multiplication, to generate fraction equivalencies. Students will represent and compare fractions of tenths and hundredths as decimals and decimals of tenths and hundredths in multiple ways.

For Patterns, Algebra, and Functional Reasoning, fourth grade will use multiple representations to reason and solve problems involving operational properties of whole numbers and decimals. Students will use the standard algorithm for addition and subtraction, as well as a variety of previously taught strategies to accurately compute the sum or difference. Students will build on their understanding of multiplication and division concepts from third grade to operate with multi-digit problems in fourth grade. Students should decompose numbers and use multiple strategies to multiply up to four-digit numbers by one-digit numbers and two-digit by two-digit numbers. Using the inverse relationship between multiplication and division, connections should be made between these two operations. Furthermore, students should also decompose and use place value strategies to divide four-digit dividends by one-digit divisors. Students will also develop an understanding of operations involving fractions. Fractions should also be interpreted as a division scenario; where a whole or quantity is divided or partitioned into equal parts. Multiple opportunities with concrete and pictorial models should be embedded in this strand and students should be able to apply the concepts to mathematical and real-world situations. Students will begin to operate with fractions with the same denominator and decimals (limited to tenths and hundredths). It is important that students understand fractions are equal parts of a whole. When adding or subtracting fractions, students should be able to visualize combining "like terms;" therefore, fractional parts must be of the same size whole. This is essential when connecting multiplying whole numbers times unit fractions. Students can make connections to repeated addition, when decomposing fractions and calculating products. Concrete models should be used when building these conceptual ideas before moving to abstract computations. Students should also use their knowledge of the four operations and number relationships to describe and extend numerical patterns following a given rule.

For Data, Probability, and Statistical Reasoning, this grade will be introduced to collecting and organizing numerical and categorical data based on observations, surveys, and experiments. Students will interpret whole number and fractional data represented in tables, scaled bar graphs, or dot plots by solving one-step problems. Probability is continued in fourth grade and builds upon their third-grade learning of representing simple events. In fourth grade, students will determine the likelihood of an event occurring. Students should be able to identify an event as impossible, equally likely, or certain. They will connect benchmark values to connect the values of 0 to “impossible”, 1 to “certain”, and “equally likely” to $\frac{1}{2}$.

For Measurement, Geometry, and Spatial Reasoning, students in this grade will solve real-world problems involving the perimeter and area of rectangles. Students will be asked to identify the missing side length when evaluating a perimeter scenario. Fourth grade students will be introduced to finding the area of a rectangle and labeling their units with square units. Students will also be asked to estimate and measure using multiple different units. These standards include money and elapsed time. Students will also be estimating and measuring length to the nearest quarter inch and half centimeter to make connections between this and equivalent fractions. In fourth grade, students will classify polygons limited to triangles, quadrilaterals, pentagons, and hexagons in a hierarchy based on attributes. Students will be asked to classify triangles by their side lengths and angle measures. Students will investigate attributes to help classify a shape.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Make meaning of a problem and use prior knowledge as an entry point to begin, plan, and choose a solution pathway. Look for another solution strategy when the solution approach tried does not make sense or does not result in a reasonable answer. Use concrete objects, pictures, or equations to explain conjectures and solve problems. Compare strategies to understand different approaches to solve relevant problems that involve multiple steps using operations with rational numbers. Use mathematical modeling to represent, analyze, and make predictions using data.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in mathematical discourse to justify a conjecture. Be specific with explanations by using objects, pictures, and symbols when describing the relationship between the operations. Use properties of operations to justify equivalence of fractions and different expressions. Provide manipulatives to encourage concrete understanding. Represent rational numbers in a variety of forms. Name and categorize shapes and use appropriate tools and units of measurement for the quantities given.
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying number sense with real-world context. Describe fractions and decimals both as parts of other numbers and analyze visual representations that support understanding of fractions. Make sense of missing numbers in equations by using the relationships between addition, subtraction, multiplication, and division.
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Critique the arguments of others, decide whether they make sense, and ask questions to clarify or revise the arguments. Construct arguments using objects, concrete materials, drawings, diagrams, actions, and mathematical symbols. Make sense and confirm correct answers, even though solutions are not generalized or made formal. Reason inductively about data, making reasonable arguments that consider the context from which the data arose. Critique when making comparisons with fractions that refer to different wholes.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects, including multi-digit numbers and shapes, and situations as being composed of multiple parts. Apply basic addition and subtraction facts, simple multiplication facts, and knowledge of place value and related division facts to combine or partition whole numbers, find fractions of sets, shapes, and quantities, and recognize area and perimeter formulas. Create and continue spatial and number patterns based on addition, subtraction, or simple multiplication.

Data, Probability, and Statistical Reasoning

4.DPSR.1. Create questions, collect, and analyze data, and communicate interpretations through multiple representations.

Indicator	*Indicator Insight*
4.DPSR.1.1 Collect and organize numerical and categorical data based on observations, investigations, surveys, and experiments using tables, scaled bar graphs, or dot plots. Use titles and labels. Scales to include whole numbers, halves, and fourths.	Students need to be aware of which graph is the best fit for the given data. Numerical data can be represented using dot plots and bar graphs. Categorical data can be represented using bar graphs. Data collection can be integrated with science and social studies content. Connect measurement data to fractions.
4.DPSR.1.2 Solve one-step, real-world problems using whole number and fractional data represented in tables, scaled picture graphs, scaled bar graphs, or dot plots. Limited to like denominators of 2, 3, 4, 5, 6, 8, and 10.	Use the data collected to answer questions.

4.DPSR.2. Represent the probability of simple events by conducting experiments to determine possible outcomes.

Indicator	*Indicator Insight*
4.DPSR.2.1 Determine the possible outcomes of a simple event and record the probability as certain, possible, or impossible.	A simple event could include but is not limited to spinning a spinner, tossing a die, drawing one card, or flipping a coin.

Measurement, Geometry, and Spatial Reasoning

4.MGSR.1. Solve area and perimeter problems in real-world and mathematical situations.

Indicator	***Indicator Insight***
4.MGSR.1.1 Apply perimeter formulas for rectangles to solve real-world situations including finding the perimeter given the side lengths and finding an unknown side length.	Students are not expected to find the perimeter of a composite rectangle. Provide opportunities for students to use square tiles, grid paper, and/or dot paper.
4.MGSR.1.2 Apply area formulas for rectangles to solve real-world situations. Use square units to label area measurements.	Explore area as an attribute that involves the covering of two-dimensional space. Provide opportunities for students to use square tiles, grid paper, and/or dot paper.

4.MGSR.2. Estimate and measure using units of length, liquid volume, weight, currency, and intervals of time.

Indicator	***Indicator Insight***
4.MGSR.2.1 Calculate the value of a collection of coins and bills in real-world situations to determine whether there is enough money to make a purchase. Justify based on comparison of money amounts.	The expectation is not to solve using decimal operations or to determine how much change is given.
4.MGSR.2.2 Solve real-world problems involving addition and subtraction of time intervals within 60 minutes to find elapsed time, start time, or end time.	Times can cross over the hour. Provide exposure to solving time problems using a number line.
4.MGSR.2.3 Measure length to the nearest quarter inch.	Connections should be made to equivalent fractions. Provide opportunities to see a ruler as a number line.
4.MGSR.2.4 Measure weight in customary units, and metric units to the nearest whole unit. Limit to oz, lb., g, and kg.	This is the first exposure to weight. Use physical models including balances and scales.
4.MGSR.2.5 Convert customary units of length, weight, and liquid volume from a larger unit to a smaller unit, given direct comparisons of the two measurements and/or the unit equivalencies within a single system of measurement. Limit to inches, feet, yards, pounds, ounces, cups, pints, quarts, and gallons when given unit equivalencies.	Connect to multiplication and function (input/output) tables, discuss reasonableness based on size of units.

4.MGSR.3. Extend geometric reasoning to attributes of polygons.

Indicator	***Indicator Insight***
4.MGSR.3.1 Classify triangles according to side length, *isosceles, equilateral, scalene*, and angle measure, *acute, obtuse, right, equiangular*.	Attributes include number of sides and angles, parallel and perpendicular line segments, and acute, right, and obtuse angles. Use the term "congruent" to refer to sides of equal length.
4.MGSR.3.2 Classify quadrilaterals in a hierarchy based on their shared attributes.	Attributes include number of sides and angles, parallel and perpendicular line segments, and acute, right, and obtuse angles.

Numerical Reasoning

4.NR.1. Represent and compare whole numbers using relationships within the base ten number system.

Indicboator	***Indicator Insight***
4.NR.1.1 Read and write whole numbers through the millions period (0 to 999,999,999) in word, standard, and equations in expanded form.	Provide experiences to see the sequence of three digits separated by commas is referred to as a "period." Emphasize where commas should be placed in a number up to 999,999,999.
4.NR.1.2 Estimate sums, differences, products, and quotients of multi-digit whole numbers, using rounding and place value to determine the reasonableness of real-world problem solutions. Write an equation for the estimate.	Round to solve. Use strategies including but not limited to front-end estimation. Write an equation for an estimation and compare it to the answer to determine if the answer is reasonable. The magnitude of numbers used for this indicator should be consistent with the indicators for the four operations. Consider reasonableness of solutions in real-world situations: over-rounding or under-rounding, situations of interpreting rounding.
4.NR.1.3 Order whole numbers within 999,999 (no more than 3) in ascending or descending order and record the comparison(s) using the symbols *is less than (<), and/or is greater than (>).*	Use scaled number lines with limited range for positioning numbers.

4.NR.2. Represent and compare fractions in multiple ways using part-whole relationships.

Indicator	***Indicator Insight***
4.NR.2.1 Represent fractions with denominators of 10 and 100 in words, models, and decimal notations.	Manipulatives including decimal grids (10x10) and base ten blocks should be used. Connect money to decimals.

Indicator	*Indicator Insight*
4.NR.2.2 Compare decimal numbers to the hundredths using the benchmarks 0, 0.5, 1.0, concrete area, and linear models. Use the symbols *is equal to (=), is less than (<), and/or is greater than (>).*	Compare whole numbers to decimals and decimals to decimals using base ten materials and number lines. Provide experiences placing decimal numbers on a number line. Number lines should be scaled and include a limited range. Use reasoning strategies to sort the decimals into categories of less than or greater than $\frac{1}{2}$. Have students explain their thinking for the placements.
4.NR.2.3 Generate equivalent fractions, including fractions greater than one, using multiple representations. Limit fractions to denominators of 2, 3, 4, 5, 6, 8, 10, 12, 20, 25, 50, and 100.	Multiple representations should include concrete, area, and linear models. Explain the *Identity Property of Multiplication* as it relates to equivalent fractions $\frac{a \times n}{b \times n}$, where $\frac{n}{n}$=1 Encourage students to find the patterns of the numerators and denominators of equivalent fractions. They should discover the patterns through exploration rather than being told. Provide opportunities for students to fold and shade an area. Students continue to fold, noticing the amount of area shaded does not change.
4.NR.2.4 Represent the composition and decomposition of fractions with the same denominator, including mixed numbers and fractions greater than 1, using multiple representations. Limit fractions to denominators of 2, 3, 4, 5, 6, 8, 10, 12, 20, 25, 50, and 100.	This connects to the indicator below to help students understand the conversion of mixed numbers and improper fractions. Models play a vital role in building this understanding.
4.NR.2.5 Explain and demonstrate how a mixed number is equivalent to a fraction greater than one and how a fraction greater than one is equivalent to a mixed number. Limit fractions to denominators of 2, 3, 4, 5, 6, 8, 10, 12, 20, 25, 50, and 100.	Use models and reasoning strategies to teach concepts. Provide experiences to connect fractions to division. The expectation in this standard is not for students to formally convert between a mixed number and a fraction greater than one. Both should be represented using visual representations. Improper fractions should be referred to as fractions greater than one.

Indicator	*Indicator Insight*
4.NR.2.6 Compare fractions and mixed numbers with like and unlike denominators applying benchmark fractions such as 0, $\frac{1}{2}$, and 1 using the symbols *is equal to (=), is less than (<), or is greater than (>).* Fractions limited to denominators of 2, 3, 4, 5, 6, 8, 10, 12, 20, 25, 50, and 100.	Use reasoning strategies to sort the fractions and into categories of less than or greater than $\frac{1}{2}$. Have students explain their thinking for the placements. Clarify using equivalence to scale fractions up or down to compare.

Patterns, Algebra, and Functional Reasoning

4.PAFR.1. Use multiple representations to reason and solve problems involving operational properties of whole numbers and decimals.

Indicator	*Indicator Insight*
4.PAFR.1.1 Use a strategy to accurately compute sums and differences of whole numbers up to 100,000 and justify the sum or difference.	Strategies should consist of multiple approaches including but not limited to a standard algorithm. Provide opportunities to select and use the strategy that is most efficient.
4.PAFR.1.2 Compute the product of a one-digit whole number by a multiple of 10 (from 10 to 90) and 100 (from 100 to 900) based on place value and properties of operations.	Use concrete materials, pictorial models, and strategies. Avoid teaching students to count the zeros. Provide experiences so students discover why zeros are added. This place value understanding is foundational when multiplying larger numbers.
4.PAFR.1.3 Decompose numbers by the value of each digit to multiply whole numbers up to four digits by a one-digit number and two two-digit whole numbers.	Strategies include but are not limited to partial products, equations, open arrays, area models, and/or properties of the operations. *Distributive Property* should continue to be used as a strategy when multiplying and dividing. Provide experiences to see to how these strategies connect to one another.
4.PAFR.1.4 Use a strategy to divide up to a four-digit dividend by a one-digit divisor, with and without remainders. Justify the calculation.	Strategies include but are not limited to partial quotients, repeated subtraction, open arrays, area models and/or properties of operations. *Distributive Property* should continue to be used as a strategy when multiplying and dividing. Provide experiences to see to how these strategies connect to one another. Use multiplication to check their answer. Provide opportunities to explore relationships between the dividend, divisor, and remainder. This may lead to the discovery of the divisibility rules. Teach divisibility rules in context as you teach division by single-digit divisors.

4.PAFR.2. Use multiple representations to reason and solve problems involving operational properties of fractions.

Indicator	***Indicator Insight***
4.PAFR.2.1 Use a strategy to accurately compute sums and differences of fractions with like denominators and justify the reasonableness of the answer. Limit denominators to 2, 3, 4, 5, 6, 8, 10, 12, 25, and 100.	Students are not required to rename fractions in lowest terms/simplest form. Problems should be posed in context and without context. Representations should include concrete, area, linear models, and/or equations.
4.PAFR.2.2 Use fraction and decimal equivalencies to add and subtract tenths and hundredths, to include mixed numbers and fractions greater than one.	Improper fractions should be referred to as fractions greater than one.
4.PAFR.2.3 Represent and compute the product of a whole number times a unit fraction. Limit denominators to 2, 3, 4, 5, 6, 8, 10, 12, 25, and 100.	Understand this as combining equal groups of the unit fraction. Representations should include concrete area, linear models, and/or equations. Students can be exposed to real-world situations for application purposes.
4.PAFR.2.4 Interpret a fraction as an equal sharing division situation, where a quantity (the numerator) is divided into equal parts (the denominator) to include real-world problems.	Representations should include concrete, area, and/or linear models. Use partitive division to share fractional amounts evenly to visualize the relationship between fractions and division.

4.PAFR.3. Use reasoning to represent and solve algebraic and numerical situations.

Indicator	***Indicator Insight***
4.PAFR.3.1 Find all factor pairs for a whole number in the range 1-50. Determine whether the whole number is prime or composite.	Identify, create, and extend patterns to determine the next three terms in a numerical sequence. Sequences should be limited to the use of a single operation.
4.PAFR.3.2 Describe and extend a numerical pattern which follows a rule, using function tables and real-world situations.	Function tables and input-output tables should be used interchangeably. In middle school, students will need to know the term "*function table*." In addition, have students find the rule when given the input and output.
4.PAFR.3.3 Solve real-world problems involving multiplicative comparison situations and write equations to represent the problem using a variable for the unknown.	Problems should include unknown product, size of group unknown, and number of groups unknown. Model using concrete materials or bar diagrams.

Indicator	*Indicator Insight*
4.PAFR.3.4 Solve two-step, real-world problems using the four operations involving whole number answers. Represent the problem using an equation with a variable as the unknown in any position.	Provide context to include measurement situations with metric and customary units. Use a letter to represent the unknown.

Fifth Grade Math Standards

The standards are designed to provide students with knowledge and skills to solve problems using critically important skills for college and career readiness. The focus in fifth grade is concentrated within the strands of Numerical Reasoning; Patterns, Algebra, and Functional Reasoning; Data, Probability, and Statistical Reasoning; and Measurement, Geometry, and Spatial Reasoning.

For Numerical Reasoning, this grade will represent and compare multi-digit numbers with decimals using relationships within the base ten number system and models. A major focus for students in fifth grade will include building a strong conceptual foundation of understanding decimal values. They will represent the equivalent forms of fractions as decimals and decimals as fractions as a method to compare numbers using reasoning strategies and number lines.

For Patterns, Algebra, and Functional Reasoning, fifth grade will use multiple representations to reason and solve problems involving operational properties of decimals, fractions, and whole numbers. Students will continue using a variety of strategies for addition, subtraction, multiplication, and division, which were previously introduced in earlier grades. A major focus for students in fifth grade will include solidifying their understanding of multi-digit whole number operations to include the use of algorithms to solve problems. Leaving fifth grade with knowledge of the standard algorithm for addition, subtraction, multiplication, and division will lead to the ability to operate fluently with decimals and fractions in middle school. Students will also develop an understanding of operations involving fractions and decimals. Multiple opportunities with concrete and pictorial models should be embedded in this strand and students should be able to apply the concepts to mathematical and real-world situations. In this grade, students will gain understanding of how factors and multiples can help to determine the common denominator and simplify fractions. Students will be introduced to graphing ordered pairs within the first quadrant of a coordinate plane and they will be formally introduced to functions. It is important for students to be able to identify the rule of a function table and to extend the patterns in the table as well. In fifth grade, students will begin to use grouping symbols and learn how to evaluate numerical expressions.

For Data, Probability, and Statistical Reasoning, this grade will be introduced to finding the range and mode using data. Students will solve one-step problems using data represented in tables, line graphs, scaled bar graphs, or dot plots. In this grade, students will make predictions or draw conclusions by analyzing categorical and numerical data in graphical displays. Probability is continued to be taught in fifth grade as students will represent the likelihood of a simple event occurring in the form of a fraction.

For Measurement, Geometry, and Spatial Reasoning, fifth grade will solve problems involving area and perimeter of composite rectangles involving whole and fractional numbers with known side lengths. Students will be introduced to the concept of volume of a right rectangular prism. In this grade, students will solve real-world problems requiring them to convert between measurements across different systems. Students will continue to extend their ability to estimate and measure lengths of objects. In fifth grade, students will be formally introduced to the coordinate system and how this applies when plotting and labeling ordered pairs in the first quadrant. Multiple opportunities should be embedded in this strand and students should be able to apply the concepts to mathematical and real-world situations.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Make meaning of a problem and use prior knowledge as an entry point to begin, plan, and choose a solution pathway. Look for another solution strategy when the solution approach tried does not make sense or does not result in a reasonable answer. Use concrete objects, pictures, or equations to explain conjectures and solve problems. Compare strategies to understand different approaches to solve relevant problems that involve multiple steps using operations with rational numbers. Use mathematical modeling to represent, analyze, and make predictions using data.
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in mathematical discourse to justify a conjecture. Be specific with explanations by using objects, pictures, and symbols when describing the relationship between the operations. Use properties of operations to justify equivalence of fractions and different expressions. Provide manipulatives to encourage concrete understanding. Represent rational numbers in a variety of forms. Name and categorize shapes and use appropriate tools and units of measurement for the quantities given.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying number sense with real-world context. Describe fractions and decimals both as parts of other numbers and analyze visual representations that support understanding of fractions. Make sense of missing numbers in equations by using the relationships between addition, subtraction, multiplication, and division.
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Critique the arguments of others, decide whether they make sense, and ask questions to clarify or revise the arguments. Construct arguments using objects, concrete materials, drawings, diagrams, actions, and mathematical symbols. Make sense and confirm correct answers, even though solutions are not generalized or made formal. Reason inductively about data, making reasonable arguments that consider the context from which the data arose. Critique when making comparisons with fractions that refer to different wholes.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects, including multi-digit numbers and shapes, and situations as being composed of multiple parts. Apply basic addition and subtraction facts, simple multiplication facts, and knowledge of place value and related division facts to combine or partition whole numbers, find fractions of sets, shapes, and quantities, and recognize area and perimeter formulas. Create and continue spatial and number patterns based on addition, subtraction, or simple multiplication.

Data, Probability, and Statistical Reasoning

5.DPSR.1. Create questions, collect, and analyze data, and communicate through multiple representations.

Indicator	***Indicator Insight***
5.DPSR.1.1 Describe data by determining the range and mode, including whole numbers, fractional data, and decimal data. Limit fractions to denominators of 2, 3, 4, 5, 6, 8, and 10, and limit decimals to decimals through the thousandths place.	Data should be given in context. In middle school, the terms for maximum and minimum will be referred to as *upper extreme* and *lower extreme*.
5.DPSR.1.2 Solve two-step, real-world problems using whole number and fractional data represented in tables, line graphs, scaled bar graphs, or dot plots. Limit fractions to denominators of 2, 3, 4, 5, 6, 8, 10, 12, 20, 25, 50, and 100.	Students should be familiar with coordinate graphs prior to the introduction of line graphs. Students could be expected to use any of the four operations.
5.DPSR.1.3 Analyze categorical and numerical data in graphical displays to make predictions or draw conclusions. Limit displays to tables, bar graphs, dot plots, line graphs, and circle graphs with scales of whole numbers, halves, fourths, and eighths.	The expectation is not to create circle graphs nor include percentages.

5.DPSR.2. Represent the probability of simple events and determine possible outcomes.

Indicator	***Indicator Insight***
5.DPSR.2.1 Represent the probability of a simple event as 0, a fraction, or 1. Limit fractions to denominators of 2, 3, 4, 5, 6, 8, 10, 20, and 25.	A simple event could include but is not limited to spinning a spinner, tossing a die, drawing one card, or flipping a coin.

Measurement, Geometry, and Spatial Reasoning

5.MGSR.1. Solve area, perimeter, and volume problems in real-world and mathematical situations.

Indicator	***Indicator Insight***
5.MGSR.1.1 Solve problems involving area and perimeter of composite figures by decomposing with rectangles.	Use concrete materials or grid paper with a shape drawn on it. Decompose rectilinear figures into smaller rectangles to find the area of each and then add them. Use square units to label area measurements.

Indicator	Indicator Insight
5.MGSR.1.2 Estimate and measure the volume of a right rectangular prism with whole-number side lengths by filling it with unit cubes.	Use containers that can be accurately measured with the unit cubes you are using (so inch cubes with a rectangular prism that measures in precise inch dimensions). Provide opportunities to recognize volume as an attribute of three-dimensional shapes that involves filling a space. Composite rectangular prisms are excluded. Use cubic units to label volume measurements.

5.MGSR.2. Convert within a given measurement system and measure length.

Indicator	Indicator Insight
5.MGSR.2.1 Given the unit equivalencies, convert within a single system of measurement from larger units to smaller units and smaller units to larger units for length, weight, liquid volume, and time. Use these conversions in solving real-world problems. Limit units to inches, feet, yards, pounds, ounces, cups, pints, quarts, gallons, seconds, minutes, hours, milli-, centi-, base unit, and kilo-.	Identify patterns and make generalizations about the larger the unit the smaller the measure and the smaller the unit the larger the measure. Provide experiences performing more than one conversion to obtain the desired unit. Connect to multiplication and division units and for metric conversions connect to place value understanding of 10 times and $\frac{1}{10}$.
5.MGSR.2.2 Estimate and measure lengths to the nearest eighth of an inch or nearest millimeter.	Connect to equivalent fractions. Connect the ruler to the number line. Provide students opportunities in measuring to the nearest $\frac{1}{8}$ of inch and millimeter both using a ruler and when given images of real-world objects aligned with a ruler.

5.MGSR.3. Represent real-world and mathematical problems by plotting ordered pairs and explain coordinate values of points in the first quadrant of the coordinate plane.

Indicator	Indicator Insight
5.MGSR.3.1 Identify the origin, *x*-axis, and *y*-axis in the coordinate system. Write, plot and label ordered pairs, including values in a function table, in the first quadrant of the coordinate plane.	This is the first time graphing in the coordinate plane is introduced. Explain how the coordinates relate. Plot the point as the distance from the origin on each axis. In a function table, note that the input is the *x*-coordinate, and the output is the *y*-coordinate. *Function tables* are also called *input/output tables*. Use these terms interchangeably. In middle school, students will use the term *function table*.

Indicator	Indicator Insight
5.MGSR.3.2 Represent mathematical and real-world situations by graphing, labeling, and interpreting points in the first quadrant of the coordinate plane.	Provide opportunities to find a point on the coordinate plane. It is important for students to examine the relationship between the x-axis and the y-axis. Real-world situations could include map situations.

Numerical Reasoning

5.NR.1. Represent and compare positive rational numbers using relationships within the base ten number system.

Indicator	Indicator Insight
5.NR.1.1 Read, write, and represent multi-digit numbers from 0 to 999 with decimals to the thousandths place. Use pictorial, word, standard, or expanded form with fraction or decimal notation.	Provide opportunities to explore with concrete objects as this is students' first exposure to thousandths. Base ten blocks and decimal grids can be used.
5.NR.1.2 Explain how the value of a digit in a multi-digit number changes if the digit moves one or more places to the left or right in the base ten system. Include decimals to the thousandths place.	Recognize that a digit to the left of another digit is ten times more, and a digit to the right of a digit is one tenth of the amount. Make the connection between decimal notation and place value.
5.NR.1.3 Round decimal numbers up to 999 with decimals to the thousandths place to the nearest hundredth, tenth, or whole number.	The same number can be used to demonstrate what happens when it is rounded to various places. Use benchmark numbers and midpoint on a vertical or horizontal number line and plot the given number to visualize which benchmark the number is closest to.
5.NR.1.4 Use patterns to explain the exponents when multiplying and dividing by powers of 10, not to exceed the thousandths place.	Focus on place value patterns within a place value chart rather than the decimal moving.

5.NR.2. Represent and compare fractions in multiple ways.

Indicator	Indicator Insight
5.NR.2.1 Compare fractions and mixed numbers with like and unlike denominators of 2, 3, 4, 5, 6, 8, 10, 12, 20, 25, and 100 using equivalence to create a common denominator. Use the symbols $<$, $>$, *or* $=$ to record the comparison.	Students should be able to apply these comparisons in real-world situations such as recipes and measurement.

Patterns, Algebra, and Functional Reasoning

5.PAFR.1. Use multiple representations to reason and solve problems involving operational properties of whole numbers and decimals.

Indicator	***Indicator Insight***
5.PAFR.1.1 Use a strategy to compute the product of a two-or-three-digit factor times a two-digit factor to include real-world problems.	Strategies should include a standard algorithm. Connect a standard algorithm to the partial products algorithm as well as the area model for multiplication. *Distributive Property* should continue to be used as a strategy when multiplying.
5.PAFR.1.2 Use a strategy to compute the quotient of a multi-digit whole number dividend by a two-digit whole number divisor, with and without remainders, to include real-world problems. Limit the dividend to four digits.	Strategies should include a standard algorithm. Connect a standard algorithm to the partial quotients algorithm as well as open arrays and repeated subtraction. *Distributive Property* should continue to be used as a strategy when dividing. Students should interpret the meaning of the remainder in context. Students should determine whether: • the remainder should be ignored, • one should be added to the quotient, or • the remainder should be written as a fraction.
5.PAFR.1.3 Use a strategy to compute sums and differences of decimal numbers to the hundredths.	Strategies should include a standard algorithm. Include using money and making change.
5.PAFR.1.4 Use a strategy to multiply a one-digit whole number by a decimal to the hundredths and divide a decimal to the hundredths (dividend) by a one-digit whole number (divisor). Justify the calculation.	Strategies should include but are not limited to concrete models and decimal grids. Justify calculations by using strategies based on place value, the properties of operations, or the inverse relationship between multiplication and division. Provide context with money.

5.PAFR.2. Use multiple representations to reason and solve problems involving operational properties of fractions.

Indicator	*Indicator Insight*
5.PAFR.2.1 Use a strategy to compute sums and differences of fractions and mixed numbers with unlike denominators and justify the sum or difference to include real-world problems. Limit denominators to 2, 3, 4, 5, 6, 8, 10, 12, 20,25, 50, and 100.	Provide exposure to the following situations: fraction-fraction, mixed number-fraction, and mixed number-mixed number. The use of equivalent fractions should be the foundation of finding common denominators. Introduce students to least common multiple (LCM). Provide opportunities to use pictorial and concrete models to add and subtract fractions.
5.PAFR.2.2 Use a strategy to multiply a fraction by a fraction or a fraction by a whole to include real-world problems. Limit denominators to 2, 3, 4, 5, 6, 8, 10, and 12.	Fractions should include standard fractions, mixed numbers, and fractions greater than 1. Initially, models should be represented before moving to the procedure of multiplying fractions.
5.PAFR.2.3 Interpret and represent division of a whole number dividend and a unit fraction divisor and a unit fraction dividend and a whole number divisor and apply to real-world problems. Limit denominators to 2, 3, 4, 5, 6, 8, 10, and 12.	Strategies should include concrete, area, linear models, and/or equations. Avoid the use of “keep, change, flip” in presenting this indicator.

5.PAFR.3. Use reasoning to represent and solve algebraic and numerical situations.

Indicator	*Indicator Insight*
5.PAFR.3.1 Determine the least common multiple (LCM) to find a common denominator. Limit denominators to 2, 3, 4, 5, 6, 8, 10, 12, 20, 25, 50, and 100.	Use the limited denominators listed in the indicator to create a common denominator. Avoid multiplying the two denominators together to determine finding the common denominator as this does not always produce the least common denominator. For example, if given $\frac{2}{5}+\frac{3}{10}$ the least common denominator is not 50.
5.PAFR.3.2 Determine the greatest common factor (GCF) of two numbers both less than or equal to 50 to simplify a fraction into its standard form.	The standard form of a fraction is the simplest form. The terms *prime* and *composite* were introduced in fourth grade when students found factor pairs of whole numbers 1-50.
5.PAFR.3.3 Identify a rule that can describe the pattern from the data of a function table and write it as an expression.	*Function tables* are also called *input/output* tables. Use these terms interchangeably. In middle school, students will use the term *function table*.

Indicator	*Indicator Insight*
5.PAFR.3.4 Translate a two-step real-world situation into a numerical expression using parentheses as grouping symbols and evaluate the expression.	Avoid teaching PEMDAS as the intent of this indicator is on students making sense of the problem. They must understand that there is an agreed-to order for solving operations. Expressions should not require the understanding of Order of Operations. Students should understand to operate within the parentheses as a first step.

Sixth Grade Math Standards

The standards for Middle School continue the work started in elementary in these four strands: Data, Probability, and Statistical Reasoning; Measurement, Geometry, and Spatial Reasoning; Numerical Reasoning; and Patterns, Algebra, and Functional Reasoning. Woven throughout all four strands are concepts building on students' understanding with problem solving to provide context to the problems they are solving which will foster critical thinking and collaboration skills.

In the Numerical Reasoning strand, sixth graders will utilize multiple representations of real numbers to translate, simplify, and solve problems using mathematical and real-world applications. Students will use their prior knowledge of whole numbers to expand into operations with integers and positive rational numbers. They will deepen their understanding of fractions, decimals, and percentages through ordering, sorting, and finding absolute value. The emphasis will be on understanding negative numbers.

In Patterns, Algebra, and Functional Reasoning, sixth graders will expand their understanding of algebraic concepts, being introduced to functions. They will learn the correct terminology related to algebraic expressions, equations, and inequalities, along with distinguishing between expressions and equations, and equations and inequalities. One-step simple equations and inequalities will be used to solve a variety of problems using positive rational numbers. Students will also be introduced to ratios and rates, and how to use them in real-world situations.

In the Data, Probability, and Statistical Reasoning strand, sixth graders will analyze data sets to identify their statistical elements. They will create graphs and plots to represent data sets, along with interpreting measures of center and spread for those data sets. They will be introduced to probability with simple and complementary events and learn that probabilities can be written as a fraction, decimal, or percent.

In Measurement, Geometry, and Spatial Reasoning, sixth graders will use the characteristics of two-dimensional and three-dimensional shapes learned in earlier grades to help them calculate area, surface area, and volume using models, nets, and formulas. Students will use angle measures to find and identify complementary or supplementary angles, along with exploring angles using a protractor. They will be introduced to all four quadrants of the coordinate plane and begin plotting and graphing ordered pairs in all four quadrants, to include graphing lines and polygons.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Interpret the meaning of a problem by imagining the situation, considering multiple entry points, making a plan, and choosing a solution pathway. Demonstrate flexibility in approaching the problem. When the solution pathway does not lead to a solution, look for another way. Recognize that multiple representations, including concrete models, drawings, expressions, equations, verbal descriptions, tables, diagrams, and graphs, are related to each other and can help them solve the problem. Compare other students' approaches to solving the problem and understand there can be multiple ways to solve a problem. To find a correct solution, consider simpler forms of the original problem. Students should continually ask themselves if a solution is reasonable.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in mathematical discourse to explain or justify a conjecture. Solve problems collaboratively. Collaborate with others by posing clarifying questions that help deepen overall understanding of the concept. Be specific with explanations by using objects, drawings, pictures, and symbolic representations. Use a variety of forms to present results to an audience. Use properties of operations to justify the equivalence of expressions. Make decisions about which tools are necessary to use, or not use, in specific situations. Demonstrate proficiency in choosing technology tools that will aid in understanding a concept or formulating a solution to the problem. Attend to precision when checking work and labeling measurements, along with making revisions as needed.
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying number sense with real-world contexts. Understand that fractions, decimals, and percentages are rational numbers. Make sense of missing numbers in equations by using the relationships among addition, subtraction, multiplication, and division. Understand that a complex problem is made up of many smaller problems needing to be solved to get to a “final solution.” Generate mathematical problems using the surrounding world.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Compare arguments, determine if the logic used is reasonable, and be able to explain any errors or flaws found. Construct written and verbal arguments using objects, numbers, drawings, diagrams, mathematical activities, and mathematical symbols. Make sense of both symbols and numbers. Reason inductively about data, making reasonable arguments that consider the context from which the data arose. As new evidence is presented, review position and revise as necessary.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects and situations as being composed of multiple parts. Apply a variety of strategies to finding solutions for a problem in context. Notice patterns and structure in repeated calculations and look for generalizations, general methods, and shortcuts. Check for reasonableness and needed adjustments in strategies while solving problems.

Data, Probability, and Statistical Reasoning

6.DPSR.1. Analyze data sets to identify their statistical elements.

Indicator	*Indicator Insight*
6.DPSR.1.1 Identify the sample size for a numerical set of data in mathematical and real-world situations.	This is the first introduction to the term *sample size*.
6.DPSR.1.2 Create box plots to represent numerical data sets in mathematical and real-world situations.	This is the first exposure to box plots. Teach using data displays, not just numerical sets.
6.DPSR.1.3 Use the shape of the graph to determine whether median or mode best describes the data set.	This indicator introduces spread and center. Shape includes right skew, left skew, symmetric, uniform, bimodal (two modes), and outliers. This is the first introduction to median.
6.DPSR.1.4 Calculate and interpret the median, mode, range, interquartile range in mathematical and real-world situations.	Compare differences between median and mode. Include positive rational numbers in the data sets.

6.DPSR.2. Calculate and interpret probability.

Indicator	*Indicator Insight*
6.DPSR.2.1 Given the probability of a random event, expressed as a number from 0 to 1, state the likelihood of the event occurring.	*Likelihood* is defined as: certain (probability of 1), impossible (probability of 0), likely, equally probable, or unlikely. Probabilities closer to 1 are likely, and those closer to 0 are unlikely events. Probability can be written as a fraction, decimal, or percent. *Likelihood* is introduced in third grade.
6.DPSR.2.2 Find the probability of simple events in mathematical and real-world situations. Fractions limited to denominators of 2, 4, 5, 8, 10, 25, 50, and 100.	In grade 5, finding probabilities of simple events (as fractions only) are introduced. Probability can be written as a fraction, decimal, or percent.
6.DPSR.2.3 Given the probability of an event, identify and calculate the complement of that event.	The probabilities of complementary events add up to 1.

Measurement, Geometry, and Spatial Reasoning

6.MGSR.1. Determine the measurements of geometric figures.

Indicator	*Indicator Insight*
6.MGSR.1.1 Find the area of a triangle, square, rectangle, parallelogram, and trapezoid.	Use composition and decomposition of the shapes as well as applications of properties and formulas. Find actual measurements using rulers to continue the practice from elementary grades.
6.MGSR.1.2 Create nets to represent three-dimensional shapes.	Include nets of both prisms and pyramids.
6.MGSR.1.3 Calculate the surface area of rectangular prisms, right triangular prisms, and right pyramids using two-dimensional nets.	Connect through patterns to the formula for surface area. Find actual measurements of some nets using rulers to continue the practice from elementary.
6.MGSR.1.4 Find the area of composite figures by decomposing them into triangles and rectangles to solve mathematical and real-world problems.	In fifth grade, students find perimeter and area of composite figures composed of rectangles.
6.MGSR.1.5 Calculate the volume of a right rectangular prism using the formula ($V = Bh$) in mathematical and real-world situations.	In fifth grade, students explore volume conceptually by filling right rectangular prisms with unit cubes and multiplying the number of unit cubes in the lowest layer (area of the base) by the number of layers of cubes (height of the prism). In sixth grade, students are deepening and applying their understanding of volume.

6.MGSR.2. Determine angle relationships.

Indicator	*Indicator Insight*
6.MGSR.2.1 Determine if two angles are complementary or supplementary.	Relate supplementary angles to the measure of straight angles and the measure of complementary angles to right angles. This is students' first exposure to the terms *complementary* and *supplementary*.
6.MGSR.2.2 Determine the measure of angles using a protractor.	Include straight angles when addressing this indicator. This is students' first time using a protractor.

6.MGSR.3. Graph on the coordinate plane.

Indicator	*Indicator Insight*
6.MGSR.3.1 Plot ordered pairs in all four quadrants and identify points on a graph by writing ordered pairs.	This is the students' first introduction to all four quadrants. The first quadrant of the coordinate plane was introduced in fifth grade. Given a point on the graph, students need to be able to identify the ordered pair as well as graph the ordered pairs.
6.MGSR.3.2 Graph a polygon on a coordinate plane given the coordinates of the vertices.	Include the use of a table (horizontal and vertical) when graphing points. (x, y).

Numerical Reasoning

6.NR.1. Translate among multiple representations of rational numbers.

Indicator	*Indicator Insight*
6.NR.1.1 Convert rational numbers into equivalent forms among terminating decimals, fractions (including mixed numbers), and percentages. Limit fractions to denominators of 2, 4, 5, 8, 10, 20, 25, 50, 100, and 200.	The expectation of this indicator excludes the conversion of repeating decimals to fractions. This indicator is students' first introduction to percentages.

6.NR.2. Utilize rational numbers in mathematical and real-world situations.

Indicator	*Indicator Insight*
6.NR.2.1 Compare two rational numbers and write statements using the symbols *is equal to (=), is not equal to (≠), is less than (<), and/or is greater than (>)* in mathematical and real-world situations.	Include absolute value, which is introduced in 6.NR.2.4. Comparisons should include real-world situations.
6.NR.2.2 Sort a set of rational numbers in ascending and/or descending order in mathematical and real-world situations. Limit sets to no more than 5 numbers.	Rational numbers should include absolute value.

Indicator	*Indicator Insight*
6.NR.2.3 Represent quantities with integers in real-world situations and explain the meaning of zero.	This is an introduction to the understanding of negative numbers and zero. Explain how integers and rational numbers fit into the Real Number System. Model integers using concrete materials, drawings, number lines (horizontal and vertical), symbols, and words.
6.NR.2.4 Identify and compare the opposite value and absolute value of positive and negative rational numbers.	Use horizontal and vertical number lines to explain concepts of opposite and absolute value. Represent opposite and absolute value numbers with real-world situations, such as temperature, financial literacy, and distances. This is the first introduction to absolute value.

Patterns, Algebra, and Functional Reasoning

6.PAFR.1. Use tables, graphs, verbal descriptions, or equations to represent a function.

Indicator	*Indicator Insight*
6.PAFR.1.1 Use tables, graphs, verbal descriptions, and equations to represent the relationship between independent and dependent variables of functions.	This is an introduction to *functions* and the relationship between *independent (input) and dependent (output) variables*. Fifth grade introduces function tables as input output tables.
6.PAFR.1.2 Identify the independent and dependent variable of a function in mathematical and real-world situations.	Connect independent variables to input and dependent variables to output (from input/output tables).

6.PAFR.2. Write, simplify, and evaluate algebraic expressions; write and solve algebraic equations and inequalities.

Indicator	*Indicator Insight*
6.PAFR.2.1 Identify parts of an algebraic expression using the mathematical terms *sum, difference, term, variable, product, factor, quotient, coefficient, constant.*	This indicator is the first introduction to terms associated with algebraic expressions.
6.PAFR.2.2 Translate numerical and algebraic expressions with positive whole number bases and positive whole number exponents into equivalent expressions.	Be careful of leaning on key words and phrases too much. The mathematical meaning can change based on the placement of key words and phrases.

Indicator	*Indicator Insight*
6.PAFR.2.3 Evaluate numerical expressions with positive whole number bases and positive whole number exponents using the Order of Operations.	This is where students are formally introduced to the Order of Operations. Grouping symbols like brackets and parentheses should be used in the expressions. Only parentheses are used in fifth grade. Provide opportunities to build conceptual understanding of the process, not just an acronym like GEMDAS.
6.PAFR.2.4 Write and evaluate expressions using variables to represent quantities in mathematical and real-world situations.	Discuss the difference between an expression and an equation.
6.PAFR.2.5 Write and solve one-step equations and inequalities with one variable involving positive rational numbers in mathematical and real-world situations.	Discuss why inequalities have a set of solutions, and how to graph them. Fifth grade is only using substitution to find a solution to an equation.
6.PAFR.2.6 Interpret the concept of a ratio as the relationship between two quantities, including part-to-part and part-to-whole.	Determine ratios using concrete models, drawings, and words. Use the following notations: $\frac{a}{b}$, a to b, a:b and all notations are read as "a to b." This is students' first introduction to ratios and ratio reasoning.
6.PAFR.2.7 Explain the relationship between ratios and rates, including unit rates.	Rates should be kept in context.
6.PAFR.2.8 Solve ratio and rate problems in real-world situations.	Include using the percent proportion and equation when solving problems.
6.PAFR.2.9 Use one-step dimensional analysis to convert units within the metric or customary systems.	Problems should include measures of mass, weight, length, and liquid.

6.PAFR.3. Apply mathematical patterns, properties, and algorithms to the set of rational numbers to find sums, differences, products, and quotients and to write equivalent expressions.

Indicator	*Indicator Insight*
6.PAFR.3.1 Represent the solutions of inequalities on a number line and explain that the solution set may contain an infinite number of solutions. Limited to the symbols *is less than (<) and is greater than (>).*	Connect solutions on the number line to solving inequalities in 6.PAFR.2.5.
6.PAFR.3.2 Identify the multiplicative inverse of a number and multiply multiplicative inverses to find their product is equal to one.	Allow students to discover this property through multiple examples that are given in context. This is students' first exposure to multiplicative inverse.

Indicator	*Indicator Insight*
6.PAFR.3.3 Identify the additive inverse of a number and add additive inverses to find their sum is equal to zero.	Allow students to discover this property through multiple examples that are given in context. Manipulatives can be used to help explain how positives and negatives create zero pairs. This is students' first exposure to the *Additive Inverse Property.*
6.PAFR.3.4 Apply the properties of operations to create equivalent algebraic expressions and justify the properties used. Limit properties to the *Identity, Inverse, Commutative, Associative, and Distributive Properties*.	Students are introduced to *Distributive Property* in fifth grade.
6.PAFR.3.5 Add, subtract, multiply, and divide integers.	Develop generalizations through multiple examples with models and finding patterns. This is an introduction to integer rules. Help students to discover the rules through use of manipulatives and strategies, including but not limited to human number line, two-color counters, and algebra tiles. Include multi-digit integers for all operations.
6.PAFR.3.6 Add, subtract, multiply, and divide positive fractions, including mixed numbers.	Division of a fraction by a fraction is new to students in sixth grade. Strategies should make the connection from models in fifth grade.
6.PAFR.3.7 Add, subtract, multiply, and divide multi-digit positive decimals, up to the thousandths place, to solve problems.	Strategies should make the connection from models in fifth grade to a standard algorithm.

Seventh Grade Math Standards

The standards for Middle School continue the work started in elementary in these four strands: Data, Probability, and Statistical Reasoning; Measurement, Geometry, and Spatial Reasoning; Numerical Reasoning; and Patterns, Algebra, and Functional Reasoning. Woven throughout all four strands are concepts building on students' understanding with problem solving to provide context to the problems they are solving which will foster critical thinking and collaboration skills.

In the Numerical Reasoning strand, seventh graders will extend their understanding of operations to include all rational numbers, promoting student understanding of how rational numbers are used in real-world situations.

In Patterns, Algebra, and Functional Reasoning, seventh graders will expand on what was learned in sixth grade to develop an understanding of proportional relationships. Students will represent algebraic concepts using tables, graphs, verbal descriptions, and equations. Students will distinguish proportional relationships from non-proportional relationships while making the connection between unit rate and constant of proportionality. The extension of this knowledge will lead to the ability to solve single and multi-step problems while working with expressions and linear equations. Students will be provided with multiple opportunities to solve a variety of percentage problems.

In the Data, Probability, and Statistical Reasoning strand, seventh graders will extend their analysis of data sets to two populations using double line graphs, back-to-back stem-and-leaf plots, and double box plots. Students will calculate and interpret problems using both experimental and theoretical probability. Students will make connections and understand probabilities written as fractions, decimals, and percentages.

In the Measurement, Geometry, and Spatial Reasoning strand, seventh graders will be working with two- and three-dimensional figures to solve problems involving area, surface area, and volume. Through exploration and discovery, students will develop an understanding of how to find the circumference and area of circles. This will be the first time these concepts have been introduced. Students will identify congruent angles and solve equations relating to angles formed when lines intersect. Distance between points on the coordinate plane will be found and connected back to the area and perimeter of polygons.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Interpret the meaning of a problem by imagining the situation, considering multiple entry points, making a plan, and choosing a solution pathway. Demonstrate flexibility in approaching the problem. When the solution pathway does not lead to a solution, look for another way. Recognize that multiple representations, including concrete models, drawings, expressions, equations, verbal descriptions, tables, diagrams, and graphs, are related to each other and can help them solve the problem. Compare other students' approaches to solving the problem and understand there can be multiple ways to solve a problem. To find a correct solution, consider simpler forms of the original problem. Students should continually ask themselves if a solution is reasonable.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in mathematical discourse to explain or justify a conjecture. Solve problems collaboratively. Collaborate with others by posing clarifying questions that help deepen overall understanding of the concept. Be specific with explanations by using objects, drawings, pictures, and symbolic representations. Use a variety of forms to present results to an audience. Use properties of operations to justify the equivalence of expressions. Make decisions about which tools are necessary to use, or not use, in specific situations. Demonstrate proficiency in choosing technology tools that will aid in understanding a concept or formulating a solution to the problem. Attend to precision when checking work and labeling measurements, along with making revisions as needed.
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying number sense with real-world contexts. Understand that fractions, decimals, and percentages are rational numbers. Make sense of missing numbers in equations by using the relationships among addition, subtraction, multiplication, and division. Understand that a complex problem is made up of many smaller problems needing to be solved to get to a "final solution." Generate mathematical problems using the surrounding world.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Compare arguments, determine if the logic used is reasonable, and be able to explain any errors or flaws found. Construct written and verbal arguments using objects, numbers, drawings, diagrams, mathematical activities, and mathematical symbols. Make sense of both symbols and numbers. Reason inductively about data, making reasonable arguments that consider the context from which the data arose. As new evidence is presented, review position and revise as necessary.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects and situations as being composed of multiple parts. Apply a variety of strategies to finding solutions for a problem in context. Notice patterns and structure in repeated calculations and look for generalizations, general methods, and shortcuts. Check for reasonableness and needed adjustments in strategies while solving problems.

Data, Probability, and Statistical Reasoning

7.DPSR.1. Analyze data sets to identify their statistical elements.

Indicator	*Indicator Insight*
7.DPSR.1.1 Create stem-and-leaf plots to represent numerical data sets in mathematical and real-world situations.	Teach using data displays, not just numerical sets. This is students' first exposure to stem-and-leaf plots.
7.DPSR.1.2 Use the shape of the graph to select which measure of center, *mean, median or mode,* best describes the data set.	This indicator continues the work with spread and center started in sixth grade. Shape includes right skew, left skew, symmetric, uniform, bimodal (two modes), and outliers. This is students' first introduction to mean.
7.DPSR.1.3 Calculate and interpret the measures of center, *mean, median, and mode*, and spread, *mean absolute deviation, interquartile range, and range*, in mathematical and real-world situations.	Compare the difference between *mean, median, and mode*. Include all rational numbers in the data sets. This is students' first exposure to mean absolute deviation.

Indicator	*Indicator Insight*
7.DPSR.1.4 Create histograms to represent data sets and interpret histograms to answer questions or draw conclusions about data sets.	Connecting a stem-and-leaf plot to a histogram can be helpful for students.

7.DPSR.2. Calculate and interpret probability.

Indicator	*Indicator Insight*
7.DPSR.2.1 Identify the sample space for a simple event.	Simple events are introduced in fifth grade.
7.DPSR.2.2 Calculate and interpret the theoretical probability of a simple random event.	This is students' first introduction to theoretical probability. Include replacement when finding probability.
7.DPSR.2.3 Calculate and interpret the experimental probability of a random event related to a simple experiment.	Conduct actual probability experiments and interpret the results.
7.DPSR.2.4 Compare and contrast the experimental and theoretical probabilities for a simple experiment.	Simple experiments include randomly selecting a card from a deck, tossing a coin, rolling a die, spinning a spinner, and randomly selecting a colored tile from a bag. Represent the probability as a fraction, decimal, or percent. Use P(event) notation. Have students determine if games are fair or unfair.

Measurement, Geometry, and Spatial Reasoning

7.MGSR.1. Determine the measurements of geometric figures.

Indicator	*Indicator Insight*
7.MGSR.1.1 Identify the parts of a circle. Parts are limited to center, radius, diameter, and chord.	Understand the definition of a circle. Be able to identify the center, radius, and diameter. Be able to distinguish between a diameter or a chord. Understand the relationship between radius and diameter.
7.MGSR.1.2 Describe the relationship between the radius, diameter, and circumference of a circle.	Physically explore the attributes of the circumference of a circle as a measure of length using concrete materials. Identify **π** through a variety of patterns and relationships. These relationships are another application of proportional reasoning.

Indicator	*Indicator Insight*
7.MGSR.1.3 Solve mathematical and real-world problems involving circumference or area of circles.	Practice finding the exact area or circumference of a circle using $\boldsymbol{\pi}$. Find estimates of area and circumference using the approximations for $\boldsymbol{\pi}$ ($\boldsymbol{\pi} \approx 3.14$, $\boldsymbol{\pi} \approx 3$, or $\boldsymbol{\pi} \approx \frac{22}{7}$). Use the formulas to find missing parts in the circumference formula. Find the area from a given circumference. The expectation is not to find the radius or diameter when given the area because that involves finding the square root, and seventh grade indicators do not include finding square roots.
7.MGSR.1.4 Determine if three given side lengths can form a triangle using the Triangle Inequality Theorem.	Exploration activities to discover patterns to form a triangle leading to the Triangle Inequality Theorem.
7.MGSR.1.5 In mathematical and real-world situations, find the volume of right prisms and right pyramids having triangular or quadrilateral bases.	Include trapezoidal bases. The formula was discovered in sixth grade.
7.MGSR.1.6 In mathematical and real-world situations, find the surface area of right prisms and right pyramids having triangular or quadrilateral bases.	Include trapezoidal bases. Find actual measurements of some figures using rulers to continue the practice from elementary.

7.MGSR.2. Determine angle relationships.

Indicator	*Indicator Insight*
7.MGSR.2.1 Determine the measure of the third angle given the measure of the other two angles of a triangle.	The intent of this indicator is to develop a conceptual understanding of the angles inside of a triangle. Write equations to find the missing angle measure.
7.MGSR.2.2 Solve mathematical and real-world problems involving dimensions and areas of geometric figures including scale drawings and scale factors.	Find the scale factor of similar figures using both the sides and the areas.
7.MGSR.2.3 Identify the relationships and measures among angles formed by two intersecting lines given the measure of one angle. Relationships are limited to supplementary, complementary, vertical, and adjacent.	Use given angle measurements to solve for unknown angle measurements.

Indicator	Indicator Insight
7.MGSR.2.4 Write and solve equations to solve mathematical and real-world problems involving the relationships among angles formed by two intersecting lines. Relationships are limited to supplementary, complementary, vertical, and adjacent.	Instead of a measurement of the angle, there is an algebraic expression that will be used to find the angle measurement. The expectation of this indicator is not to have variables on both sides.

7.MGSR.3. Graph on the coordinate plane.

Indicator	*Indicator Insight*
7.MGSR.3.1 Find distances between ordered pairs on the coordinate plane, limited to the same x-coordinate or the same y-coordinate.	Connect to finding area and perimeter of polygons by calculating vertical and horizontal distances.

Numerical Reasoning

7.NR.1. Translate among multiple representations of rational numbers.

Indicator	*Indicator Insight*
7.NR.1.1 Convert rational numbers into equivalent forms among fractions (including mixed numbers), decimals, and percentages. Exclude the conversion of repeating decimals to fractions.	In sixth grade, denominators are limited.

7.NR.2. Utilize rational numbers in mathematical and real-world situations.

Indicator	*Indicator Insight*
7.NR.2.1 Compare two rational numbers and write statements using *is equal to (=), is not equal to (≠), is less than (<), is greater than (>), is greater than or equal to (≥), and/or is less than or equal to (≤).*	Include negative rational numbers. Practice placing all rational numbers on a number line. Comparisons should include real-world situations.

Patterns, Algebra, and Functional Reasoning

7.PAFR.1. Use tables, graphs, verbal descriptions, or equations to represent a function.

Indicator	*Indicator Insight*
7.PAFR.1.1 Apply proportional reasoning to solve problems in mathematical and real-world situations involving ratios and percentages.	Use a variety of situations, including but not limited to markups (percent increase), markdowns (percent decrease), tip, tax, coupons, discounts, commission, percent error, depreciation, and simple interest.
7.PAFR.1.2 Create a model with functions that address a proportional relationship in real-world situations.	Models should include tables, functions and their graphs, equations, diagrams, and verbal descriptions.

Indicator	*Indicator Insight*
7.PAFR.1.3 Identify the constant of proportionality within proportional relationships.	The constant of proportionality is the unit rate. Use tables, graphs, and equations to identify the constant of proportionality. Introduce $y = kx$.

7.PAFR.2. Write, simplify, and evaluate algebraic expressions; write and solve algebraic equations and inequalities.

Indicator	*Indicator Insight*
7.PAFR.2.1 Write and solve multi-step equations and inequalities in one variable involving rational numbers in mathematical and real-world situations.	Include a fraction bar as a grouping symbol. Combine like terms, but do not include variables on both sides; one side only.
7.PAFR.2.2 Write and evaluate expressions in one variable that model mathematical and real-world situations.	Include all rational numbers when writing and evaluating expressions.
7.PAFR.2.3 Compute unit rates, including those involving complex fractions with like or different units.	Introduce complex fractions, also known as compound fractions.
7.PAFR.2.4 Use dimensional analysis to convert units between the metric and the customary systems.	Problems should include measures of mass, weight, length, and liquid. Convert from metric to customary and customary to metric.

7.PAFR.3. Apply mathematical patterns, properties, and algorithms to the set of rational numbers to find sums, differences, products, and quotients and to write equivalent expressions.

Indicator	*Indicator Insight*
7.PAFR.3.1 Simplify numerical expressions that include integer exponents using the laws of exponents. Rules are limited to the following: *Product Rule, Quotient Rule, Power to a Power, Product to a Power, Quotient to a Power, and Zero Power Property.*	Expose students to expressions and models to look for patterns to create a generalization through examples. Provide experiences to discover the rules.
7.PAFR.3.2 Identify linear expressions that are equivalent.	Combine like terms when needed to show equivalence.
7.PAFR.3.3 Recognize that algebraic expressions may have a variety of equivalent forms and determine an appropriate form for a given real-world situation.	Use the context to determine an equivalent expression that best matches the situation. Know that there can be multiple forms of the same expression.
7.PAFR.3.4 Factor linear expressions with positive and negative whole number coefficients using the greatest common factor (GCF).	Students learn GCF in fifth grade.

Indicator	***Indicator Insight***
7.PAFR.3.5 Apply all operations with rational numbers to solve problems in mathematical and real-world situations.	Include positive and negative fractions and decimals. Develop generalizations through multiple examples with models to find patterns.

Seventh & Eighth Grade Compacted Math Standards

The compacted course for seventh grade is the first course in the accelerated middle school mathematics progression. This course incorporates all the seventh-grade standards and specific eighth grade standards that extend the learning from seventh grade. These standards continue the work started in elementary in these four strands: Data, Probability, and Statistical Reasoning; Measurement, Geometry, and Spatial Reasoning; Numerical Reasoning; and Patterns, Algebra, and Functional Reasoning. Woven throughout all four strands are concepts building on students' understanding with problem solving to provide context to the problems they are solving and learning about which will foster critical thinking and collaboration skills.

In the Numerical Reasoning strand, seventh graders taking this course will extend their understanding of operations with all rational numbers, promoting student understanding of how rational numbers are used in real-world situations. The accelerated pathway will extend the concept to include converting any form of a rational number to any other form. This will include the conversion of repeating decimals to fractions. Broadening the understanding of operations with all rational numbers is critical as integer operations are now taught in sixth grade while seventh grade includes operations with all rational numbers. The accelerated pathway will extend even further to real numbers through classifying and ordering subsets of real numbers in the number system.

In Patterning, Algebraic, and Functional Reasoning, students will expand on what was learned in sixth grade to develop an understanding of proportional relationships. They will represent algebraic concepts using tables, graphs, verbal descriptions, and equations. Students will distinguish proportional relationships from non-proportional relationships while making the connection between unit rate and constant of proportionality. The extension of this knowledge will lead to the ability to solve single- and multi-step problems while working with expressions and linear equations. Students will be provided with multiple opportunities to solve a variety of percentage problems. In this accelerated course, there will be an emphasis on functions, particularly linear functions. Students will also see variables on both sides of an equation.
In the Data, Probability, and Statistical Reasoning strand, the seventh graders taking this course will extend their analysis of data sets to two populations on double line graphs, back-to-back stem-and-leaf plots, and double box plots. Students will calculate and interpret with experimental and theoretical probability. Since probability is only measured between 0 and 1, this makes for an easy connection to fractions, decimals, and percentages. There are no accelerated extensions in this strand.

In the Measurement, Geometric, and Spatial Reasoning strand, seventh graders will be working with two- and three-dimensional figures to solve problems involving area, surface area, and volume. As an extension for the accelerated progression, students will apply geometric formulas to find the volume of cones, cylinders, and spheres in mathematical and real-world situations. Through exploration and discovery, students will develop an understanding of how to find the circumference and area of circles. This will be the first time these concepts have been introduced. Students will identify congruent angles and solve equations relating to angles formed when lines intersect. Distance between points on the coordinate plane will be found and connected back to the area and perimeter of polygons. Transformations on and off the coordinate plane, along with relationships between angles of parallel lines cut by a transversal, will be explored in this accelerated progression.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Interpret the meaning of a problem by imagining the situation, considering multiple entry points, making a plan, and choosing a solution pathway. Demonstrate flexibility in approaching the problem. When the solution pathway does not lead to a solution, look for another way. Recognize that multiple representations, including concrete models, drawings, expressions, equations, verbal descriptions, tables, diagrams, and graphs, are related to each other and can help them solve the problem. Compare other students' approaches to solving the problem and understand there can be multiple ways to solve a problem. To find a correct solution, consider simpler forms of the original problem. Students should continually ask themselves if a solution is reasonable.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in mathematical discourse to explain or justify a conjecture. Solve problems collaboratively. Collaborate with others by posing clarifying questions that help deepen overall understanding of the concept. Be specific with explanations by using objects, drawings, pictures, and symbolic representations. Use a variety of forms to present results to an audience. Use properties of operations to justify the equivalence of expressions. Make decisions about which tools are necessary to use, or not use, in specific situations. Demonstrate proficiency in choosing technology tools that will aid in understanding a concept or formulating a solution to the problem. Attend to precision when checking work and labeling measurements, along with making revisions as needed.
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying number sense with real-world contexts. Understand that fractions, decimals, and percentages are rational numbers. Make sense of missing numbers in equations by using the relationships among addition, subtraction, multiplication, and division. Understand that a complex problem is made up of many smaller problems needing to be solved to get to a “final solution.” Generate mathematical problems using the surrounding world.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Compare arguments, determine if the logic used is reasonable, and be able to explain any errors or flaws found. Construct written and verbal arguments using objects, numbers, drawings, diagrams, mathematical activities, and mathematical symbols. Make sense of both symbols and numbers. Reason inductively about data, making reasonable arguments that consider the context from which the data arose. As new evidence is presented, review position and revise as necessary.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects and situations as being composed of multiple parts. Apply a variety of strategies to finding solutions for a problem in context. Notice patterns and structure in repeated calculations and look for generalizations, general methods, and shortcuts. Check for reasonableness and needed adjustments in strategies while solving problems.

Data, Probability, and Statistical Reasoning

78.DPSR.1. Analyze data sets to identify their statistical elements.

Indicator	***Indicator Insight***
7.DPSR.1.1 Create stem-and-leaf plots to represent numerical data sets in mathematical and real-world situations.	Teach using data displays, not just numerical sets. This is students’ first exposure to stem-and-leaf plots.
7.DPSR.1.2 Use the shape of the graph to select the measure of center, *mean, median or mode*, that best describes the data set.	This indicator continues the work with spread and center started in sixth grade. Shape includes right skew, left skew, symmetric, uniform, bimodal (two modes), and outliers. This is students’ first introduction to mean.
7.DPSR.1.3 Calculate and interpret the measures of center, *mean, median, and mode*, and spread, *mean absolute deviation, interquartile range, and range*, in mathematical and real-world situations.	Compare the difference between mean, median, and mode. Include all rational numbers in the data sets. This is students’ first exposure to mean absolute deviation.

Indicator	*Indicator Insight*
7.DPSR.1.4 Create histograms to represent data sets and interpret histograms to answer questions or draw conclusions about data sets.	Connecting a stem-and-leaf plot to a histogram can be helpful for students.

78.DPSR.2. Calculate and interpret probability.

Indicator	*Indicator Insight*
7.DPSR.2.1 Identify the sample space for a simple event.	Simple events are introduced in fifth grade.
7.DPSR.2.2 Calculate and interpret the theoretical probability of a simple random event.	This is students' first introduction to theoretical probability. Include replacement when finding probability.
7.DPSR.2.3 Calculate and interpret the experimental probability of a random event related to a simple experiment.	Conduct actual probability experiments and interpret the results.
7.DPSR.2.4 Compare and contrast the experimental and theoretical probabilities for a simple experiment.	Simple experiments include randomly selecting a card from a deck, tossing a coin, rolling a die, spinning a spinner, and randomly selecting a colored tile from a bag. Represent the probability as a fraction, decimal, or percent. Use P(event) notation. Have students determine if games are fair or unfair.

Measurement, Geometry, and Spatial Reasoning

78.MGSR.1. Determine the measurements of geometric figures.

Indicator	*Indicator Insight*
7.MGSR.1.1 Identify the parts of a circle. Parts are limited to *center, radius, diameter, and chord.*	Understand the definition of a circle. Be able to distinguish between a diameter and other chords. Understand the relationship between radius and diameter.
7.MGSR.1.2 Describe the relationship between the radius, diameter, and circumference of a circle.	Physically explore the attributes of the circumference of a circle as a measure of length using concrete materials. Identify **π** through a variety of patterns and relationships. These relationships are another application of proportional reasoning.

Indicator	*Indicator Insight*
7.MGSR.1.3 Solve mathematical and real-world problems involving circumference or area of circles.	Practice finding the exact area or circumference of a circle using $\boldsymbol{\pi}$. Find estimates of area and circumference using the approximations for $\boldsymbol{\pi}$ ($\boldsymbol{\pi} \approx 3.14$, $\boldsymbol{\pi} \approx 3$ or $\boldsymbol{\pi} \approx \frac{22}{7}$). Use the formulas to find missing parts in the circumference formula. Find the area from a given circumference. The expectation is not to find the radius or diameter when given the area because that involves finding the square root, and seventh grade indicators do not include finding square roots.
7.MGSR.1.4 Determine if three given side lengths can form a triangle using the Triangle Inequality Theorem.	Exploration activities to discover patterns to form a triangle leading to the Triangle Inequality Theorem.
7.MGSR.1.5 In mathematical and real-world situations, find the volume of prisms and pyramids having triangular or quadrilateral bases.	Include trapezoidal bases. The formula was discovered in sixth grade.
7.MGSR.1.6 In mathematical and real-world situations, find the surface area of prisms and pyramids having triangular or quadrilateral bases.	Include trapezoidal bases. Find actual measurements of some figures using rulers to continue the practice from elementary.
8.MGSR.1.1 Given the geometric formulas, find the volume of cones, cylinders, and spheres in mathematical and real-world situations.	Show that the volume of a cone is $\frac{1}{3}$ the volume of a cylinder with congruent heights and bases through hands-on experiences.

78.MGSR.2. Determine angle relationships.

Indicator	*Indicator Insight*
7.MGSR.2.1 Determine the measure of the third angle given the measure of the other two angles of a triangle.	The intent of this indicator is to develop a conceptual understanding of the angles inside of a triangle. Write equations to find the missing angle measure.
7.MGSR.2.2 Solve mathematical and real-world problems involving dimensions and areas of geometric figures including scale drawings and scale factors.	Find the scale factor of similar figures using both the sides and the areas.
7.MGSR.2.3 Identify the relationships and measures among angles formed by two intersecting lines given the measure of one angle. Relationships are limited to supplementary, complementary, vertical, and adjacent.	Use given angle measurements to solve for unknown angle measurements.

Indicator	*Indicator Insight*
7.MGSR.2.4 Write and solve equations to solve mathematical and real-world problems involving the relationships among angles formed by two intersecting lines. Relationships are limited to supplementary, complementary, vertical, and adjacent.	Instead of a measurement of the angle, there is an algebraic expression that will be used to find the angle measurement. Avoid variables on both sides.
8.MGSR.2.1 Determine missing angle measurements created when parallel lines are cut by a transversal.	Consider complementary, supplementary, vertical, adjacent, same side interior, alternate interior, and alternate exterior angles. At this point, parallel and perpendicular lines should be defined.
8.MGSR.2.2 Determine if two-dimensional figures are congruent or similar.	Use proportional reasoning to determine if figures are congruent or similar.
8.MGSR.2.3 Identify the congruent corresponding angles of similar polygons.	Use appropriate labeling.
8.MGSR.2.5 Apply proportional reasoning to find the missing side lengths of two similar figures.	Given lengths of corresponding sides, use a proportion to solve for the missing side. Sides could include algebraic expressions limited to linear equations.

78.MGSR.3. Graph on the coordinate plane.

Indicator	*Indicator Insight*
7.MGSR.3.1 Find distances between ordered pairs on the coordinate plane, limited to the same x-coordinate or the same y-coordinate.	Connect to finding area and perimeter of polygons by calculating vertical and horizontal distances.
8.MGSR.3.1 Identify the transformation as a rotation, reflection, and/or translation. Rotations should be limited to multiples of 90 degrees centered on the origin.	Can be on or off a coordinate plane. Given a preimage and image, name the transformation. Attention should be given to congruence to the two images. Use a variety of methods including but not limited to manipulatives and technology.
8.MGSR.3.3 Translate geometric figures vertically and/or horizontally.	Use verbal descriptions as well as ordered pairs to describe the translations. Use a variety of methods including but not limited to manipulatives and technology.
8.MGSR.3.4 Reflect geometric figures with respect to the x-axis and/or y-axis.	Focus only on reflections over the x-axis or y-axis, not over any other lines. Use a variety of methods including but not limited to manipulatives and technology.
8.MGSR.3.5 Rotate geometric figures 90, 180, and 270 degrees, both clockwise and counterclockwise, about the origin in a coordinate plane.	Identify rotational symmetry of two-dimensional figures. Use a variety of methods including but not limited to manipulatives and technology. This will be students' introduction to symmetry.

Indicator	***Indicator Insight***
8.MGSR.3.6 Create a dilation using a given scale factor and describe the effect of a dilation.	Dilation is centered at origin. Name the scale factor. Use a variety of methods including but not limited to manipulatives and technology.
8.MGSR.3.7 Describe the effect of a series of transformations, including *dilations, translations, rotations, and reflections*, on two-dimensional figures using coordinates on the coordinate plane.	Rotate in multiples of 90 degrees around the origin and dilate centered on origin. Translate geometric figures horizontally and vertically. Use ordered pairs to describe the translation. Given two congruent figures, determine the sequence of transformation. Use a variety of methods including but not limited to manipulatives and technology.

Numerical Reasoning

78.NR.1. Translate among multiple representations of rational numbers.

Indicator	***Indicator Insight***
7.NR.1.1 Convert rational numbers into equivalent forms among fractions, decimals, and percentages. Exclude the conversion of repeating decimals to fractions.	In sixth grade, the denominators are limited.
8.NR.1.1 Convert any form of a rational number to any other form including fractions (mixed numbers), decimals, and percentages.	Include the conversion of repeating decimals to fractions.

78.NR.2. Utilize real numbers in mathematical and real-world situations.

Indicator	***Indicator Insight***
7.NR.2.1 Compare two rational numbers and write statements using *is equal to (=), is not equal to (≠), is less than (<), is greater than (>), is greater than or equal to (≥), and/or is less than or equal to (≤)* in mathematical and real-world situations.	Include negative rational numbers. Practice placing all rational numbers on a number line. Comparisons should include real-world situations.
8.NR.2.1 Compare real numbers and write statements using *is equal to (=), is not equal to (≠), is less than (<), is greater than (>), is greater than or equal to (≥), or is less than or equal to (≤).*	Comparisons should include problems based on real-world situations.
8.NR.2.2 Classify and order the subsets of real numbers in the number system including natural, whole, integer, rational, and irrational numbers.	Use a Venn diagram to classify numbers. Use a number line to locate and order them. Describe the difference between a rational and irrational number.

Patterns, Algebra, and Functional Reasoning

78.PAFR.1. Determine if a table, graph, verbal description, or equation represents a function and describe its characteristics.

Indicator	***Indicator Insight***
7.PAFR.1.1 Apply proportional reasoning to solve problems in mathematical and real-world situations involving ratios and percentages.	Use a variety of situations, including markups (percent increase), markdowns (percent decrease), tip, tax, coupons, discounts, commission, percent error, depreciation, simple interest.
7.PAFR.1.2 Create a model with functions that address a proportional relationship in real-world situations.	Models should include tables, functions and their graphs, equations, diagrams, and verbal descriptions.
7.PAFR.1.3 Identify the constant of proportionality within proportional relationships.	The constant of proportionality is the unit rate. Use tables, graphs, and equations to identify the constant of proportionality. Introduce $y = kx$.
8.PAFR.1.1 Define an equation in slope-intercept form ($y = mx + b$) as being a linear function.	Introduce that slope-intercept form is a linear function.
8.PAFR.1.2 Identify and describe the constant rate of change of a linear function using a graph and table.	Interpret the rate of change and y intercept in context. Connect $y = kx$ (constant of proportionality) to constant rate of change.
8.PAFR.1.3 Determine if a graph, table, mapping, or verbal description is a function (linear or nonlinear) or not a function.	Identify the domain and range as a list of numbers or as an inequality (could include compound inequalities). Have students recognize that a table may not determine a function.
8.PAFR.1.4 Describe the key features of given functions, including domain, range, intervals of increasing or decreasing, constant, discrete, continuous, and intercepts.	Identify the domain and range as a list of numbers or as an inequality (could include compound inequalities). Describe whether the function is increasing, decreasing, or constant. Draw the graph from a written description or write a description of the graphical representation.
8.PAFR.1.6 Translate among the multiple representations including mappings, tables, graphs, verbal description, and equations (only when linear) of a function.	Technology such as spreadsheets for tables and graphing tools for graphs is suggested.

78.PAFR.2. Write, simplify, and evaluate algebraic expressions; write and solve algebraic equations and inequalities.

Indicator	*Indicator Insight*
7.PAFR.2.1 Write and solve multi-step equations and inequalities in one variable involving rational numbers in mathematical and real-world situations.	Include a fraction bar as a grouping symbol. Combine like terms, but do not include variables on both sides; one side only.
7.PAFR.2.2 Write and evaluate expressions in one variable that model mathematical and real-world situations.	Include all rational numbers when writing and evaluating expressions.
7.PAFR.2.3 Compute unit rates, including those involving complex fractions with like or different units.	Introduce complex fractions, also known as compound fractions.
7.PAFR.2.4 Use dimensional analysis to convert units between the metric and the customary systems.	Problems should include measures of mass, weight, length, and liquid. Include mass, weight, length, and liquid measures. Convert from metric to customary and customary to metric.
8.PAFR.2.1 Solve multi-step one variable equations and inequalities with variables on both sides with rational coefficients.	This is students' introduction to equations and inequalities with variables on both sides.
8.PAFR.2.3 Identify the rate of change for a linear function as the slope of the line.	This indicator helps students understand the slope is the rate of change.

78.PAFR.3. Apply mathematical patterns, properties, and algorithms to the set of rational numbers to find sums, differences, products, and quotients and to write equivalent expressions.

Indicator	*Indicator Insight*
7.PAFR.3.1 Simplify numerical expressions that include integer exponents using the laws of exponents. Rules are limited to the following: *Product Rule, Quotient Rule, Power to a Power, Product to a Power, Quotient to a Power, and Zero Power Property.*	Expose students to expressions and models to look for patterns to create a generalization through examples. Provide experiences to discover the rules.
7.PAFR.3.2 Identify linear expressions that are equivalent.	Combine like terms when needed to show equivalence.
7.PAFR.3.3 Recognize that algebraic expressions may have a variety of equivalent forms and determine an appropriate form for a given real-world situation.	Use the context to determine an equivalent expression that best matches the situation. Know that there can be multiple forms of the same expression.
7.PAFR.3.4 Factor linear expressions with integer coefficients using the greatest common factor (GCF).	Students learn GCF in fifth grade.

Indicator	*Indicator Insight*
7.PAFR.3.5 Apply all operations with rational numbers to solve problems in mathematical and real-world situations.	Include positive and negative fractions and decimals. Develop generalizations through multiple examples with models to find patterns.
8.PAFR.3.3 Apply laws of exponents to simplify algebraic expressions involving no more than three variables and integer exponents.	This indicator extends the laws of exponents from seventh grade where students are evaluating numerical expressions.

Eighth Grade Math Standards

The standards for Middle School continue the work started in elementary in these four strands: Data, Probability, and Statistical Reasoning; Measurement, Geometry, and Spatial Reasoning; Numerical Reasoning; and Patterns, Algebra, and Functional Reasoning. Woven throughout all four strands are concepts building on students' understanding with problem solving to provide context to the problems they are solving which will foster critical thinking and collaboration skills.

In the Numerical Reasoning strand, eighth graders will convert any form of rational numbers to other forms, which for the first time includes translating repeating decimals to their fraction form. This strand also has students identify the subsets of Real Numbers and contrast rational and irrational numbers, which will include working with perfect squares and cubes and their roots. They will write equations and inequalities to compare real numbers given in real-world settings. Students will apply the Laws of Exponents learned in seventh grade to include algebraic expressions.

In the Patterns, Algebra, and Functional Reasoning strand, eighth graders will concentrate on functions, learning the slope-intercept form of a linear function. Students' connect proportionality and linear functions together so that the constant rate of change (slope) and *y*-intercept can be identified and interpreted. Students will analyze multiple representations of functions to determine if they represent a linear or nonlinear function or represent a non-function. For the first time, students compare two equations to determine if they represent functions with one solution, no solution, or infinite solutions. Also, for the first time, they solve one-variable multi-step equations and inequalities with the same variable on both sides.

In Data, Probability, and Statistical Reasoning, eighth graders will compare bivariate (two variable) data. This is the first time that students will work with two variables simultaneously. They will use scatter plots to organize bivariate data from real-world situations. Students will estimate the line of best fit for scatter plots and describe associations among the data points by their direction, form, strength, and, when applicable, clusters, gaps, and outliers. Eighth graders will identify sample spaces and calculate and interpret the probability of compound events, using fractions, decimals, or percentages to report the probability of events.

In the Measurement, Geometry, and Spatial Reasoning strand, eighth graders will use technology to explore volume and other formulas to include the *Pythagorean Theorem*. The focus on right triangles will also include Pythagorean Triples, the Triangle Sum Theorem, the relationship among the measures of triangles' interior and exterior angles, and sums of angle measures of polygons decomposed into triangles. Eighth graders will study transformations and dilations of polygons graphed on or off of the coordinate plane. Students will study angle relationships of parallel lines. Students will also use proportional reasoning to determine congruence or similarity among polygons, finding the missing side lengths and identifying corresponding angles.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Interpret the meaning of a problem by imagining the situation, considering multiple entry points, making a plan, and choosing a solution pathway. Demonstrate flexibility in approaching the problem. When the solution pathway does not lead to a solution, look for another way. Recognize that multiple representations, including concrete models, drawings, expressions, equations, verbal descriptions, tables, diagrams, and graphs, are related to each other and can help them solve the problem. Compare other students' approaches to solving the problem and understand there can be multiple ways to solve a problem. To find a correct solution, consider simpler forms of the original problem. Students should continually ask themselves if a solution is reasonable.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in mathematical discourse to explain or justify a conjecture. Solve problems collaboratively. Collaborate with others by posing clarifying questions that help deepen overall understanding of the concept. Be specific with explanations by using objects, drawings, pictures, and symbolic representations. Use a variety of forms to present results to an audience. Use properties of operations to justify the equivalence of expressions. Make decisions about which tools are necessary to use, or not use, in specific situations. Demonstrate proficiency in choosing technology tools that will aid in understanding a concept or formulating a solution to the problem. Attend to precision when checking work and labeling measurements, along with making revisions as needed.
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying number sense with real-world contexts. Understand that fractions, decimals, and percentages are rational numbers. Make sense of missing numbers in equations by using the relationships among addition, subtraction, multiplication, and division. Understand that a complex problem is made up of many smaller problems needing to be solved to get to a "final solution." Generate mathematical problems using the surrounding world.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Compare arguments, determine if the logic used is reasonable, and be able to explain any errors or flaws found. Construct written and verbal arguments using objects, numbers, drawings, diagrams, mathematical activities, and mathematical symbols. Make sense of both symbols and numbers. Reason inductively about data, making reasonable arguments that consider the context from which the data arose. As new evidence is presented, review position and revise as necessary.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects and situations as being composed of multiple parts. Apply a variety of strategies to finding solutions for a problem in context. Notice patterns and structure in repeated calculations and look for generalizations, general methods, and shortcuts. Check for reasonableness and needed adjustments in strategies while solving problems.

Data, Probability, and Statistical Reasoning

8.DPSR.1. Analyze data sets to identify their statistical elements.

Indicator	*Indicator Insight*
8.DPSR.1.1 Create and analyze scatter plots to represent numerical data sets in mathematical and real-world situations.	Analyze the correlation of the data points to determine whether it is strong, weak, or no correlation. Determine if there is a negative, positive, or no relationship.
8.DPSR.1.2 Draw inferences about data sets from two populations using the shape of the distribution, measures of center, and measures of variability. Measures are limited to *mean, median, mode, range, mean absolute deviation, and interquartile range*.	Give examples of similarities and differences and usefulness of these measures of center and variability. Use a box plot to compare two different populations. Draw inferences about data sets that contain outliers.
8.DPSR.1.3 Describe how adding and deleting data throughout the data set can affect the mean, median, mode, and distribution of the data set.	Data set discussions should include the effects of outliers.

Indicator	Indicator Insight
8.DPSR.1.4 For two data sets, compare and interpret the centers, spreads, and overlap of data to draw inferences about data in mathematical and real-world situations. Limit displays to double line graphs, back-to-back stem-and-leaf plots, and double box plots.	Give a visual comparison between two data sets. Data sets should include numerical or graphical sets. This would be a good place to compare correlation versus causation.

8.DPSR.2. Calculate and interpret probability.

Indicator	Indicator Insight
8.DPSR.2.1 Determine the sample space for a compound event.	Use organized lists, tables, or tree diagrams.
8.DPSR.2.2 Calculate and interpret the probability of compound independent and dependent events.	Use organized lists, tables, and tree diagrams. Report probability as a fraction, decimal, or percentage.

Measurement, Geometry, and Spatial Reasoning

8.MGSR.1. Determine the measurements of geometric figures.

Indicator	Indicator Insight
8.MGSR.1.1 Given the geometric formulas, find the volume of cones, cylinders, and spheres in mathematical and real-world situations.	Show that the volume of a cone is $\frac{1}{3}$ the volume of a cylinder with congruent heights and bases through hands-on experiences.
8.MGSR.1.2 Find the distance between any two points in the coordinate plane using the *Pythagorean Theorem*.	Use the *Pythagorean Theorem* to find the length of the diagonal line in the coordinate plane by drawing a right triangle.
8.MGSR.1.3 Given the *Pythagorean Theorem*, determine unknown side lengths in right triangles in mathematical and real-world situations.	The *Pythagorean Theorem* can be used to find any side of the right triangle, not just the hypotenuse.
8.MGSR.1.4 Determine if a given set of sides forms a right triangle.	Identify the pattern in Pythagorean triples. Use Converse of *Pythagorean Theorem*.

8.MGSR.2. Determine angle relationships.

Indicator	Indicator Insight
8.MGSR.2.1 Determine missing angle measurements created when parallel lines are cut by a transversal.	Consider complementary, supplementary, vertical, adjacent, same side interior, alternate interior, and alternate exterior angles. At this point, parallel and perpendicular lines should be defined.
8.MGSR.2.2 Determine if two-dimensional figures are congruent or similar.	Use proportional reasoning to determine if figures are congruent or similar.
8.MGSR.2.3 Identify the congruent corresponding angles of similar polygons.	Use appropriate labeling.

Indicator	*Indicator Insight*
8.MGSR.2.4 Discover and apply the Exterior Angle Theorem of triangles to find a missing angle.	Connect to the study of supplementary angles in seventh grade.
8.MGSR.2.5 Apply proportional reasoning to find the missing side lengths of two similar figures.	Given lengths of corresponding sides, use a proportion to solve for the missing side. Sides could include algebraic expressions limited to linear equations.

8.MGSR.3. Graph on a coordinate plane.

Indicator	*Indicator Insight*
8.MGSR.3.1 Identify the transformation as a rotation, reflection, and/or translation. Rotations should be limited to multiples of 90 degrees centered on the origin.	Can be on or off a coordinate plane. Given a preimage and image, name the transformation. Attention should be given to congruence to the two images. Use a variety of methods including but not limited to manipulatives and technology.
8.MGSR.3.2 Identify congruent angles and congruent line segments of a preimage and its image.	Congruent images should include a single and/or multiple rigid transformations.
8.MGSR.3.3 Translate geometric figures vertically and/or horizontally.	Use verbal descriptions as well as ordered pairs to describe the translations. Use a variety of methods including but not limited to manipulatives and technology.
8.MGSR.3.4 Reflect geometric figures with respect to the x-axis and/or y-axis.	Focus only on reflections over the x-axis or y-axis, not over any other lines. Use a variety of methods including but not limited to manipulatives and technology.
8.MGSR.3.5 Rotate geometric figures 90, 180, and 270 degrees, both clockwise and counterclockwise, about the origin in a coordinate plane.	Identify rotational symmetry of two-dimensional figures. Use a variety of methods including but not limited to manipulatives and technology. This will be students' introduction to symmetry.
8.MGSR.3.6 Create a dilation using a given scale factor and describe the effect of a dilation.	Dilation is centered at origin. Name the scale factor. Use a variety of methods including but not limited to manipulatives and technology.

Indicator	Indicator Insight
8.MGSR.3.7 Describe the effect of a series of transformations, including dilations, translations, rotations, and reflections, on two-dimensional figures using coordinates on the coordinate plane.	Rotate in multiples of 90 degrees around the origin and dilate centered on origin. Translate geometric figures horizontally and vertically. Use ordered pairs to describe the translation. Given two congruent figures, determine the sequence of transformation. Use a variety of methods including but not limited to manipulatives and technology.

Numerical Reasoning

8.NR.1. Translate among multiple representations of rational numbers.

Indicator	Indicator Insight
8.NR.1.1 Convert any form of a rational number to any other form including fractions (mixed numbers), decimals, and percentages.	Include the conversion of repeating decimals to fractions.

8.NR.2. Utilize real numbers in mathematical and real-world situations.

Indicator	Indicator Insight
8.NR.2.1 Compare real numbers and write inequality statements using *is equal to (=), is not equal to (≠), is less than (<), is greater than (>), is greater than or equal to (≥), or is less than or equal to (≤).*	Comparisons should include problems based on real-world situations.
8.NR.2.2 Classify and order the subsets of real numbers in the number system including natural, whole, integer, rational, and irrational numbers.	Use a Venn diagram to classify numbers. Use a number line to locate and order them. Describe the difference between a rational and irrational number.

Patterns, Algebra, and Functional Reasoning

8.PAFR.1. Determine if a table, graph, verbal description, or equation represents a function and describe its characteristics.

Indicator	Indicator Insight
8.PAFR.1.1 Define an equation in slope-intercept form ($y = mx + b$) as being a linear function.	Introduce that slope-intercept form is a linear function.
8.PAFR.1.2 Identify and describe the constant rate of change of a linear function using a graph and table.	Interpret the rate of change and y intercept in context. Connect $y = kx$ (constant of proportionality) that was learned in seventh grade to constant rate of change.

Indicator	*Indicator Insight*
8.PAFR.1.3 Determine if a graph, table, mapping, or verbal description is a function (linear or nonlinear) or not a function.	Identify the domain and range as a list of numbers or as an inequality (could include compound inequalities). Have students recognize that a table may not determine a function.
8.PAFR.1.4 Describe the key features of given functions, including *domain, range, intervals of increasing or decreasing, constant, discrete, continuous, and intercepts*.	Identify the domain and range as a list of numbers or as an inequality (could include compound inequalities). Describe whether the function is increasing, decreasing, or constant. Draw the graph from a written description or write a description of the graphical representation.
8.PAFR.1.5 Use multiple representations including mappings, tables, graphs, verbal description, and equations (only when linear) of two functions to compare the functions and draw conclusions.	Technology such as spreadsheets for tables and Graphing Utility for graphs is suggested.
8.PAFR.1.6 Translate among the multiple representations including mappings, tables, graphs, verbal description, and equations (only when linear) of a function.	Technology such as spreadsheets for tables and Graphing Utility for graphs is suggested.

8.PAFR.2. Write, simplify, and evaluate algebraic expressions; write and solve algebraic equations and inequalities.

Indicator	*Indicator Insight*
8.PAFR.2.1 Solve multi-step one variable equations and inequalities with variables on both sides with rational coefficients.	This is students' introduction to equations and inequalities with variables on both sides.
8.PAFR.2.2 Describe single-variable equations as having one solution, no solution, or an infinite number of solutions.	Students need to recognize the three types of possible solutions using tables, graphs, or equations.
8.PAFR.2.3 Identify the rate of change for a linear function as the slope of the line.	This indicator helps students understand the slope is the rate of change.
8.PAFR.2.4 Explain why the slope, m, is the same between any two distinct points on a linear graph.	Students need to understand that the distance between points on the line are always proportionally the same.
8.PAFR.2.5 Given a table or a graph, identify the slope and the y-intercept of a line and write a linear equation to express that line.	Include multiple symbolic representations.

8.PAFR.3. Apply mathematical patterns, properties, and algorithms to the set of rational numbers to find sums, differences, products, and quotients and to write equivalent expressions.

Indicator	***Indicator Insight***
8.PAFR.3.1 Analyze patterns of perfect squares and perfect cubes to evaluate square roots and cube roots. Limit to square roots less than or equal to 400 and cube roots less than or equal to 1,000.	Look at patterns to make connections to geometric squares and cubes. Use tiles, unit cubes, and/or centimeter cubes to build geometric squares and cubes.
8.PAFR.3.2 Approximate non-perfect square roots and cube roots to nearest tenth. Limit to square roots less than or equal to 400 and cube roots less than or equal to 1,000.	Use a variety of strategies, including but not limited to manipulatives and number lines, to help build student understanding.
8.PAFR.3.3 Apply laws of exponents to simplify algebraic expressions involving no more than three variables and integer exponents.	This indicator extends the laws of exponents from seventh grade where students are evaluating only numerical expressions.

Eighth Grade & Geometry Compacted Math Standards

Students taking this course are a part of the accelerated progression. This course will be a combination of eighth grade math indicators and Geometry with Statistics indicators. The indicators from eighth grade that were chosen to be embedded in this course are those that align with the indicators for Geometry, along with others that will help prepare students to be successful in this Geometry course.

Geometry with Statistics is a newly designed course that builds on the students' experiences in the middle grades. It is the first of three required courses in high school mathematics, providing a common experience for all students entering high-school-level mathematics. Geometry with Statistics builds essential concepts necessary for students to meet their postsecondary goals, whether they pursue additional study or enter the workforce, to function as effective citizens, and to recognize the wonder, joy, and beauty of mathematics (NCTM, 2018). This is important because it helps students develop mathematical knowledge and skills through visual representations prior to the more abstract development of Algebra.

Offering Geometry with Statistics in eighth grade allows students the opportunity to build their reasoning and sensemaking skills, see the applicability of mathematics, and prepare more effectively for further studies in Algebra. The course also focuses on statistics in analyzing data, which provides students with tools to describe, show, and summarize data in the world around them.

In Geometry with Statistics, students incorporate knowledge and skills from several mathematics content areas, leading to a deeper understanding of fundamental relationships within the discipline and building a solid foundation for further study. In the content area of Geometry and Measurement, students build on and deepen prior understanding of transformations, congruence, similarity, and coordinate geometry concepts. Informal explorations of transformations provide a foundation for more formal considerations of congruence and similarity, including development of criteria for triangle congruence and similarity. An emphasis on reasoning throughout the content area promotes exploration, conjecture testing, and informal and formal justification. In the content area of Algebra and Functions, students perform algebraic calculations with specific application to Geometry that build on foundations of Algebra from seventh and eighth grades. Probability is important because it educates one in the logic of uncertainty and randomness, which occur in almost every aspect of daily life. Therefore, studying probability structures will enhance students' ability to organize information and improve decision-making.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Interpret the meaning of a problem by imagining the situation, considering multiple entry points, making a plan, and choosing a solution pathway. Demonstrate flexibility in approaching the problem. When the solution pathway does not lead to a solution, look for another way. Recognize that multiple representations, including concrete models, drawings, expressions, equations, verbal descriptions, tables, diagrams, and graphs, are related to each other and can help them solve the problem. Compare other students' approaches to solving the problem and understand there can be multiple ways to solve a problem. To find a correct solution, consider simpler forms of the original problem. Students should continually ask themselves if a solution is reasonable.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in mathematical discourse to explain or justify a conjecture. Solve problems collaboratively. Collaborate with others by posing clarifying questions that help deepen overall understanding of the concept. Be specific with explanations by using objects, drawings, pictures, and symbolic representations. Use a variety of forms to present results to an audience. Use properties of operations to justify the equivalence of expressions. Make decisions about which tools are necessary to use, or not use, in specific situations. Demonstrate proficiency in choosing technology tools that will aid in understanding a concept or formulating a solution to the problem. Attend to precision when checking work and labeling measurements, along with making revisions as needed.
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Make connections applying number sense with real-world contexts. Understand that fractions, decimals, and percentages are rational numbers. Make sense of missing numbers in equations by using the relationships among addition, subtraction, multiplication, and division. Understand that a complex problem is made up of many smaller problems needing to be solved to get to a "final solution." Generate mathematical problems using the surrounding world.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Compare arguments, determine if the logic used is reasonable, and be able to explain any errors or flaws found. Construct written and verbal arguments using objects, numbers, drawings, diagrams, mathematical activities, and mathematical symbols. Make sense of both symbols and numbers. Reason inductively about data, making reasonable arguments that consider the context from which the data arose. As new evidence is presented, review position and revise as necessary.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Recognize complex mathematical objects and situations as being composed of multiple parts. Apply a variety of strategies to finding solutions for a problem in context. Notice patterns and structure in repeated calculations and look for generalizations, general methods, and shortcuts. Check for reasonableness and needed adjustments in strategies while solving problems.

Data, Probability, and Statistical Reasoning

GS.DPSR.1. Summarize, represent, and interpret data on two categorical and quantitative variables.

Indicator	***Indicator Insight***
GS.DPSR.1.1 Represent data for two quantitative variables on a scatter plot and describe how the variables are related.	Include linear and nonlinear associations.
GS.DPSR.1.2 Use two representative points from the data to find an approximate line of fit and compare it to the line of best fit.	Use a low-tech approach to identify possible pairs of points for the approximate line of best fit.
GS.DPSR.1.3 Conduct an investigation for a statistical question, interpret statistical significance in the context of a situation, and answer investigative questions appropriately.	Distinguish statistical questions from other types of questions. Compose statistical questions to collect and analyze appropriate data to answer the statistical investigative question.

8.DPSR.1. Analyze data sets to identify their statistical elements.

Indicator	***Indicator Insight***
8.DPSR.1.1 Create and analyze scatter plots to represent numerical data sets in mathematical and real-world situations.	Analyze the correlation of the data points to determine whether it is strong, weak, or no correlation. Determine if there is a negative, positive, or no relationship.
8.DPSR.1.2 Draw inferences about data sets from two populations using the shape of the distribution, measures of center, and measures of variability. Measures are limited to *mean, median, mode, range, mean absolute deviation, and interquartile range*.	Give examples of similarities and differences and usefulness of these measures of center and variability. Use a box plot to compare two different populations. Draw inferences about data sets that contain outliers.
8.DPSR.1.3 Give examples of similarities and differences and usefulness of these measures of center and variability. Use a box plot to compare two different populations. Include data sets with outliers.	Data set discussions should include the effects of outliers.
8.DPSR.1.4 For two data sets, compare and interpret the centers, spreads, and overlap of data to draw inferences about data in mathematical and real-world situations. Limit displays to double line graphs, back-to-back stem-and-leaf plots, and double box plots.	Give a visual comparison between two data sets. Data sets should include numerical or graphical sets. This would be a good place to compare correlation versus causation.

GS.DPSR.2. Analyze and interpret models for two quantitative variables.

Indicator	***Indicator Insight***
GS.DPSR.2.1 Distinguish between correlation and causation.	Explore possible reasons for an association: • Predictor causes response, • Response causes predictor, • Lurking variable, or • Random occurrence.

8.DPSR.2. Calculate and interpret probability.

Indicator	***Indicator Insight***
8.DPSR.2.1 Determine the sample space for a compound event.	Use organized lists, tables, or tree diagrams.
8.DPSR.2.2 Calculate and interpret the probability of compound independent and dependent events.	Use organized lists, tables, and tree diagrams. Report probability as a fraction, decimal, or percentage.

GS.DPSR.3. Solve problems involving the probability of compound events in real-world situations.

Indicator	***Indicator Insight***
GS.DPSR.3.1 Describe categories of events as subsets of a sample space using *unions, intersections, or complements of other events*.	Consider using Venn Diagrams.
GS.DPSR.3.2 Apply the *Addition Rule* to find the probability of both mutually exclusive and not mutually exclusive events and interpret the answers in context.	Consider using Venn Diagrams.
GS.DPSR.3.3 Apply the Multiplication Rule to determine the probability of independent events and interpret the answers in context.	Give real-world examples of events occurring simultaneously. Consider using Venn Diagrams.

Measurement, Geometry, and Spatial Reasoning

GS.MGSR.1. Compute area and volume of figures by determining how the figure might be obtained from simpler figures by dissection and recombination.

Indicator	***Indicator Insight***
GS.MGSR.1.1 Apply area and volume formulas of two-/three-dimensional figures to solve real-world problems.	Use two-dimensional and three-dimensional irregular, regular, and composite figures.
GS.MGSR.1.2 Identify the shape of a two-dimensional cross section of a three-dimensional figure.	Consider including comparison of the figures.
GS.MGSR.1.3 Use cross sections of three-dimensional figures to model and solve mathematical and real-world situations.	Dynamic geometry software should be used to visualize cross sections of three-dimensional figures.

8.MGSR.1. Determine the measurements of geometric figures.

Indicator	***Indicator Insight***
8.MGSR.1.2 Find the distance between any two points in the coordinate plane using the *Pythagorean Theorem*.	Use the *Pythagorean Theorem* to find the length of the diagonal line in the coordinate plane by drawing a right triangle.
8.MGSR.1.3 Given the *Pythagorean Theorem*, determine unknown side lengths in right triangles in mathematical and real-world situations.	The *Pythagorean Theorem* can be used to find any side of the right triangle, not just the hypotenuse.
8.MGSR.1.4 Determine if a given set of sides forms a right triangle.	Identify the pattern in Pythagorean triples. Use Converse of *Pythagorean Theorem*.

GS.MGSR.2. Apply rigid geometric transformations to figures describing their attributes and symmetries.

Indicator	***Indicator Insight***
GS.MGSR.2.1 Describe the results of transformations on a given figure using geometric terminology from the definitions of the transformations.	Apply rotations, reflections, and translations to figures using graph paper, tracing paper, and dynamic geometry software. Discuss orientation and what distinguishes the new figure from the original figure.
GS.MGSR.2.2 Describe and apply a sequence of transformations that maps a preimage onto its image.	Develop definitions of rotations, reflection, and translation in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

8.MGSR.2. Determine angle relationships.

Indicator	***Indicator Insight***
8.MGSR.2.4 Discover and apply the Exterior Angle Theorem of triangles to find a missing angle.	Connect to the study of supplementary angles in seventh grade.

GS.MGSR.3. Determine that two figures are congruent by demonstrating that a rigid motion or a sequence of rigid motions maps one figure onto the other.

Indicator	***Indicator Insight***
GS.MGSR.3.1 Identify types of symmetry of polygons, including line, point, rotational, and self-congruence, and use symmetry to analyze mathematical situations.	Consider using areas and volumes to show similarity and symmetry.
GS.MGSR.3.2 Demonstrate that triangles and quadrilaterals are congruent by a combination of translations, rotations, and reflections.	Dynamic geometry software can be used to demonstrate congruence.
GS.MGSR.3.3 Recognize the criteria for showing triangles are congruent using a sequence of rigid motions that map one triangle to another and justify the two triangles are congruent by applying the *Side-Side-Side, Side-Angle-Side, Angle-Side-Angle, Angle-Angle-Side, and Hypotenuse-Leg* congruence conditions.	Justify two triangles are congruent by applying the side-side-side, Side-Angle-Side, Angle-Side-Angle, Angle-Angle-Side, and Hypotenuse-Leg congruence conditions. Justifications might be supported by sketches using dynamic geometry software.

8.MGSR.3. Graph on a coordinate plane.

Indicator	***Indicator Insight***
8.MGSR.3.2 Identify congruent angles and congruent line segments of a preimage and its image.	Congruent images should include a single and/or multiple rigid transformations

GS.MGSR.4. Determine that two figures are similar by demonstrating a similarity transformation or a sequence of similarity transformations that maps one figure onto the other.

Indicator	***Indicator Insight***
GS.MGSR.4.1 Demonstrate experimentally the properties of dilations given by a center and a scale factor.	Consider using dynamic geometry software to verify and determine similarity. Determine that two figures are similar by demonstrating a similarity transformation, dilation or composite of a dilation with a rigid motion, or equivalently, a sequence of similarity transformations that maps one figure onto the other.
GS.MGSR.4.2 Justify experimentally that a dilation of a line segment is longer or shorter given the ratio.	Justify facts using specific examples. Explore the ratios.
GS.MGSR.4.3 Recognize the criteria for showing triangles are similar using a similarity transformation that maps one figure to the other and justify the two triangles are similar by applying the *Angle-Angle, Side-Side-Side, and Side-Angle-Side* similarity conditions.	Consider using dynamic geometry software to verify and determine similarity. Determine that two figures are similar by demonstrating a similarity transformation, dilation or composite of a dilation with a rigid motion, or equivalently, a sequence of similarity transformations that maps one figure onto the other.

GS.MGSR.5. Demonstrate whether a conjecture or theorem is true or false using a variety of algebraic and geometric explanations.

Indicator	***Indicator Insight***
GS.MGSR.5.1 Justify and apply the attributes of angle relationships/lines in mathematical and real-world situations.	Proofs of theorems can sometimes be made with transformations, coordinates, or algebra; all approaches can be useful, and in some cases, one may provide a more accessible or understandable argument than another. Apply in mathematical and real-world contexts when: • vertical angles are congruent; • a transversal crosses parallel lines, alternate interior angles are congruent, alternate exterior angles are congruent, and consecutive interior angles are supplementary; • any point on a perpendicular bisector of a line segment is equidistant from the endpoints of the segment; • perpendicular lines form four right angles; and • base angles of isosceles triangles are congruent. Define *angle, perpendicular line, parallel line, line segment, ray, circle, and skew* in terms of the undefined notions of point, line, and plane.
GS.MGSR.5.2 Apply the attributes of triangles in mathematical and real-world situations	Apply in mathematical and real-world situations including but not limited to: • segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; and • medians of a triangle meet at a point. Define *angle, perpendicular line, parallel line, line segment, ray, circle, and skew* in terms of the undefined notions of point, line, and plane. Use geometric figures, both physical and within geometry software, to model, represent and describe real-world objects.

Indicator	*Indicator Insight*
GS.MGSR.5.3 Apply the attributes of quadrilaterals, including diagonals, sides, and angles, to prove that a given quadrilateral is a parallelogram in mathematical and real-world situations.	Proofs of theorems can sometimes be made with transformations, coordinates, algebra, two-column, flow chart or paragraph; all approaches can be useful, and in some cases, one may provide a more accessible or understandable argument than another. Verify and apply in mathematical and real-world situations in which: • opposite sides of a parallelogram are congruent; • opposite angles of a parallelogram are congruent; • diagonals of a parallelogram bisect each other; • rectangles are parallelograms with congruent diagonals; and • parallelogram is a rhombus if and only if the diagonals are perpendicular.

GS.MGSR.6. Discover and apply relationships in similar right triangles.

Indicator	*Indicator Insight*
GS.MGSR.6.1 Discover and apply the converse of *Pythagorean Theorem*.	Use visual proofs of the Pythagorean Theorem.
GS.MGSR.6.2 Discover and apply the constant ratios of the sides in 30-60-90 and 45-45-90 right triangles.	Use the Pythagorean Theorem to derive the constant ratios.
GS.MGSR.6.3 Define the trigonometric ratios using the properties of similar right triangles.	Use a proportion relating corresponding sides of right triangles to define sine, cosine, and tangent.
GS.MGSR.6.4 Determine the sine, cosine, and tangent of an acute angle in a right triangle in the context of mathematical and real-world situations.	Consider examples including but not limited to a ladder against a building, angle of elevation, and angle of depression.
GS.MGSR.6.5 Apply trigonometric ratios (sine, cosine, tangent) and the *Pythagorean Theorem* to solve right triangles problems in real-world situations.	Use trigonometric ratios and the *Pythagorean Theorem* as models of problems in real-world contexts.

G.MGSR.7. Investigate and apply relationships among segments and angles in circles.

Indicator	*Indicator Insight*
GS.MGSR.7.1 Use angle and segment relationships in circles to solve mathematical and real-world situations.	Dynamic geometry software should be used to support investigations.

Indicator	Indicator Insight
GS.MGSR.7.2 Investigate and apply relationships in circles, including inscribed angles, radii, secants, and chords; among inscribed angles, central angles, and circumscribed angles; and between radii and tangents to circles.	Dynamic geometry software should be used to support investigations.

Numerical Reasoning

GS.NR.1. Represent all points on the number line as irrational and rational numbers in the real number system.

Indicator	Indicator Insight
GS.NR.1.1 Rewrite numerical expressions of irrational and rational numbers involving radicals, including addition, subtraction, multiplication, and division, to recognize geometric patterns.	Include operations with radicals. This is students' first introduction to simplifying radicals.

Patterns, Algebra, and Functional Reasoning

GS.PAFR.1. Analyze the structure of an equation or inequality to determine an efficient strategy to find a solution, if one exists, then justify the solution.

Indicator	Indicator Insight
GS.PAFR.1.1 Discover and apply the formulas for the length of an arc and the area of a sector in a circle to develop mathematical models and solve mathematical and real-world problems.	Use proportions and proportional reasoning to derive formulas.
GS.PAFR.1.2 Analyze and apply the derivations of the formulas for the circumference of a circle, area of a circle, and volume of a cylinder, pyramid, and cone to model real phenomena and solve mathematical and real-world problems.	This indicator builds on the laws of exponents students have learned in middle school.

8.PAFR.1. Determine if a table, graph, verbal description, or equation represents a function and describe its characteristics.

Indicator	Indicator Insight
8.PAFR.1.5 Use multiple representations including mappings, tables, graphs, verbal description, and equations (only when linear) of two functions to compare the functions and draw conclusions.	Technology such as spreadsheets for tables and graphing tools for graphs is suggested.

GS.PAFR.2. Interpret the structure of expressions, equations, and inequalities to analyze and make predictions in different contexts.

Indicator	*Indicator Insight*
GS.PAFR.2.1 Apply surface area and volume formulas for prisms, cylinders, pyramids, cones, spheres, and/or compositions of figures to solve problems and justify results.	Include problems that involve algebraic expressions, composite figures/solids, geometric probability, and real-world applications as part of the mathematical modeling cycle.
GS.PAFR.2.2 Analyze slopes of lines to determine whether lines are parallel, perpendicular, or neither.	Address the occurrence of coincidental lines. Exploration of parallel and perpendicular lines outside of its connection to shapes and transversals is a new concept for students.
GS.PAFR.2.3 Determine the equation of a line passing through a given point that is parallel or perpendicular to a given line.	Slope-intercept form of a linear equation. Solve geometric and real-world problems involving lines and slopes.

8.PAFR.2. Write, simplify, and evaluate algebraic expressions; write and solve algebraic equations and inequalities.

Indicator	*Indicator Insight*
8.PAFR.2.2 Describe single-variable equations as having one solution, no solution, or an infinite number of solutions.	Students need to recognize the three types of possible solutions using tables, graphs, or equations.
8.PAFR.2.4 Explain why the slope, m, is the same between any two distinct points on a linear graph.	Students need to understand that the distance between points on the line are always proportionally the same.
8.PAFR.2.5 Given a table or a graph, identify the slope and the y-intercept of a line and write a linear equation to express that line.	Include multiple symbolic representations.

GS.PAFR.3. Determine the exact or approximate solutions of equations and inequalities using graphs on the coordinate plane.

Indicator	*Indicator Insight*
GS.PAFR.3.1 Use coordinates to prove simple geometric theorems algebraically.	Focus on quadrilaterals, right triangles, and circles.
GS.PAFR.3.2 Determine distance and midpoint of segments in a coordinate plane to find areas of triangles and quadrilaterals when given coordinates.	Eighth grade uses *Pythagorean Theorem* to find distance in the coordinate plane. Use distance and midpoint formula to find area in a coordinate plane.

8.PAFR.3. Apply mathematical patterns, properties, and algorithms to the set of rational numbers to find sums, differences, products, and quotients and to write equivalent expressions.

Indicator	***Indicator Insight***
8.PAFR.3.1 Analyze patterns of perfect squares and perfect cubes to evaluate square roots and cube roots. Limit to square roots less than or equal to 400 and cube roots less than or equal to 1,000.	Look at patterns to make connections to geometric squares and cubes. Use tiles, unit cubes, and/or centimeter cubes to build geometric squares and cubes.
8.PAFR.3.2 Approximate non-perfect square roots and cube roots to nearest tenth. Limit to square roots less than or equal to 400 and cube roots less than or equal to 1,000.	Use a variety of strategies, including but not limited to manipulatives and number lines, to help build student understanding.

Geometry with Statistics Standards

Geometry with Statistics is a newly designed course that builds on the students' experiences in the middle grades. It is the first of four required courses in high school mathematics, providing a common ninth grade experience for all students entering high-school-level mathematics. Geometry with Statistics builds essential concepts necessary for students to meet their postsecondary goals, whether they pursue additional study or enter the workforce, to function as effective citizens, and to recognize the wonder, joy, and beauty of mathematics (NCTM, 2018). It is important because it develops mathematical knowledge and skills through visual representations prior to the more abstract development of algebra.

Beginning high school mathematics with Geometry with Statistics in ninth grade offers students the opportunity to build their reasoning and sensemaking skills, see the applicability of mathematics, and prepare more effectively for further studies in algebra. The course also focuses on statistics in analyzing data, which provides students with tools to describe, show, and summarize data in the world around them.

In Geometry with Statistics, students incorporate knowledge and skills from several mathematics content areas, leading to a deeper understanding of fundamental relationships within the discipline and building a solid foundation for further study. In the content area of Geometry and Measurement, students build on and deepen prior understanding of transformations, congruence, similarity, and coordinate geometry concepts. Informal explorations of transformations provide a foundation for more formal considerations of congruence and similarity, including development of criteria for triangle congruence and similarity. An emphasis on reasoning throughout the content area promotes exploration, conjecture testing, and informal and formal justification. In the content area of Algebra and Functions, students perform algebraic calculations with specific application to geometry that build on foundations of algebra from seventh and eighth grades. Probability is important because it educates one in the logic of uncertainty and randomness, which occur in almost every aspect of daily life. Therefore, studying probability structures will enhance students' ability to organize information and improve decision-making.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Identify the meaning of a problem, utilize appropriate tools, and clearly articulate the "what" of the question. Draw on prior knowledge, analyze given information including constraints, relationships, and goals to find entry points or pathways to a solution. Employ critical thinking skills to consider analogous problems, using special cases and simpler forms of the problem to gain additional insight into the solution. Explain similarities and differences between equations and expressions, including their graphical and tabular representations. Draw diagrams, graph data to clarify information, show relationships, and search for patterns and trends.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse to explain reasoning and select tools, both physical and electronic, that are helpful to explore, model, and deepen students' understanding of mathematical concepts. Understand and use definitions, verbal, and written information to construct arguments and prove conjectures. Students can actively listen to the mathematical ideas of others while communicating on their own, and they can solve problems collaboratively. Compare two arguments, distinguish and explain the difference between correct and flawed logic, and explain what is flawed or correct and why. Present conclusions and results using a variety of ways including, but not limited to, tables, graphs, formulas, diagrams, flowcharts, interactive models, and dynamic software. Collaborative work involves joint thinking among individuals as part of problem solving. Technology tools such as graphing utilities, dynamic geometry, spreadsheets, and computer algebra systems are essential for learning mathematics in high school.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Students can identify relevant quantities and apply what they know to solve problems related to real-world situations. Identify important quantities in real-world situations and create a pathway representing relationships applying appropriate tools, such as diagrams, two-way tables, graphs, flowcharts, and formulas as well as electronic tools such as graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry. Students can confidently apply what they know, making assumptions and approximations to simplify complicated situations. Students can evaluate the reasonableness of their thinking and solution(s) and be willing to make revisions if necessary. Connect and apply the techniques from prior knowledge towards topics such as proportional relationships, rates, and percentages to real-world complex tasks.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Make sense of quantities and their application to relationships in mathematical and real-world representations. Evaluate multiple sources of information from text, charts, tables, graphs, and other diverse media and formats. Students can write explanatory text that conveys their mathematical analyses and thinking. Apply concrete details, relevant facts, and coherent discussions of ideas to support thinking. Decontextualize by pulling information from a given situation, representing it symbolically, then manipulating the representing symbols as if they are their own entities, not necessarily relative to what the symbol stands for. Contextualize by pausing during the manipulation process to explore the meaning of symbols within the given situation.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Examine, discern, and recognize patterns or structures as complex mathematical objects composed of more than one simple object. Students can attend to detail and continually evaluate the reasonableness of their results. Students can transform more complex structures into something they know. Discern and recognize regularity in repeated reasoning.

Data, Probability, and Statistical Reasoning

GS.DPSR.1. Summarize, represent, and interpret data on two categorical and quantitative variables.

Indicator	*Indicator Insight*
GS.DPSR.1.1 Represent data for two quantitative variables on a scatter plot and describe how the variables are related.	Include linear and nonlinear associations.

Indicator	Indicator Insight
GS.DPSR.1.2 Use two representative points from the data to find an approximate line of fit and compare it to the line of best fit.	Use a low-tech approach to identify possible pairs of points for the approximate line of best fit.
GS.DPSR.1.3 Conduct an investigation for a statistical question, interpret statistical significance in the context of a situation, and answer investigative questions appropriately.	Distinguish statistical questions from other types of questions. Compose statistical questions to collect and analyze appropriate data to answer the statistical investigative question.

GS.DPSR.2. Analyze and interpret models for two quantitative variables.

Indicator	Indicator Insight
GS.DPSR.2.1 Distinguish between correlation and causation.	Explore possible reasons for an association: • Predictor causes response, • Response causes predictor, • Lurking variable, or • Random occurrence.

GS.DPSR.3. Solve problems involving the probability of compound events in real-world situations.

Indicator	Indicator Insight
GS.DPSR.3.1 Describe categories of events as subsets of a sample space using *unions, intersections, or complements of other events*.	Consider using Venn Diagrams.
GS.DPSR.3.2 Apply the *Addition Rule* to find the probability of both mutually exclusive and not mutually exclusive events and interpret the answers in context.	Consider using Venn Diagrams.
GS.DPSR.3.3 Apply the Multiplication Rule to determine the probability of independent events and interpret the answers in context.	Give real-world examples of events occurring simultaneously. Consider using Venn Diagrams.

Measurement, Geometry, and Spatial Reasoning

GS.MGSR.1. Compute area and volume of figures by determining how the figure might be obtained from simpler figures by dissection and recombination.

Indicator	Indicator Insight
GS.MGSR.1.1 Apply area and volume formulas of two-/three-dimensional figures to solve real-world problems.	Use two-dimensional and three-dimensional irregular, regular, and composite figures.
GS.MGSR.1.2 Identify the shape of a two-dimensional cross section of a three-dimensional figure.	Consider including comparison of the figures.
GS.MGSR.1.3 Use cross sections of three-dimensional figures to model and solve mathematical and real-world situations.	Dynamic geometry software should be used to visualize cross sections of three-dimensional figures.

GS.MGSR.2. Apply rigid geometric transformations to figures describing their attributes and symmetries.

Indicator	***Indicator Insight***
GS.MGSR.2.1 Describe the results of transformations on a given figure using geometric terminology from the definitions of the transformations.	Apply rotations, reflections, and translations to figures using graph paper, tracing paper, and dynamic geometry software. Discuss orientation and what distinguishes the new figure from the original figure.
GS.MGSR.2.2 Describe and apply a sequence of transformations that maps a preimage onto its image.	Develop definitions of rotations, reflection, and translation in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

GS.MGSR.3. Determine that two figures are congruent by demonstrating that a rigid motion or a sequence of rigid motions maps one figure onto the other.

Indicator	***Indicator Insight***
GS.MGSR.3.1 Identify types of symmetry of polygons, including line, point, rotational, and self-congruence, and use symmetry to analyze mathematical situations.	Consider using areas and volumes to show similarity and symmetry.
GS.MGSR.3.2 Demonstrate that triangles and quadrilaterals are congruent by a combination of translations, rotations, and reflections.	Dynamic geometry software can be used to demonstrate congruence.
GS.MGSR.3.3 Recognize the criteria for showing triangles are congruent using a sequence of rigid motions that map one triangle to another and justify the two triangles are congruent by applying the *Side-Side-Side, Side-Angle-Side, Angle-Side-Angle, Angle-Angle-Side, and Hypotenuse-Leg* congruence conditions.	Justifications might be supported by sketches using dynamic geometry software.

GS.MGSR.4. Determine that two figures are similar by demonstrating a similarity transformation or a sequence of similarity transformations that maps one figure onto the other.

Indicator	***Indicator Insight***
GS.MGSR.4.1 Demonstrate experimentally the properties of dilations given by a center and a scale factor.	Consider using dynamic geometry software to verify and determine similarity. Determine that two figures are similar by demonstrating a similarity transformation, dilation or composite of a dilation with a rigid motion, or equivalently, a sequence of similarity transformations that maps one figure onto the other.

Indicator	*Indicator Insight*
GS.MGSR.4.2 Justify experimentally that a dilation of a line segment is longer or shorter given the ratio.	Justify facts using specific examples. Explore the ratios.
GS.MGSR.4.3 Recognize the criteria for showing triangles are similar using a similarity transformation that maps one figure to the other and justify the two triangles are similar by applying the *Angle-Angle, Side-Side-Side, and Side-Angle-Side* similarity conditions.	Consider using dynamic geometry software to verify and determine similarity. Determine that two figures are similar by demonstrating a similarity transformation, dilation or composite of a dilation with a rigid motion, or equivalently, a sequence of similarity transformations that maps one figure onto the other.

GS.MGSR.5. Demonstrate whether a conjecture or theorem is true or false using a variety of algebraic and geometric explanations.

Indicator	*Indicator Insight*
GS.MGSR.5.1 Justify and apply the attributes of angle relationships/lines in mathematical and real-world situations.	Proofs of theorems can sometimes be made with transformations, coordinates, or algebra; all approaches can be useful, and in some cases, one may provide a more accessible or understandable argument than another. Apply in mathematical and real-world contexts when: • vertical angles are congruent; • a transversal crosses parallel lines, alternate interior angles are congruent, alternate exterior angles are congruent, and consecutive interior angles are supplementary; • any point on a perpendicular bisector of a line segment is equidistant from the endpoints of the segment; • perpendicular lines form four right angles; and • base angles of isosceles triangles are congruent. Define *angle, perpendicular line, parallel line, line segment, ray, circle, and skew* in terms of the undefined notions of point, line, and plane.

<table>
<tr><th>Indicator</th><th>Indicator Insight</th></tr>
<tr><td>GS.MGSR.5.2 Apply the attributes of triangles in mathematical and real-world situations</td><td>Apply in mathematical and real-world situations including but not limited to:
segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; and
medians of a triangle meet at a point.
Define angle, perpendicular line, parallel line, line segment, ray, circle, and skew in terms of the undefined notions of point, line, and plane.
Use geometric figures, both physical and within geometry software, to model, represent and describe real-world objects.</td></tr>
<tr><td>GS.MGSR.5.3 Apply the attributes of quadrilaterals, including diagonals, sides, and angles, to prove that a given quadrilateral is a parallelogram in mathematical and real-world situations.</td><td>Proofs of theorems can sometimes be made with transformations, coordinates, algebra, two-column, flow chart or paragraph; all approaches can be useful, and in some cases, one may provide a more accessible or understandable argument than another.
Verify and apply in mathematical and real-world situations in which:
opposite sides of a parallelogram are congruent;
opposite angles of a parallelogram are congruent;
diagonals of a parallelogram bisect each other;
rectangles are parallelograms with congruent diagonals; and
parallelogram is a rhombus if and only if the diagonals are perpendicular.</td></tr>
</table>

GS.MGSR.6. Discover and apply relationships in similar right triangles.

Indicator	*Indicator Insight*
GS.MGSR.6.1 Discover and apply the converse of *Pythagorean Theorem*.	Use visual proofs of the *Pythagorean Theorem.*
GS.MGSR.6.2 Discover and apply the constant ratios of the sides in 30-60-90 and 45-45-90 right triangles.	Use the *Pythagorean Theorem* to derive the constant ratios.
GS.MGSR.6.3 Define the trigonometric ratios using the properties of similar right triangles.	Use a proportion relating corresponding sides of right triangles to define sine, cosine, and tangent.

Indicator	*Indicator Insight*
GS.MGSR.6.4 Determine the sine, cosine, and tangent of an acute angle in a right triangle in the context of mathematical and real-world situations.	Consider examples including but not limited to a ladder against a building, angle of elevation, and angle of depression.
GS.MGSR.6.5 Apply trigonometric ratios (sine, cosine, tangent) and the *Pythagorean Theorem* to solve right triangles problems in real-world situations.	Use trigonometric ratios and the *Pythagorean Theorem* as models of problems in real-world contexts.

GS.MGSR.7. Investigate and apply relationships among segments and angles in circles.

Indicator	*Indicator Insight*
GS.MGSR.7.1 Use angle and segment relationships in circles to solve mathematical and real-world situations.	Dynamic geometry software should be used to support investigations.
GS.MGSR.7.2 Investigate and apply relationships in circles, including inscribed angles, radii, secants, and chords; among inscribed angles, central angles, and circumscribed angles; and between radii and tangents to circles.	Dynamic geometry software should be used to support investigations.

Numerical Reasoning

GS.NR.1. Represent all points on the number line as irrational and rational numbers in the real number system.

Indicator	*Indicator Insight*
GS.NR.1.1 Rewrite numerical expressions of irrational and rational numbers involving radicals, including addition, subtraction, multiplication, and division, to recognize geometric patterns.	Include operations with radicals. This is students' first introduction to simplifying radicals.

Patterns, Algebra, and Functional Reasoning

GS.PAFR.1. Analyze the structure of an equation or inequality to determine an efficient strategy to find a solution, if one exists, then justify the solution.

Indicator	*Indicator Insight*
GS.PAFR.1.1 Discover and apply the formulas for the length of an arc and the area of a sector in a circle to develop mathematical models and solve mathematical and real-world problems.	Use proportions and proportional reasoning to derive formulas.

Indicator	*Indicator Insight*
GS.PAFR.1.2 Analyze and apply the derivations of the formulas for the circumference of a circle, area of a circle, and volume of a cylinder, pyramid, and cone to model real phenomena and solve mathematical and real-world problems.	This indicator builds on the laws of exponents students have learned in middle school.

GS.PAFR.2. Interpret the structure of expressions, equations, and inequalities to analyze and make predictions in different contexts.

Indicator	*Indicator Insight*
GS.PAFR.2.1 Apply surface area and volume formulas for prisms, cylinders, pyramids, cones, spheres, and/or compositions of figures to solve problems and justify results.	Include problems that involve algebraic expressions, composite figures/solids, geometric probability, and real-world applications as part of the mathematical modeling cycle.
GS.PAFR.2.2 Analyze slopes of lines to determine whether lines are parallel, perpendicular, or neither.	Address the occurrence of coincidental lines. Exploration of parallel and perpendicular lines outside of its connection to shapes and transversals is a new concept for students.
GS.PAFR.2.3 Determine the equation of a line passing through a given point that is parallel or perpendicular to a given line.	Slope-intercept form of a linear equation. Solve geometric and real-world problems involving lines and slopes.

GS.PAFR.3. Determine the exact or approximate solutions of equations and inequalities using graphs on the coordinate plane.

Indicator	*Indicator Insight*
GS.PAFR.3.1 Use coordinates to prove simple geometric theorems algebraically.	Focus on quadrilaterals, right triangles, and circles.
GS.PAFR.3.2 Determine distance and midpoint of segments in a coordinate plane to find areas of triangles and quadrilaterals when given coordinates.	Eighth grade uses *Pythagorean Theorem* to find distance in the coordinate plane. Use distance and midpoint formula to find area in a coordinate plane.

Algebra 1 Standards

Algebra 1 builds essential concepts necessary for students to meet their postsecondary goals; whether they pursue additional study or enter the workforce. This can result in helping students to function as effective citizens, and to recognize the wonder, joy, and beauty of mathematics (NCTM, 2018). Algebra is important and useful in most careers. It is one of the most common and malleable types of mathematics, because it is valuable in a range of activities from ordinary decision-making to advanced training in scientific and technological fields. The ability to understand and apply algebraic thinking is a crucial stepping stone on a successful journey in life. Algebra is a collection of unifying concepts that enable one to solve problems flexibly.

The study of algebra is inextricably linked to the study of functions, which are fundamental objects in mathematics that model many life situations involving change. This course provides experiences for students to see how mathematics can be used systematically to represent patterns and relationships among numbers and other objects, analyze change, and model everyday events and problems of life and society.

Algebra 1 emphasizes functions including linear (as introduced in seventh and eighth grades), absolute value, quadratic, and exponential, and functions as explicit and recursive. Properties of algebra are applied to convert between forms of expressions and to solve equations.

Graphing is a vital component of study in Algebra 1. Graphs of equations and inequalities consist of all points (discrete or continuous) whose ordered pairs satisfy the relationship within the domain and range. Students find points of intersection between two graphed functions that correspond to the solutions of the equations of the two functions, and transform graphs of functions (through translation, reflection, rotation, and dilation) by performing operations on the input or output.

Algebra 1 serves as a study of linear, quadratic, exponential, and absolute value functions. Equations and expressions with linear and quadratic terms are also studied to learn how algebraic expressions model real-world situations. Statistical reasoning is studied to learn how data is represented and interpreted and how models, particularly linear, can be used to make predictions.

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Identify the meaning of a problem, utilize appropriate tools, and clearly articulate the "what" of the question. Draw on prior knowledge, analyze given information including constraints, relationships, and goals to find entry points or pathways to a solution. Employ critical thinking skills to consider analogous problems, using special cases and simpler forms of the problem to gain additional insight into the solution. Explain similarities and differences between equations and expressions, including their graphical and tabular representations. Draw diagrams, graph data to clarify information, show relationships, and search for patterns and trends.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse to explain reasoning and select tools, both physical and electronic, that are helpful to explore, model, and deepen students' understanding of mathematical concepts. Understand and use definitions, verbal, and written information to construct arguments and prove conjectures. Students can actively listen to the mathematical ideas of others while communicating their own, and they can solve problems collaboratively. Compare two arguments, distinguish and explain the difference between correct and flawed logic, and explain what is flawed or correct and why. Present conclusions and results using a variety of ways including, but not limited to, tables, graphs, formulas, diagrams, flowcharts, interactive models, and dynamic software. Collaborative work involves joint thinking among individuals as part of problem solving. Technology tools such as graphing utilities, dynamic geometry, spreadsheets, and computer algebra systems are essential for learning mathematics in high school.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Students can identify relevant quantities and apply what they know to solve problems related to real-world situations. Identify important quantities in real-world situations and create a pathway representing relationships applying appropriate tools, such as diagrams, two-way tables, graphs, flowcharts, and formulas as well as electronic tools such as graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry. Students can confidently apply what they know, making assumptions and approximations to simplify complicated situations. Students can evaluate the reasonableness of their thinking and solution(s) and be willing to make revisions if necessary. Connect and apply the techniques from prior knowledge towards topics such as proportional relationships, rates, and percentages to real-world complex tasks.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Make sense of quantities and their application to relationships in mathematical and real-world representations. Evaluate multiple sources of information from text, charts, tables, graphs, and other diverse media and formats. Students can write explanatory text that conveys their mathematical analyses and thinking. Apply concrete details, relevant facts, and coherent discussions of ideas to support thinking. Decontextualize by pulling information from a given situation, representing it symbolically, then manipulating the representing symbols as if they are their own entities, not necessarily relative to what the symbol stands for. Contextualize by pausing during the manipulation process to explore the meaning of symbols within the given situation.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Examine, discern, and recognize patterns or structures as complex mathematical objects composed of more than one simple object. Students can attend to detail and continually evaluate the reasonableness of their results. Students can transform more complex structures into something they know. Discern and recognize regularity in repeated reasoning.

Data, Probability, and Statistical Reasoning

A1.DPSR.1. Use successive approximations as a method to solve the system $y = f(x)$ and $y = g(x)$ to find approximate solutions with graphs and tables.

Indicator	***Indicator Insight***
A1.DPSR.1.1 Summarize categorical data in two-way frequency tables, interpret relative frequencies in real-world situations, and informally determine possible associations and trends in the data.	Include joint, marginal, and conditional relative frequencies.
A1.DPSR.1.2 Summarize quantitative data in a table and on a scatter plot and describe how the variables are associated. Limit to linear data.	Description must include: • direction - positive or negative; and • association - none, weak, moderate, or strong.
A1.DPSR.1.3 Find a linear function for a scatter plot that suggests a linear association.	Use technology to assist with finding the line of best fit for two quantitative variables. Use the given model or choose a model suggested by the shape of the graph. Explore interpolation and extrapolation. Discuss the dangers of extrapolation.
A1.DPSR.1.4 For linear associations, use technology to determine the correlation coefficient, evaluate the strength of the association, and find the line of best fit.	Use technology or statistical software to assist in finding linear associations.

A1.DPSR.2. Analyze and interpret models for two categorical and quantitative variables.

Indicator	***Indicator Insight***
A1.DPSR.2.1 Use two-way frequency tables to make inferences and interpret the data in terms of real-world or mathematical situations.	Use relative frequencies to identify possible associations.
A1.DPSR.2.2 Interpret the slope and the intercept of a linear model in the context of the data.	Interpret slope as a unit rate of change (including units). For every one unit of increase in the x variable, the y variable will increase or decrease the amount and the direction of the slope. The y-intercept of a linear model may not make sense when interpreted within the context of the data.
A1.DPSR.2.3 Use a linear model to interpolate and extrapolate unknown values close to the data set.	Use technology or statistical software. Correlation applies to linear models only.

Measurement, Geometry, and Spatial Reasoning

A1.MGSR.1. Use geometric concepts and measurement opportunities to model mathematical and real-world situations.

Indicator	*Indicator Insight*
A1.MGSR.1.1 Identify any limitations specific to a real-world situation.	Produce a graph for a contextual situation and determine a scale that shows key features of the graph. Limitations might include measuring to the nearest cent or dollar or whole unit, such as people or cars, when a fraction does not make sense.

Numerical Reasoning

A1.NR.1. Represent all points on the number line as irrational and rational numbers in the real number system.

Indicator	*Indicator Insight*
A1.NR.1.1 Rewrite numerical and algebraic expressions of irrational and rational numbers involving radicals, including addition, subtraction, multiplication, and division. Limit to square and cube roots.	Include all operations with algebraic expressions with emphasis on rational and radical terms.

A1.NR.2. Represent exponents and radical expressions in different ways.

Indicator	*Indicator Insight*
A1.NR.2.1 Translate between rational exponents and radical expressions of irrational and rational numbers. Use properties of addition, subtraction, multiplication, and division to simplify radical and rational expressions. Limit to square and cube roots.	Limit the number of variables to five or less.

Patterns, Algebra, and Functional Reasoning

A1.PAFR.1. Transform and/or solve equations and expressions in one variable that model real-world and mathematical problems, interpret the solutions, and determine whether they are reasonable.

Indicator	*Indicator Insight*
A1.PAFR.1.1 Transform an equation in one variable to create new equations that have the same solution as the original and justify the steps taken.	Linear forms include standard, intercept, *y*-intercept, and point-slope. Quadratic forms include vertex, standard, and factored. Limit exponential to the same bases.

Indicator	*Indicator Insight*
A1.PAFR.1.2 Solve literal equations and formulas for a specified variable including equations and formulas that arise in a variety of disciplines.	The process of solving literal equations should incorporate similar strategies used in solving for unknown numerical quantities.
A1.PAFR.1.3 Solve mathematical and real-world problems using linear, quadratic, exponential (same bases), and linear absolute value equations in one variable.	The steps used for solving an equation should be identified as a justification for the solution process.
A1.PAFR.1.4 Add, subtract, and multiply polynomials with initial terms up to a degree of 2.	When performing operations with polynomials, relate to the properties of equality.

A1.PAFR.2. Create, solve, and transform equations and inequalities in two or more variables to represent relationships between quantities and graph the equations on coordinate axes using appropriate labels, units, and scales.

Indicator	*Indicator Insight*
A1.PAFR.2.1 Transform linear, quadratic, exponential, and linear absolute value functions to equivalent forms to identify slope and y-intercept for linear, vertex and roots (if any) for quadratic and linear absolute value, and y-intercept for exponential.	Determine which equation is used to identify the information. Fluently transform quadratic functions into multiple forms. Fluently transform exponential functions using growth and decay models.
A1.PAFR.2.2 Solve quadratic equations by completing the square, factoring, and the quadratic formula, explaining the connection between the zeros of the function derived from the equation, its linear factors (if it factors), the x-intercepts of its graph (if they exist), and the solutions (if any) to the corresponding quadratic equation.	Completing the square may include a visual model such as algebra tiles. Quadratic equations that result in negative numbers underneath the square root are determined to have no solutions in the real number system.
A1.PAFR.2.3 Solve and graph linear, quadratic, exponential, and linear absolute value equations given in tabular, symbolic, and/or verbal forms using intercepts, domain and range, intervals of increasing and decreasing, vertex (maximum and minimum), end behavior, and symmetry, and interpret these in terms of mathematical and real-world situations.	Tabular form should involve a spreadsheet.
A1.PAFR.2.4 Create, solve, and graph linear inequalities in two variables.	Inequalities are used to solve contextual problems.

Indicator	*Indicator Insight*
A1.PAFR.2.5 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.	Use contextual situations and sets of ordered pairs to create functions to describe relationships.
A1.PAFR.2.6 Create symbolic representations of linear and exponential functions, including arithmetic and geometric sequences, given graphs, verbal descriptions, and tables.	When given an addition/subtraction pattern or a multiplication/division sequence, generalize an arithmetic or geometric sequence; create both explicit and recursive functions for the pattern. Connect exponential functions and geometric sequences.
A1.PAFR.2.7 Use graphs to obtain exact and/or approximate solutions of equations, inequalities, and systems of linear equations in two variables (given or obtained by using technology).	A possible strategy to use successive approximations as a method to solve the system $y = f(x)$ and $y = g(x)$ to find approximate solutions with graphs and tables.
A1.PAFR.2.8 Solve an equation of the form $f(x) = g(x)$ graphically by identifying the x-coordinate(s) of the point(s) of intersection of the graphs of $y = f(x)$ and $y = g(x)$.	The x-coordinate(s) of the point(s) where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solution(s) of the equation $f(x) = g(x)$.
A1.PAFR.2.9 Solve systems of linear equations algebraically and graphically.	Solving algebraically means using linear combinations (elimination) and substitution. Teachers are encouraged to teach solving equations collectively, not in isolation.
A1.PAFR.2.10 Analyze the growth/decay rate between linear and exponential functions specifically between consecutive integers.	Demonstrate that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals. Use graphs and tables to recognize that a quantity increasing exponentially eventually exceeds a quantity increasing linearly.

A1.PAFR.3. Represent and interpret functions symbolically and graphically.

Indicator	*Indicator Insight*
A1.PAFR.3.1 Recognize that $f(x)$ denotes the output of function f that corresponds to the input x, and this corresponds to the set of all the ordered pairs (x, y) that satisfy the equation $y = f(x)$ both tabularly and graphically.	Function notation reveals both the input and output in a single statement. Connect the statements “the graph of *f*” and “the graph of $y = f(x)$."

Indicator	*Indicator Insight*
A1.PAFR.3.2 Use the definition of a function to analyze the domain and range of a function in relation to its graph, mapping, table, verbal, and/or symbolic description, and where applicable, using interval and set notation.	Tabular representation may be done using a spreadsheet.
A1.PAFR.3.3 Translate among graphical, tabular, verbal, and symbolic representations in function notation to identify intercepts, intervals where the function is increasing, decreasing, constant, maximums and minimums, and symmetries and explain their meanings in real-world and mathematical situations.	A computer algebra system may be used for translating among the different representations.
A1.PAFR.3.4 Interpret how lead coefficients impact the shape of a function's graph.	Relate the value of the coefficients to geometric transformations.

A1.PAFR.4. Reason with parent functions in varying representations to find families of functions that all have similar distinguishing attributes common to the family and use common characteristics to aid in rewriting and identifying linear, linear absolute value, quadratic, and exponential functions.

Indicator	*Indicator Insight*
A1.PAFR.4.1 Describe the effect of the transformations $kf(x)$, $f(x)+k$, $f(x+k)$, and combinations of such transformations on the graph of parent function $y = f(x)$ for any real number k, find the value of k given the graphs, and write the equation of a transformed parent function given its graph.	Use technology with a parent function to explore the results when different transformations, translations, reflections, and dilations, are applied.
A1.PAFR.4.2 Given a real-world or mathematical situation, determine the parent graph that best models the situation.	Consider rates of change, graphs, context, or a table of values to determine if a function is linear, exponential, or quadratic.
A1.PAFR.4.3 Given different representations of two different functions, compare key features including intercepts, domain and range, intervals of increasing and decreasing, constant, average rate of change, and maximum and minimum values.	Flexibly use different representations of functions, including graphs, tables, verbal, and symbols, to compare key features of the functions.

Algebra 2 with Probability Standards

Algebra 2 is a course designed for students seeking access to higher levels of mathematics after completing Geometry and Algebra 1. Algebra 2 serves to deepen understanding and intuition about a wide variety of functions like polynomial, rational, radical, exponential, and piecewise. Building on principles learned from Geometry and Algebra 1, the purpose of this course is to graphically investigate and compare functions, analyze rates of change, and determine solutions of "real-world" problems at a higher conceptual level than can be achieved algebraically. In this document, many of the instructional considerations recommend the use of a graphing calculator or a computer algebra system to enable students to visualize mathematics and increase their conceptual understanding. With this said, National Council of Teachers of Mathematics's *Catalyzing Change in High School Mathematics* states:

> Careful consideration needs to be given to when and how technology can be used to ***shift*** the focus ***from*** learning many individual procedures for algebra ***to*** considering multiple equivalent forms of expressions and equations, interpreting the results of manipulations, and making strategic choices about which forms of an expression or equation to use. (p. 47)

In addition to increasing student knowledge of "parent functions," Algebra 2 also includes the study of complex numbers, matrices, and probability. The study of complex numbers introduces students to the complex number system and its impact on solutions of equations. Matrices provide a method for students to organize, store, and mathematically work with large amounts of data. Algebra 2 will concentrate on using small data sets. Finally, the study of probability will continue the study of data, probability, and statistical reasoning units that began in Geometry. Finding the likelihood of an event occurring enables students, bombarded with data, to make more informed decisions.

Prerequisite courses: Geometry > Algebra 1

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Identify the meaning of a problem, utilize appropriate tools, and clearly articulate the "what" of the question. Draw on prior knowledge, analyze given information including constraints, relationships, and goals to find entry points or pathways to a solution. Employ critical thinking skills to consider analogous problems, using special cases and simpler forms of the problem to gain additional insight into the solution. Explain similarities and differences between equations and expressions, including their graphical and tabular representations. Draw diagrams, graph data to clarify information, show relationships, and search for patterns and trends.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse to explain reasoning and select tools, both physical and electronic, that are helpful to explore, model, and deepen students' understanding of mathematical concepts. Understand and use definitions, verbal, and written information to construct arguments and prove conjectures. Students can actively listen to the mathematical ideas of others while communicating their own, and they can solve problems collaboratively. Compare two arguments, distinguish and explain the difference between correct and flawed logic, and explain what is flawed or correct and why. Present conclusions and results using a variety of ways including, but not limited to, tables, graphs, formulas, diagrams, flowcharts, interactive models, and dynamic software. Collaborative work involves joint thinking among individuals as part of problem solving. Technology tools such as graphing utilities, dynamic geometry, spreadsheets, and computer algebra systems are essential for learning mathematics in high school.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Students can identify relevant quantities and apply what they know to solve problems related to real-world situations. Identify important quantities in real-world situations and create a pathway representing relationships applying appropriate tools, such as diagrams, two-way tables, graphs, flowcharts, and formulas as well as electronic tools such as graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry. Students can confidently apply what they know, making assumptions and approximations to simplify complicated situations. Students can evaluate the reasonableness of their thinking and solution(s) and be willing to make revisions if necessary. Connect and apply the techniques from prior knowledge towards topics such as proportional relationships, rates, and percentages to real-world complex tasks.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Make sense of quantities and their application to relationships in mathematical and real-world representations. Evaluate multiple sources of information from text, charts, tables, graphs, and other diverse media and formats. Students can write explanatory text that conveys their mathematical analyses and thinking. Apply concrete details, relevant facts, and coherent discussions of ideas to support thinking. Decontextualize by pulling information from a given situation, representing it symbolically, then manipulating the representing symbols as if they are their own entities, not necessarily relative to what the symbol stands for. Contextualize by pausing during the manipulation process to explore the meaning of symbols within the given situation.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Examine, discern, and recognize patterns or structures as complex mathematical objects composed of more than one simple object. Students can attend to detail and continually evaluate the reasonableness of their results. Students can transform more complex structures into something they know. Discern and recognize regularity in repeated reasoning.

Data, Probability, and Statistical Reasoning

A2P.DPSR.1. Understand independence and conditional probability and use them to interpret data.

Indicator	***Indicator Insight***
A2P.DPSR.1.1 Describe events as subsets of a sample space using characteristics or categories of the outcomes, or as *unions, intersections, or complements of other events*.	Use symbolic representations of union and intersection, including but not limited to Venn Diagrams.
A2P.DPSR.1.2 Explain whether two events, A and B, are independent if and only if the probability of A and B occurring together is the product of their probabilities and use this characterization to determine if they are independent.	Use tree diagrams or two-way tables.
A2P.DPSR.1.3 Determine whether the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B in mathematical and real-world situations.	Use conditional probability to show that two events are independent in mathematical and real-world situations.
A2P.DPSR.1.4 Recognize and explain the concepts of conditional probability and independence.	Use everyday language and situations.

A2P.DPSR.2. Use the rules of probability to compute probabilities of compound events in a uniform probability model.

Indicator	***Indicator Insight***
A2P.DPSR.2.1 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A and interpret the answer in terms of the model.	Provide opportunities to build understanding that P(A|B) represents the outcomes remaining for A to occur once B has already occurred. This is a fraction of outcomes of B that also belongs to A.
A2P.DPSR.2.2 Apply the Addition Rule, P(A or B) = P(A) + P(B) − P(A and B) and interpret the answer in terms of the model.	Explore disjoint or mutually exclusive events.
A2P.DPSR.2.3 Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)·P(B|A) = P(B)·P(A|B) and interpret the answer in terms of the model.	Explore and provide clarification among uniform and nonuniform probability models. In a uniform probability model, all events possess an equal chance of occurring.

Indicator	*Indicator Insight*
A2P.DPSR.2.4 Use permutations and combinations to determine the number of possible outcomes in a sample space.	Consider using technology to determine the number of possible outcomes.

Measurement, Geometry, and Spatial Reasoning

A2P.MGSR.1. Explore and analyze sine and cosine functions using the unit circle, right triangle definitions and models of periodic phenomena.

Indicator	*Indicator Insight*
A2P.MGSR.1.1 Build the unit circle for sine and cosine functions using right triangle definitions.	Use radian measure. Use the unit circle and right triangle definitions to evaluate sine and cosine for the following angles and their multiples from 0 to $2\colon 0,\ \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}$, and $\frac{\pi}{2}$.
A2P.MGSR.1.2 Use models of periodic phenomena to evaluate and analyze the graph of sine and cosine functions.	This indicator is students' first introduction to the unit circle. Students are only expected to evaluate and analyze graph of sine and cosine functions, not graph or transform graphs.

Numerical Reasoning

A2P.NR.1. Recognize that the complex number system extends the real number system to allow for solution to all polynomial equations.

Indicator	*Indicator Insight*
A2P.NR.1.1 Understand that there is an imaginary unit i such that $i^2 = -1$ and explain the structure of a complex number as $a + bi$, where a and b are real.	Refer to the number system hierarchy.
A2P.NR.1.2 Add, subtract, and multiply complex numbers.	Simplify powers of i.

A2P.NR.2. Represent and manipulate data using matrices.

Indicator	*Indicator Insight*
A2P.NR.2.1 Perform operations with matrices including addition, subtraction, and scalar multiplication.	This is the introduction of matrices. Use only two-by-two. For real-world applications, consider using technology.

Patterns, Algebra, and Functional Reasoning

A2P.PAFR.1. Explore and analyze quadratic and polynomial functions and inequalities and use them to model real-world situations.

Indicator	*Indicator Insight*
A2P.PAFR.1.1 Graph, identify roots, and analyze quadratic functions in mathematical and real-world situations.	Solve quadratic equations in one variable that have complex solutions.
A2P.PAFR.1.2 Solve quadratic inequalities that model mathematical and real-world situations.	For real-world applications, consider using technology such as a graph or a computer algebra system.
A2P.PAFR.1.3 Graph and analyze polynomial functions in mathematical and real-world situations.	Identify the number of zeros that exist for any polynomial based upon the greatest degree and the end behavior of the polynomial by observing the sign of the leading coefficient. Identify the zeros of polynomial functions and their multiplicities to construct a graph using key features of these polynomial functions. **Refer to A2P.PAFR.4.1.** Key features of polynomial functions include: intercepts and their multiplicity, end behavior, domain and range, intervals of increase and/or decrease, intervals where the function is positive and/or negative. Discuss multiplicity and its relationship to the graph's behavior at these intercepts. To state key intervals, use interval and set notation. Using all the zeros of a polynomial function, list and multiply all the factors to write a multiple of the polynomial function in standard form for no more than degree 4. Divide polynomials using technology. Relate the Remainder and Factor Theorems to the process of division of polynomials. The division of polynomials leads to the discussion of rational expressions. For real-world applications, consider using technology.
A2P.PAFR.1.4 Solve polynomial inequalities that model mathematical and real-world situations.	For real-world applications, consider using technology.
A2P.PAFR.1.5 Recognize perfect squares and perfect cubes and use them to describe the structure of polynomials.	Consider using technology to relate the zeros. Discuss the graphical connections.

A2P.PAFR.2. Explore and analyze rational and radical functions and use them to model real-world phenomena.

Indicator	*Indicator Insight*
A2P.PAFR.2.1 Graph rational and radical functions and describe their key features. Limit to square roots and cube roots only.	**Refer to A2P.PAFR.4.1** Key features of rational and radical functions include: intercepts, horizontal and vertical asymptotes (rational), domain, range, intervals of increase and decrease, and end behavior. To state key intervals, use interval and set notation. For real-world applications, consider using technology.
A2P.PAFR.2.2 Perform arithmetic operations on rational expressions, including problems in context and express rational expressions in irreducible form.	For real-world applications, consider using technology.
A2P.PAFR.2.3 Create and solve rational and radical equations in one variable, including those that model real-world situations and verify solutions to identify extraneous solutions if they appear.	For real-world applications, consider using technology.

A2P.PAFR.3. Explore and analyze exponential functions and use them to model real-world phenomena.

Indicator	*Indicator Insight*
A2P.PAFR.3.1. Create, solve, and graph exponential functions, including those that model real-world situations.	For real-world applications, consider using technology. Introduce and incorporate *e.* **Refer to A2P.PAFR.4.1.**
A2P.PAFR.3.2 Find the sum of the terms of arithmetic and geometric sequences.	Arithmetic: Use student knowledge of linear functions to derive the "formula." Geometric: Use student knowledge of exponential functions to derive the "formula."

A2P.PAFR.4. Reason with parent functions to find families of functions that all have similar distinguishing attributes common to the family, and use common characteristics to aid in rewriting and identifying functions.

Indicator	*Indicator Insight*
A2P.PAFR.4.1 Identify the effect on the graph of replacing $f(x)$ by $kf(x)$, $f(x)+k$, $f(x+k)$, and $f(kx)$ for any real number k including multiple transformations; write an equation of a transformed parent function given its graph. (Extend to equations	Use graphing technology/computer algebra systems to explore transformations.

Indicator	*Indicator Insight*
involving rational, polynomial, radical, exponential, and piecewise.)	

A2P.PAFR.5. Explore and analyze piecewise functions and linear absolute value inequalities and use them to model real-world phenomena.

Indicator	*Indicator Insight*
A2P.PAFR.5.1 Graph piecewise functions and describe their key features.	Evaluate a piecewise function at given elements of the domain. Key features of piecewise functions include: domain, range, end behavior, intercepts, intervals of increase and decrease, and interval where the function is positive and/or negative. **Refer to A2P.PAFR.4.1.** Model real-world problems with piecewise-defined functions that incorporate constant, linear, quadratic, and exponential functions. For real-world applications, consider using technology.
A2P.PAFR.5.2 Solve linear absolute value inequalities.	Use the distance definition to define and solve linear absolute value inequalities. For real-world applications, consider using technology.

A2P.PAFR.6. Represent and interpret functions symbolically and graphically.

Indicator	*Indicator Insight*
A2P.PAFR.6.1 Find the inverse of functions and verify graphically.	Function composition is not introduced until Pre-Calculus; therefore, students cannot verify algebraically at this point. Discuss the identity function and its importance in graphically verifying inverses. Use technology.
A2P.PAFR.6.2 Calculate and interpret the average rate of change of the function over a specified interval, given a function in graphical, symbolic, or numerical form.	Explore the rate of change between different points and recognize that the average rate of change is not constant, as it is for linear functions.
A2P.PAFR.6.3 Use linear programming to solve systems of equations and inequalities by addressing the constraints that arise in real-world situations.	For real-world applications, consider using technology.

Pre-Calculus Standards

In South Carolina College- and Career-Ready (SC CCR) Pre-Calculus, students build on the conceptual knowledge and skills for mathematics they mastered in previous mathematics courses and construct a foundation necessary for subsequent mathematical study. The standards for those courses provide students with a foundation in the theory of functions, roots and factors of polynomials, exponential and logarithmic functions, the complex number system, and an introduction to trigonometry.

In this course, students are expected to apply mathematics in meaningful ways to solve problems that arise in the workplace, society, and real-world situations through the process of modeling. Mathematical modeling involves creating appropriate equations, graphs, functions, or other mathematical representations to analyze real-world situations and answer questions. The use of technological tools, such as handheld graphing calculators, is important in creating and analyzing mathematical representations used in the modeling process and should be used during instruction and assessment. However, technology should not be limited to handheld graphing calculators. Students should use a variety of technologies, such as graphing utilities, spreadsheets, and computer algebra systems to solve problems and to master standards in all strands of this course.

Pre-Calculus serves as a study of piecewise, rational, radical, exponential, logarithmic, and trigonometric functions. Furthermore, the course addresses the study of polar coordinates, conic sections, vectors, and matrices. Mathematical modeling for solving real-world problems and the use of technological tools such as computer algebra systems and spreadsheets are integrated into the instructional approaches for addressing the standards.

Prerequisite courses: Geometry > Algebra 1 > Algebra 2

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Identify the meaning of a problem, utilize appropriate tools, and clearly articulate the "what" of the question. Draw on prior knowledge, analyze given information including constraints, relationships, and goals to find entry points or pathways to a solution. Employ critical thinking skills to consider analogous problems, using special cases and simpler forms of the problem to gain additional insight into the solution. Explain similarities and differences between equations and expressions, including their graphical and tabular representations. Draw diagrams, graph data to clarify information, show relationships, and search for patterns and trends.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse to explain reasoning and select tools, both physical and electronic, that are helpful to explore, model, and deepen students' understanding of mathematical concepts. Understand and use definitions, verbal, and written information to construct arguments and prove conjectures. Students can actively listen to the mathematical ideas of others while communicating their own, and they can solve problems collaboratively. Compare two arguments, distinguish and explain the difference between correct and flawed logic, and explain what is flawed or correct and why. Present conclusions and results using a variety of ways including, but not limited to, tables, graphs, formulas, diagrams, flowcharts, interactive models, and dynamic software. Collaborative work involves joint thinking among individuals as part of problem solving. Technology tools such as graphing utilities, dynamic geometry, spreadsheets, and computer algebra systems are essential for learning mathematics in high school.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Students can identify relevant quantities and apply what they know to solve problems related to real-world situations. Identify important quantities in real-world situations and create a pathway representing relationships applying appropriate tools, such as diagrams, two-way tables, graphs, flowcharts, and formulas as well as electronic tools such as graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry. Students can confidently apply what they know, making assumptions and approximations to simplify complicated situations. Students can evaluate the reasonableness of their thinking and solution(s) and be willing to make revisions if necessary. Connect and apply the techniques from prior knowledge towards topics such as proportional relationships, rates, and percentages to real-world complex tasks.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Make sense of quantities and their application to relationships in mathematical and real-world representations. Evaluate multiple sources of information from text, charts, tables, graphs, and other diverse media and formats. Students can write explanatory text that conveys their mathematical analyses and thinking. Write explanatory text that conveys their mathematical analyses and thinking. Apply concrete details, relevant facts, and coherent discussions of ideas to support thinking. Decontextualize by pulling information from a given situation, representing it symbolically, then manipulating the representing symbols as if they are their own entities, not necessarily relative to what the symbol stands for. Contextualize by pausing during the manipulation process to explore the meaning of symbols within the given situation.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Examine, discern, and recognize patterns or structures as complex mathematical objects composed of more than one simple object. Students can attend to detail and continually evaluate the reasonableness of their results. Students can transform more complex structures into something they know. Discern and recognize regularity in repeated reasoning.

Measurement, Geometry, and Spatial Reasoning

PC.MGSR.1. Analyze the behaviors of conic sections and polar coordinates to model mathematical and real-world problems.

Indicator	*Indicator Insight*
PC.MGSR.1.1 Identify and graph different conic sections given the equations in standard form.	Explore circles, parabolas, ellipses, and hyperbolas.
PC.MGSR.1.2 Identify different conic sections in general form and complete the square to convert the equation of a conic section into standard form.	Investigate orbital paths, whispering galleries, satellite dishes, etc.
PC.MGSR.1.3 Define polar coordinates and relate polar coordinates to Cartesian coordinates.	Connect the trigonometric function in the Cartesian Plane to the corresponding polar function in the Polar Plane. Use graphing technology.

PC.MGSR.2. Solve problems and model periodic phenomena with trigonometric expressions and functions.

Indicator	*Indicator Insight*
PC.MGSR.2.1 Determine the area of a triangle to solve problems.	Use *Heron's Formula* when given the length of sides.
PC.MGSR.2.2 Prove and apply the *Law of Sines* and the *Law of Cosines* to find unknown measurements in right and non-right triangles	Consider investigating surveying problems, resultant forces, etc.
PC.MGSR.2.3 Derive the formulas for the length of an arc and the area of a sector in a circle and apply these formulas to solve mathematical and real-world problems.	Convert between degree and radian measures. Develop the radian measure of the quadrantal angles. Work with radian measures that are in terms of π and those not in terms of π.
PC.MGSR.2.4 Determine geometrically the values of the sine, cosine, and tangent for $\pi/6$, $\pi/4$, and $\pi/3$ by special triangles, and use the unit circle to express the values of sine, cosine, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ in terms of their values for x, where x is any real number.	Connect the radian angle names on the 17-point unit circle to portions of 2π radians. Use radian measures corresponding to reference angles $\pi/6$, $\pi/4$, and $\pi/3$.
PC.MGSR.2.5 Define the six trigonometric ratios in terms of *x, y,* and *r* using the unit circle centered at the origin of the coordinate plane and interpret radian measures of angles as a rotation, both counterclockwise and clockwise around the unit circle.	Utilize the parametric interpretation of the coordinates on the unit circle as (cos(t), sin(t)).
PC.MGSR.2.6 Explain symmetry, both odd and even, and periodicity of trigonometric functions.	Investigate by using the unit circle and the graphical representations of the trigonometric functions.

Numerical Reasoning

PC.NR.1. Represent and manipulate data using matrices.

Indicator	*Indicator Insight*
PC.NR.1.1 Identify the identity and zero matrices for any dimension and add, subtract, and multiply matrices.	Includes identity and zero matrix. Recognize that matrix multiplication is not commutative. Perform operations with matrices of appropriate dimensions including addition, subtraction, and scalar multiplication for matrices greater than two-by-two.
PC.NR.1.2 Find the additive and multiplicative inverses of square matrices.	Use technology as appropriate.
PC.NR.1.3 Explain the role of the determinant in determining if a square matrix has a multiplicative inverse.	The determinant must not be zero.
PC.NR.1.4 Find the determinant of a square matrix if and only if the matrix has a multiplicative inverse.	Use technology as appropriate.

PC.NR.2. Represent and model with vector quantities.

Indicator	*Indicator Insight*
PC.NR.2.1 Represent vector quantities as directed line segments and represent magnitude and direction of vectors in component form.	Represent vectors and their magnitudes with varied and appropriate symbols.
PC.NR.2.2 Find the components of a vector by adding and subtracting vectors on a coordinate plane using a variety of methods.	Explore, recognize, and explain tail-to-head, component-wise, and the parallelogram law of vector addition.
PC.NR.2.3 Solve problems, including real-world situations, which can be represented by vectors.	Use terms, including but not limited to *velocity, force*, etc.
PC.NR.2.4 Add and subtract vectors and multiply vectors by a scalar to find the resultant vector.	Solve problems both algebraically and graphically.

PC.NR.3. Represent complex numbers and their operations on the complex plane.

Indicator	*Indicator Insight*
PC.NR.3.1 Represent complex numbers on the complex plane in rectangular and polar form, including real and imaginary numbers, and explain why the rectangular and polar forms of a given complex number represent the same number.	Use formulas to multiply and divide complex numbers in polar form.

Indicator	Indicator Insight
PC.NR.3.2 Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation.	Use properties of this type of representation for computation and show how the functions can be interpreted geometrically on the complex plane.

Patterns, Algebra, and Functional Reasoning

PC.PAFR.1. Build new functions from existing functions to solve mathematical and real-world situations.

Indicator	*Indicator Insight*
PC.PAFR.1.1 Combine and compose functions algebraically, tabularly, and graphically.	Use the operations of addition, subtraction, multiplication, and division. Evaluate the composition of functions at a given element of the domain given symbolic, tabular, and graphical representations.
PC.PAFR.1.2 Find the inverse of functions and verify algebraically, numerically, and graphically.	Given that a function has an inverse, write an expression for its inverse. Verify by composition that two functions are inverses of each other: $f(g(x)) = g(f(x)) = x$. Verify graphically that functions are inverses of each other. Verify numerically that functions are inverses of each other.
PC.PAFR.1.3 Compare the key features of a function and its inverse function and use the relationship to model real-world situations and solve problems.	For real-world application, consider using spreadsheet and computer algebra system technology as appropriate.
PC.PAFR.1.4 Graph and describe the effect on the graph $f(x)$ of $f(x)+k$, $f(x+k)$, $k \cdot f(x)$, and $f(k \cdot x)$, for specific values of both negative and positive values of k.	Given the graph, identify possible values of k. Functions include trigonometric, rational, and general piecewise-defined functions with and without technology.

PC.PAFR.2. Explore and analyze the behaviors of rational and piecewise functions to model contextual mathematical problems.

Indicator	*Indicator Insight*
PC.PAFR.2.1 Graph rational functions and describe their key features.	Key features of rational functions include: intercepts, asymptotes, symmetries about vertical asymptotes and zeros, domain, range, y-intercepts, intervals of increase and decrease, relative extrema, removable points of discontinuities, and end behavior. Consider using technology. To state key intervals, use interval and set notation.

Indicator	*Indicator Insight*
PC.PAFR.2.2 Solve rational equations and inequalities in one variable and explain when extraneous solutions may arise.	Investigate real-world problems such as uniform motion, work, mixtures, etc.
PC.PAFR.2.3 Transform rational expressions in different forms.	Use inspection, long division, or a computer algebra system for more complicated examples.
PC.PAFR.2.4 Graph piecewise-defined functions, to include step functions and absolute value functions, and describe their key features.	Key features of functions include: domain, range, continuity, end behavior, intercepts, and intervals of increase and decrease. Model real-world problems with piecewise-defined functions that incorporate polynomial, logarithmic, exponential, and radical functions.

PC.PAFR.3. Explore and analyze structures and patterns for radical functions and use radical expressions, equations, and functions to model real-world phenomena.

Indicator	*Indicator Insight*
PC.PAFR.3.1 Transform radical expressions as expressions with rational exponents and extend the properties of integer exponents to rational exponents.	Use the product rule, quotient rule, and power rule to manipulate expressions with rational exponents.
PC.PAFR.3.2 Solve radical equations and describe how extraneous solutions may arise.	Include *Heron's Formula* as a potential method of solution.
PC.PAFR.3.3 Analyze and graph radical functions.	Analyze both symbolic and graphical forms. Key features of a radical function include: domain, range, intercepts, roots, zeros, solutions, intervals (increasing, decreasing, positive, and/or negative), maximum and minimum values (including endpoint extrema), non-symmetry, and end behavior. Use graphing technology to analyze functions as appropriate.

PC.PAFR.4. Explore and analyze structures and patterns for exponential and logarithmic functions and use exponential and logarithmic expressions, equations, and functions to model real-world phenomena.

Indicator	***Indicator Insight***
PC.PAFR.4.1 Graph logarithmic functions and describe their key features.	Key features of logarithmic functions include: domain, range, intercepts, asymptotes, intervals of positive and/or negative, intervals of increase and/or decrease, non-symmetry, and end behavior. To state key intervals, use interval and set notation. Determine the effects to the function or graph when key features are manipulated.
PC.PAFR.4.2 Use the definition of a logarithm, logarithmic properties, and the inverse relationship between exponential and logarithmic functions to solve problems, including real-world context.	Must include common and natural logarithms. Apply knowledge of inverse relationships.
PC.PAFR.4.3 Model real-world situations and solve problems involving exponential and logarithmic functions.	Investigate and solve problems such as: exponential growth, exponential decay, half-life, compound interest, Newton's Law of Cooling, and Richter Scale.

PC.PAFR.5. Explore and analyze structures and patterns of trigonometric functions and use trigonometric functions to model real-world phenomena.

Indicator	***Indicator Insight***
PC.PAFR.5.1 Graph trigonometric functions and their inverses and describe their key features.	Key features of trigonometric functions include: period, midline, amplitude, phase shift, intercepts, asymptotes, symmetries, domain, range, relative extrema, intervals of increasing, decreasing, positive, or negative. To state key intervals, use interval and set notation.
PC.PAFR.5.2 Restrict the domain of a trigonometric function to define the six inverse trigonometric functions, graph the inverse function, and evaluate inverse trigonometric expressions.	Relate the characteristics of inverse trigonometric functions to the given output values with and without the use of technology.
PC.PAFR.5.3 Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions and interpret them in terms of the context.	Pay attention to the given interval and domain restrictions on the function.

PC.PAFR.6. Manipulate, prove, and apply trigonometric identities and equations to solve contextual mathematical problems.

Indicator	***Indicator Insight***
PC.PAFR.6.1 Apply the fundamental trigonometric identities to simplify expressions and verify other identities.	Include quotient, reciprocal, Pythagorean identities, even/odd, and cofunction identities.
PC.PAFR.6.2 Apply the sum, difference, double-angle, and half-angle formulas for sine, cosine, and tangent and use them to solve problems.	Consider investigating the connection between the identities as they are derived.
PC.PAFR.6.3 Model real-world situations and solve problems involving trigonometric equations.	Real-world situations to investigate include but are not limited to a Ferris Wheel, tidal wave, swinging pendulum, etc.

PC.PAFR.7. Represent data with matrices, perform mathematical operations, and solve systems of linear equations for mathematical problems.

Indicator	***Indicator Insight***
PC.PAFR.7.1 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Understand that such systems may have zero, one, or two solutions.	Graphically identify the point or points of intersection.
PC.PAFR.7.2 Solve an equation of the form $f(x) = g(x)$ graphically by identifying the x-coordinate(s) of the point(s) of intersection of the graphs of $y = f(x)$ and $y = g(x)$.	Extend to include transformed parent functions introduced in Pre-calculus.
PC.PAFR.7.3 Represent a system of linear equations as a single matrix equation in a vector variable.	Discuss that a matrix can take the form $AX = B$, where A represents the coefficient of variables, X represents variables, and B represents the output to the equations.

Calculus Standards

In South Carolina College- and Career-Ready (SC CCR) Calculus, students build on the conceptual knowledge and the problem-solving skills they learned in previous mathematics courses. This course prepares students for postsecondary mathematical study but is not designed to prepare students for an Advanced Placement exam. SC CCR Calculus focuses on a conceptual understanding of calculus as well as computational competency. The standards promote a multi-representational approach to calculus with concepts, results, and problems being expressed graphically, numerically, analytically, and verbally. These representations facilitate an understanding of the connections among limits, derivatives, and integrals.

In this course, students are expected to apply mathematics in meaningful ways to solve problems that arise in the workplace, society, and real-world situations through the process of modeling. Modeling involves choosing or creating appropriate equations, graphs, functions, or other mathematical representations to analyze real-world situations and answer questions. The use of technological tools, such as handheld graphing calculators, is important in creating and analyzing mathematical representations used in the modeling process and should be used during instruction and assessment. However, technology should not be limited to handheld graphing calculators. Students should use a variety of technologies, such as graphing utilities, spreadsheets, and computer algebra systems, to solve problems and to master standards in all Strands of this course.

Prerequisite courses: Geometry > Algebra 1 > Algebra 2> Pre-Calculus

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Identify the meaning of a problem, utilize appropriate tools, and clearly articulate the "what" of the question. Draw on prior knowledge, analyze given information including constraints, relationships, and goals to find entry points or pathways to a solution. Employ critical thinking skills to consider analogous problems, using special cases and simpler forms of the problem to gain additional insight into the solution. Explain similarities and differences between equations and expressions, including their graphical and tabular representations. Draw diagrams, graph data to clarify information, show relationships, and search for patterns and trends.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse to explain reasoning and select tools, both physical and electronic, that are helpful to explore, model, and deepen students' understanding of mathematical concepts. Understand and use definitions, verbal, and written information to construct arguments and prove conjectures. Students can actively listen to the mathematical ideas of others while communicating their own, and they can solve problems collaboratively. Compare two arguments, distinguish and explain the difference between correct and flawed logic, and explain what is flawed or correct and why. Present conclusions and results using a variety of ways including, but not limited to, tables, graphs, formulas, diagrams, flowcharts, interactive models, and dynamic software. Collaborative work involves joint thinking among individuals as part of problem solving. Technology tools such as graphing utilities, dynamic geometry, spreadsheets, and computer algebra systems are essential for learning mathematics in high school.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Students can identify relevant quantities and apply what they know to solve problems related to real-world situations. Identify important quantities in real-world situations and create a pathway representing relationships applying appropriate tools, such as diagrams, two-way tables, graphs, flowcharts, and formulas as well as electronic tools such as graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry. Students can confidently apply what they know, making assumptions and approximations to simplify complicated situations. Students can evaluate the reasonableness of their thinking and solution(s) and be willing to make revisions if necessary. Connect and apply the techniques from prior knowledge towards topics such as proportional relationships, rates, and percentages to real-world complex tasks.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Make sense of quantities and their application to relationships in mathematical and real-world representations. Evaluate multiple sources of information from text, charts, tables, graphs, and other diverse media and formats. Students can write explanatory text that conveys their mathematical analyses and thinking. Apply concrete details, relevant facts, and coherent discussions of ideas to support thinking. Decontextualize by pulling information from a given situation, representing it symbolically, then manipulating the representing symbols as if they are their own entities, not necessarily relative to what the symbol stands for. Contextualize by pausing during the manipulation process to explore the meaning of symbols within the given situation.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Examine, discern, and recognize patterns or structures as complex mathematical objects composed of more than one simple object. Students can attend to detail and continually evaluate the reasonableness of their results. Students can transform more complex structures into something they know. Discern and recognize regularity in repeated reasoning.

Measurement, Geometry, and Spatial Reasoning

C.MGSR.1. Explain the concept of the integral of a function geometrically, numerically, analytically, and contextually.

Indicator	***Indicator Insight***
C.MGSR.1.1 Explain how the definite integral is used to solve area problems.	Use visual examples to introduce left, right, and midpoint Riemann sums.

Indicator	*Indicator Insight*
C.MGSR.1.2 Approximate definite integrals by a finite sum.	Calculate Riemann sums using left, right, and midpoint evaluations, as well as trapezoidal sums.
C.MGSR.1.3 Interpret the definite integral as a limit of Riemann sums.	Use visual examples to aid in the interpretation.
C.MGSR.1.4 Explain the relationship between the integral and derivative as expressed in both parts of the Fundamental Theorem of Calculus. Interpret the relationship in terms of rates of change.	Consider looking at the statements of the theorem.

C.MGSR.2. Apply theorems and rules of integration to solve mathematical and real-world problems.

Indicator	*Indicator Insight*
C.MGSR.2.1 Apply the Fundamental Theorems of Calculus to solve mathematical and real-world problems.	Determine which fundamental theorem is needed to solve mathematical and real-world problems based upon the context.
C.MGSR.2.2 Explain graphically and verbally the properties of the definite integral. Apply these properties to evaluate basic definite integrals.	Important properties of definite integrals are: • *Adding Function Property* • *Adding Intervals Property* • *Interval of Zero-length Property* • *Reversing the Interval Property* • *The Area Above – Area Below Property*
C.MGSR.2.3 Evaluate integrals using substitution.	Include mathematical and real-world problems.

Numerical Reasoning

C.NR.1. Apply the concepts of a limit graphically, numerically, analytically, and contextually.

Indicator	*Indicator Insight*
C.NR.1.1 Estimate and verify limits using tables, graphs of functions, and technology.	Include continuous functions and functions with removable, infinite, oscillating, and jump discontinuities.
C.NR.1.2 Calculate limits, including one-sided limits, algebraically using direct substitution, simplification, rationalization, and the limit laws for constant multiples, sums, differences, products, and quotients.	Find limits such as: • limits by substitution; • limits of sums, differences, products, and quotients; • limits of rational functions that are undefined at a point; • one-sided limits; and • special limits such as $\lim_{x\to 0}\frac{\sin x}{x}$.

Indicator	Indicator Insight
C.NR.1.3 Calculate infinite limits and limits at infinity and use the limits to identify asymptotes.	When finding asymptotes, include rational, exponential, and logarithmic functions. Decide when a limit is infinite and use limits involving infinity to describe asymptotic behavior.

Patterns, Algebra, and Functional Reasoning

C.PAFR.1. Apply the definition and graphical interpretation of continuity of a function.

Indicator	*Indicator Insight*
C.PAFR.1.1 Apply the definition of continuity of a function at a point to solve problems.	Decide if a function is continuous at a point.
C.PAFR.1.2 Classify discontinuities as removable, jump, or infinite. Justify that classification using the definition of continuity.	Find the types of discontinuities of a function.
C.PAFR.1.3 Understand the Intermediate Value Theorem and apply the theorem to prove the existence of solutions of equations arising in mathematical and real-world problems.	Use the *Intermediate Value Theorem* on a function over a closed interval. Apply the *Extreme Value Theorem*. Understand continuity in terms of limits.

C.PAFR.2. Understand the concept of the derivative of a function geometrically, numerically, analytically, and verbally.

Indicator	*Indicator Insight*
C.PAFR.2.1 Interpret the value of the derivative of a function as the slope of the corresponding tangent line.	Interpret using real-world and mathematical situations in context.
C.PAFR.2.2 Interpret the value of the derivative as an instantaneous rate of change in a variety of real-world contexts such as velocity and population growth.	Include examples such as velocity and population growth and compare to average rate of change around the same point.
C.PAFR.2.3 Approximate the derivative graphically by finding the slope of the tangent line drawn to a curve at a given point and numerically by using the difference quotient.	Find equations for the tangent line and the normal line to the graph of a function.
C.PAFR.2.4 Explain graphically and analytically the relationship between differentiability and continuity.	The graph of a differentiable function has a non-vertical tangent line at each interior point in its domain.
C.PAFR.2.5 Explain graphically and analytically the relationship between the average rate of change and the instantaneous rate of change.	Find the average rate of change and the instantaneous rate of change in the context of a real-world system.

Indicator	Indicator Insight
C.PAFR.2.6 Use the definition of the derivative to determine the derivatives of various functions.	Consider using algebraic, exponential and trigonometric functions.

C.PAFR.3. Apply the rules of differentiation to functions.

Indicator	*Indicator Insight*
C.PAFR.3.1 Identify and apply the derivatives of constant, power, trigonometric, inverse trigonometric, exponential, and logarithmic functions.	Connect these derivatives back to the limit definition of the derivative.
C.PAFR.3.2 Use the constant multiple, sum, difference, product, quotient, and chain rules to find the derivatives of functions.	Blend chain rule with prior rules.
C.PAFR.3.3 Apply the methods of implicit and logarithmic differentiation.	In implicit differentiation, differentiate each side of an equation with two variables (usually x and y) by treating one of the variables as a function of the other.

C.PAFR.4. Apply theorems and rules of differentiation to solve mathematical and real-world problems.

Indicator	*Indicator Insight*
C.PAFR.4.1 Explain the mathematical and real-world meanings of the *Extreme Value Theorem* and the *Mean Value Theorem*.	Include geometric, symbolic, and verbal explanations.
C.PAFR.4.2 Write an equation of a line tangent to the graph of a function at a point.	Include both mathematical and real-world examples.
C.PAFR.4.3 Explain the relationship between the increasing/decreasing behavior of f and the signs of f'. Use the relationship to generate a graph of f given the graph of f', and vice versa, and to identify relative and absolute extrema of f.	Explain how the sign of the first derivative describes the shape of a function's graph. State the first derivative test for critical points.
C.PAFR.4.4 Explain the relationships among the concavity of the graph of f, the increasing/decreasing behavior of f' and the signs of f''. Use those relationships to generate graphs of f, f', and f'' given any one of them and identify the points of inflection of f.	Use concavity and inflection points to explain how the sign of the second derivative describes the shape of a function's graph. State the second derivative test for local extrema.
C.PAFR.4.5 Solve a variety of real-world problems involving related rates, optimization, linear approximation, and rates of change.	In real-world situations, the derivative can tell you at which speed you are driving, or help you predict fluctuations on the stock market; in machine learning, derivatives are important for function optimization.

Reasoning in Mathematics Standards

T Reasoning in Mathematics engages students in relevant problems that focus on how mathematics and statistics inform decision-making. It prepares students for postsecondary options with instruction that focuses on modeling real-world problems.

This course emphasizes statistics, quantitative reasoning, modeling, and financial applications and features a variety of mathematical and statistical tools useful for decision-making. Students will make sense of authentic problems and persevere in solving them. They will reason abstractly and quantitatively while communicating mathematics to others. Students will use appropriate tools, including technology, to model mathematics. Students will use structure and regularity of reasoning to describe mathematical situations and solve problems.

Prerequisite courses: Geometry > Algebra 1

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Identify the meaning of a problem, utilize appropriate tools, and clearly articulate the "what" of the question. Draw on prior knowledge, analyze given information including constraints, relationships, and goals to find entry points or pathways to a solution. Employ critical thinking skills to consider analogous problems, using special cases and simpler forms of the problem to gain additional insight into the solution. Explain similarities and differences between equations and expressions, including their graphical and tabular representations. Draw diagrams, graph data to clarify information, show relationships, and search for patterns and trends.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse to explain reasoning and select tools, both physical and electronic, that are helpful to explore, model, and deepen students' understanding of mathematical concepts. Understand and use definitions, verbal, and written information to construct arguments and prove conjectures. Students can actively listen to the mathematical ideas of others while communicating their own, and they can solve problems collaboratively. Compare two arguments, distinguish and explain the difference between correct and flawed logic, and explain what is flawed or correct and why. Present conclusions and results using a variety of ways including, but not limited to, tables, graphs, formulas, diagrams, flowcharts, interactive models, and dynamic software. Collaborative work involves joint thinking among individuals as part of problem solving. Technology tools such as graphing utilities, dynamic geometry, spreadsheets, and computer algebra systems are essential for learning mathematics in high school.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Students can identify relevant quantities and apply what they know to solve problems related to real-world situations. Identify important quantities in real-world situations and create a pathway representing relationships applying appropriate tools, such as diagrams, two-way tables, graphs, flowcharts, and formulas as well as electronic tools such as graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry. Students can confidently apply what they know, making assumptions and approximations to simplify complicated situations. Students can evaluate the reasonableness of their thinking and solution(s) and be willing to make revisions if necessary. Connect and apply the techniques from prior knowledge towards topics such as proportional relationships, rates, and percentages to real-world complex tasks.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Make sense of quantities and their application to relationships in mathematical and real-world representations. Evaluate multiple sources of information from text, charts, tables, graphs, and other diverse media and formats. Students can write explanatory text that conveys their mathematical analyses and thinking. Apply concrete details, relevant facts, and coherent discussions of ideas to support thinking. Decontextualize by pulling information from a given situation, representing it symbolically, then manipulating the representing symbols as if they are their own entities, not necessarily relative to what the symbol stands for. Contextualize by pausing during the manipulation process to explore the meaning of symbols within the given situation.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Examine, discern, and recognize patterns or structures as complex mathematical objects composed of more than one simple object. Students can attend to detail and continually evaluate the reasonableness of their results. Students can transform more complex structures into something they know. Discern and recognize regularity in repeated reasoning.

Data, Probability, and Statistical Reasoning

RM.DPSR.1. Apply statistical reasoning to complete investigations.

Indicator	*Indicator Insight*
RM.DPSR.1.1 Formulate a statistical question and develop a statistical method to address questions/studies through exploration of the research cycle.	Discuss data sources (including what constitutes primary data and secondary data) and the ethics of data collection, particularly with human subjects.

Indicator	*Indicator Insight*
RM.DPSR.1.2 Write and identify a null hypothesis and an alternative hypothesis, as well as what makes up an experimental study.	Introduce case studies, and then determine whether given studies are observational or experimental and learn about identification of participants, assignment of treatments, and the placebo effect.
RM.DPSR.1.3 Identify the population of interest and the variables to be used in each study. Students then determine the appropriate sampling design, sampling technique, and statistical analysis for each research question.	Identify various sampling techniques used.

RM.DPSR.2. Analyze data of a statistical experiment.

Indicator	*Indicator Insight*
RM.DPSR.2.1 Compare and contrast categorical and quantitative data.	The focus is narrowed to quantitative data and then to univariate data.
RM.DPSR.2.2 Identify the variable of interest, interpret a variety of graphical displays (particularly histograms and box plots), and estimate center, spread, shape, outliers, and unusual features.	Compare and contrast multiple data sets. Throughout this section, students communicate their analyses orally and/or in writing, using appropriate statistical language as well as nontechnical language.
RM.DPSR.2.3 Analyze histograms in depth, analyzing the effect of changing the bin size (also known as interval width).	Consider having students explore these concepts in a research project. Use technology to construct graphical representations.
RM.DPSR.2.4 Analyze the appropriateness and usefulness of the chosen measure of center and of the graphical display.	Consider having students explore these concepts in a research project.
RM.DPSR.2.5 Analyze the shape, spread and unusual features of data sets and identify limitations based on data collection.	Consider having students explore these concepts in a research project.

RM.DPSR.3. Explore the sources of variability in sampling methods.

Indicator	*Indicator Insight*
RM.DPSR.3.1 Analyze possible sources of variability in the data, including biased sampling methods (such as non-representative sampling and under coverage) and biased statistics, as well as natural and induced variability.	Explore the importance of designing surveys and/or observation instruments as they finalize their own study and presentation of their results.
RM.DPSR.3.2 Identify and explore various possible sources of statistical bias (such as response bias, nonresponse bias, and observer effect) and examine the effects of statistical bias on the generalizability of results.	Investigate and explore bias such as response bias, nonresponse bias, and observer effect bias.

Measurement, Geometry, and Spatial Reasoning

RM.MGSR.1. Identify transformations using matrices.

Indicator	***Indicator Insight***
RM.MGSR.1.1 Use matrices to organize information and identify matrices that can be used to describe geometric transformations.	Represent figures using matrices and then look at ways of determining different matrices that answer questions arising from different situations. Students will create and "move" their own figures using matrices, as seen in animation.
RM.MGSR.1.2 Represent figures using matrices and explore ways of determining different transformations, including *translations, reflection, rotations, dilations, or combinations*.	Dynamic geometry software can be used by students to apply in real-world situations.

RM.MGSR.2. Analyze truth tables to validate real-world situations.

Indicator	***Indicator Insight***
RM.MGSR.2.1 Analyze truth tables to determine and verify the validity of arguments.	Work with a variety of statements and arguments, which quickly become more complicated and generally more applicable.
RM.MGSR.2.2 Create arguments and statements to validate their own and peers' arguments.	Work with a variety of statements and arguments, which quickly become more complicated and generally more applicable.

Numerical Reasoning

RM.NR.1. Analyze numerical data through estimation and approximation in real-world situations.

Indicator	***Indicator Insight***
RM.NR.1.1 Use various numerical techniques when estimating and calculating very large and small values.	Real-world situations may include assessing the size of the crowd and calculating the number of possible telephone numbers in the US.
RM.NR.1.2 Apply proportional reasoning with aspect ratios.	Include aspect ratios in photography, in movies, in theaters, and on TV.
RM.NR.1.3 Use weighted averages and sums.	Decision-making may include: the best grading system, averages in sport ratings, cost indices for attending an event, and the Gunning Fog Index for measuring the readability of a piece of writing.

Indicator	Indicator Insight
RM.NR.1.4 Investigate and validate identification numbers.	Investigate real-world situations of identification numbers, including but not limited to check digits to prevent fraud, creation of Universal Product Codes (UPCs). Decision-making may include choosing the appropriate number of digits necessary to create unique ID numbers.

RM.NR.2. Analyze present and future value of investments involving interest.

Indicator	*Indicator Insight*
RM.NR.2.1 Compare and contrast the nominal interest rate with the annual percentage rate (APR).	Use exponential functions representing the future value of an investment compounded annually and monthly.
RM.NR.2.2 Determine the future value of an investment given the present value.	Investigate the future and present value of an annuity.

RM.NR.3. Analyze real-world scenarios involving credit card debt and loans.

Indicator	*Indicator Insight*
RM.NR.3.1 Determine the monthly payment to retire a debt at a fixed rate.	Use credit card statements to understand the concept of minimum payment, length of time to pay off debt using minimum payments, and the APR of minimum payments.
RM.NR.3.2 Compare and contrast different credit card offers using minimum payments.	Compare bank or credit union car loans, automobile dealer car loans, and cash-back features.

Patterns, Algebra, and Functional Reasoning

RM.PAFR.1. Analyze regression of linear functions.

Indicator	*Indicator Insight*
RM.PAFR.1.1 Compute and analyze the correlation coefficient of the data to determine the strength of the linear model.	Explore data that follow an exponential pattern using the idea of a common ratio between consecutive values. Decision-making may include determining an appropriate model and how far one could safely extrapolate.
RM.PAFR.1.2 Analyze data that follow a linear pattern using recursively defined rules and compare those rules to explicit function rules.	Students should be familiar with finding recursive and explicit formulas of arithmetic sequences.

RM.PAFR.2. Analyze step and piecewise function in real-world situations.

Indicator	***Indicator Insight***
RM.PAFR.2.1 Explore step and piecewise functions to make predictions and decisions about a variety of mathematical and real-world situations.	Consider the use of scatter plots to assess the validity of a model and the function rule to determine values of the function at specific points in time. Students use these values to make predictions and decisions about a variety of problem situations.

RM.PAFR.3. Analyze data that follow an exponential pattern using the idea of a common ratio between consecutive values.

Indicator	***Indicator Insight***
RM.PAFR.3.1 Find recursive rules to model the data and make connections between the recursive rule and the explicit function rule of the exponential relationship.	Consider including the following to help develop students' understanding: • Recursion in Exponential • Growth and Decay (For example: Recursion and Exponential Functions and comparing models) • Recursion Using Rate of Change (For example: Newton's Law of Coding; Rates of Change in Exponential Models) • Recursion in Cyclical Models (For example: Modeling the Singapore Flyer)

Applications and Modeling Standards

Mathematical Modeling is a newly-designed, specialized mathematics course developed to expand on and reinforce the concepts introduced in Algebra 1 and Geometry by using those concepts to represent and analyze data and make predictions and inform judgments about real-world phenomena.

Mathematical Modeling is designed to engage students in doing, thinking about, and discussing mathematics, statistics, and modeling in real-world situations. It allows students to experience mathematics and its applications in a variety of ways that promote financial literacy and career-based decision-making.

In this course, students explore decision-making for financial planning and management, design in three dimensions, interpret statistical studies, and create functions that model problems faced by society. Measurements are taken from the real-world, and technology is used extensively for computation, with an emphasis on students' interpretation and explanation of results in context.

Prerequisite courses: Geometry > Algebra 1

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Identify the meaning of a problem, utilize appropriate tools, and clearly articulate the "what" of the question. Draw on prior knowledge, analyze given information including constraints, relationships, and goals to find entry points or pathways to a solution. Employ critical thinking skills to consider analogous problems, using special cases and simpler forms of the problem to gain additional insight into the solution. Explain similarities and differences between equations and expressions, including their graphical and tabular representations. Draw diagrams, graph data to clarify information, show relationships, and search for patterns and trends.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse to explain reasoning and select tools, both physical and electronic, that are helpful to explore, model, and deepen students' understanding of mathematical concepts. Understand and use definitions, verbal, and written information to construct arguments and prove conjectures. Students can actively listen to the mathematical ideas of others while communicating their own, and they can solve problems collaboratively. Compare two arguments, distinguish and explain the difference between correct and flawed logic, and explain what is flawed or correct and why. Present conclusions and results using a variety of ways including, but not limited to, tables, graphs, formulas, diagrams, flowcharts, interactive models, and dynamic software. Collaborative work involves joint thinking among individuals as part of problem solving. Technology tools such as graphing utilities, dynamic geometry, spreadsheets, and computer algebra systems are essential for learning mathematics in high school.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Students can identify relevant quantities and apply what they know to solve problems related to real-world situations. Identify important quantities in real-world situations and create a pathway representing relationships applying appropriate tools, such as diagrams, two-way tables, graphs, flowcharts, and formulas as well as electronic tools such as graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry. Students can confidently apply what they know, making assumptions and approximations to simplify complicated situations. Students can evaluate the reasonableness of their thinking and solution(s) and be willing to make revisions if necessary. Connect and apply the techniques from prior knowledge towards topics such as proportional relationships, rates, and percentages to real-world complex tasks.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Make sense of quantities and their application to relationships in mathematical and real-world representations. Evaluate multiple sources of information from text, charts, tables, graphs, and other diverse media and formats. Students can write explanatory text that conveys their mathematical analyses and thinking. Apply concrete details, relevant facts, and coherent discussions of ideas to support thinking. Decontextualize by pulling information from a given situation, representing it symbolically, then manipulating the representing symbols as if they are their own entities, not necessarily relative to what the symbol stands for. Contextualize by pausing during the manipulation process to explore the meaning of symbols within the given situation.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Examine, discern, and recognize patterns or structures as complex mathematical objects composed of more than one simple object. Students can attend to detail and continually evaluate the reasonableness of their results. Students can transform more complex structures into something they know. Discern and recognize regularity in repeated reasoning.

Data, Probability, and Statistical Reasoning

AM.DPSR.1. Summarize and interpret data represented in tables or graphs to make predictions.

Indicator	***Indicator Insight***
AM.DPSR.1.1 Summarize and interpret trends to make predictions in real-world situations.	Applications could include forecasting growth and decline of various career fields by interpreting data from charts and graphs, or predicting trends about population change that will affect employment rate.
AM.DPSR.1.2 Calculate and explain pay scale based on occupational outlook projections.	Use student career path predictions to develop spreadsheets of occupational projections.
AM.DPSR.1.3 Calculate and explain operating costs, including cost of materials, supplies, equipment, license fees, and insurance fees.	Community members and educational business partners could provide estimated operational cost.
AM.DPSR.1.4 Construct and analyze charts that reflect current demographics in various industries.	Use community information to determine industry needs in the area.

AM.DPSR.2. Solve problems involving probability and probability models, and use expected value to make informed decisions in real-world situations.

Indicator	***Indicator Insight***
AM.DPSR.2.1 Determine the probability of simple and compound events in real-world situations.	Probability Rules: general addition rule, general multiplication rule.
AM.DPSR.2.2 Use probabilities to make and justify decisions about risks in real-world situations.	Real-world applications could include analyzing insurance rates and utilizing risk analysis to develop a job safety analysis plan.
AM.DPSR.2.3 Calculate and analyze the expected value of a probability model, including binominal, normal, and Poisson distributions, for a real-world situation to make decisions about fairness, payoff, and risk.	Consider using technology for creating probability models.

Measurement, Geometry, and Spatial Reasoning

AM.MGSR.1. Apply trigonometric principles to solve real-world geometric situations involving inaccessible distances.

Indicator	*Indicator Insight*
AM.MGSR.1.1 Apply sine, cosine, and tangent ratios and the Laws of Sines and the Law of Cosines to discover distances.	Suggested activities could include: • Clinometer activity (indirect measurement) • Wheelchair Access • Landscaping

AM.MGSR.2. Critique the appropriateness of measurements in terms of precision, accuracy, and approximate error.

Indicator	*Indicator Insight*
AM.MGSR.2.1 Determine dimensions by scaling plans or blueprints.	Demonstrate an understanding of blueprints and drawings.
AM.MGSR.2.2 Apply knowledge of fractions for reading a ruler to 1/16 inch to interpreting blueprints and measuring materials.	Identify various measuring tools and demonstrate their use to verify precision, accuracy, and approximate error.
AM.MGSR.2.3 Compare metric and imperial systems of measurements used in industry.	Identify countries in the world that use the imperial system and metric system and connect it to industry connections. Convert between English and metric measurement systems.

AM.MGSR.3. Apply two- and three-dimensional representations, geometric transformations, and scale models in planning, designing, and constructing solutions to real-world situations.

Indicator	*Indicator Insight*
AM.MGSR.3.1 Calculate lengths utilizing the *Pythagorean Theorem*.	Use a blueprint or scale drawing of a house to determine the amount of materials to be purchased. Identify functions of various plumbing components.
AM.MGSR.3.2 Apply the concepts of area, volume, scale factors, and scale drawings to applied problems for a specific project.	Calculate estimates for construction, house planning or repair projects.
AM.MGSR.3.3 Determine the level of precision and the appropriate tools for taking the measurements in constructing a two-dimensional visual representation of a three-dimensional object or structure.	Create drawings to represent a given solid structure, using technology where appropriate and determine which measurements cannot be taken directly and must be calculated based on other measurements when constructing two-dimensional and three-dimensional figures.
AM.MGSR.3.4 Apply *Heron's Formula* for finding the area of a triangular region.	Use *Heron's Formula* to find the area of different types of triangles: scalene, isosceles, and equilateral.

AM.MGSR.4. Apply two- and three-dimensional representations in coordinate systems to find solutions in real-world situations.

Indicator	***Indicator Insight***
AM.MGSR.4.1 Plot coordinates on a three-dimensional Cartesian coordinate system and use relationships between coordinates to solve design problems.	Consider using dynamic geometric software to model real-world situations to design solutions to real-world problems.
AM.MGSR.4.2 Use technology and other tools to explore the results of simple transformations using three-dimensional coordinates, including translations in the *x, y,* and/or *z* directions; rotations of 90º, 180º, or 270º about the *x, y,* and *z* axes; reflections over the *xy, yz,* and *xy* planes; and dilations from the origin.	Three-dimensional design and video game designs are examples of ways to bring relevance to the coordinate system.

AM.MGSR.5. Use vectors and matrices to represent, organize, and describe data to solve problems in mathematical and real-world situations.

Indicator	***Indicator Insight***
AM.MGSR.5.1 Apply vectors to mathematical and real-world situations by recognizing vectors as mathematical objects having both magnitude and direction.	Solve problems using vectors in areas such as transportation, computer graphics, and the physics of force and motion.
AM.MGSR.5.2 Use and apply matrices to represent geometric transformations in real-world situations.	Solve problems using matrices in fields such as computer animations and banking.

Numerical Reasoning

AM.NR.1. Solve problems using fractions, percents, and ratios for real-world situations involving linear, quadratic, exponential and absolute functions.

Indicator	***Indicator Insight***
AM.NR.1.1 Apply numerical reasoning to real-world situations involving percent increase and decrease.	Apply percent increase and decrease. Applications are related to tolerance, stock transactions, credit cards, taxes, budgets, automobile purchases, fuel economy, Social Security, Medicare, retirement planning, checking and saving accounts, and other related finance applications.

Patterns, Algebra, and Functional Reasoning

AM.PAFR.1. Create and analyze mathematical models to make decisions on real-world situations.

Indicator	*Indicator Insight*
AM.PAFR.1.1 Use exponential functions to model change in a variety of financial situations.	Use exponential models related to earning, investing, spending, and borrowing money.
AM.PAFR.1.2 Compare the various means of paying for an automobile including leasing, purchasing by cash, and purchasing by loan.	Investigate financing options for leasing and purchasing and the difference between finance companies and banks.
AM.PAFR.1.3 Use sequences to represent simple and compound interest and depreciation.	Investigate growth and reduction of credit card debt using spreadsheets.

AM.PAFR.2. Analyze and solve application-based problems relating to direct, inverse, and joint variation.

Indicator	*Indicator Insight*
AM.PAFR.2.1 Apply variations to mathematical and real-world situations to describe troubleshooting in business and industrial applications.	Applications could include calculating the proper size of a water service line and drainage fixture units for a given pipe size.
AM.PAFR.2.2 Utilize mathematical skills for troubleshooting in business and industrial applications.	Applications could include: • calculating wattage consumed by energized units, solving problems in electrical circuits using Ohm's law, and determining voltage/amperage for various welding applications; and • calculating the proper size of a water service line and drainage fixture units for a given pipe size.

AM.PAFR.3. Analyze and apply linear programming to mathematical and real-world situations.

Indicator	*Indicator Insight*
AM.PAFR.3.1 Calculate the values of the variables that maximize or minimize the objective function given four or more constraints.	Applications could include: • calculating the optimal material thickness for various projects; • calculating the load capacity in various applications; • calculating the fitting allowances and thread makeup using dimension tables; • calculating the grade and elevation of a trench for a sewer line; and • demonstrating and contrasting the variables for heat input and welding effects.

Statistical Modeling Standards

Statistical modeling is a newly-designed course that extends students' understanding of statistics. The Statistical Modeling course offers students opportunities to strengthen their understanding of the statistical method of inquiry and statistical simulations. Students will formulate statistical investigative questions to be answered using data, design and implement a plan to collect the appropriate data, select appropriate graphical and numerical methods for data analysis, and interpret their results to make connections with the initial question. The process standards, through a statistical lens, will provide the foundation for instruction and assessment. Topics should be introduced and assessed using simulations and appropriate supporting technology.

Statistical Inquiry Process: Developing Statistical Questions, Collecting Data, Analyzing Data, Interpreting Results

Prerequisite courses: Geometry > Algebra 1 > Algebra 2

Mathematical Process Standards

STANDARD AREA	**INDICATOR**	**INDICATOR INSIGHT**
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Identify the meaning of a problem, utilize appropriate tools, and clearly articulate the "what" of the question. Draw on prior knowledge, analyze given information including constraints, relationships, and goals to find entry points or pathways to a solution. Employ critical thinking skills to consider analogous problems, using special cases and simpler forms of the problem to gain additional insight into the solution. Explain similarities and differences between equations and expressions, including their graphical and tabular representations. Draw diagrams, graph data to clarify information, show relationships, and search for patterns and trends.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
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STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Students can identify relevant quantities and apply what they know to solve problems related to real-world situations. Identify important quantities in real-world situations and create a pathway representing relationships applying appropriate tools, such as diagrams, two-way tables, graphs, flowcharts, and formulas as well as electronic tools such as graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry. Students can confidently apply what they know, making assumptions and approximations to simplify complicated situations. Students can evaluate the reasonableness of their thinking and solution(s) and be willing to make revisions if necessary. Connect and apply the techniques from prior knowledge towards topics such as proportional relationships, rates, and percentages to real-world complex tasks.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Make sense of quantities and their application to relationships in mathematical and real-world representations. Evaluate multiple sources of information from text, charts, tables, graphs, and other diverse media and formats. Students can write explanatory text that conveys their mathematical analyses and thinking. Apply concrete details, relevant facts, and coherent discussions of ideas to support thinking. Decontextualize by pulling information from a given situation, representing it symbolically, then manipulating the representing symbols as if they are their own entities, not necessarily relative to what the symbol stands for. Contextualize by pausing during the manipulation process to explore the meaning of symbols within the given situation.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Examine, discern, and recognize patterns or structures as complex mathematical objects composed of more than one simple object. Students can attend to detail and continually evaluate the reasonableness of their results. Students can transform more complex structures into something they know. Discern and recognize regularity in repeated reasoning.

Data, Probability, and Statistical Reasoning

SM.DPSR.1. Communicate using descriptive and inferential statistics by collecting, critiquing, analyzing, and interpreting real-world data.

Indicator	*Indicator Insight*
SM.DPSR.1.1 Calculate and interpret z-scores as a measure of relative standing to standardize units.	Use z-scores as statistical tools that enable comparison of samples with different units and that can be used with any distribution regardless of shape. Use z-scores to make decisions when analyzing real-world data. Use technology to calculate the standard deviation to determine z-scores, where necessary.
SM.DPSR.1.2 Approximate percentages using the *Empirical Rule* and z-scores for normally distributed data.	Use technology such as calculators, spreadsheets, or tables to estimate areas under a normal curve. Understand that the rule is not appropriate for data sets that are not normally distributed.
SM.DPSR.1.3 Using simulations taken from a given population, model sample-to-sample variability in sampling distributions of a statistic.	Use simulations to determine if a given model accurately reflects real outcomes. Use statistics from repeated samples of the same size to explore sample-to-sample variability.
SM.DPSR.1.4 Construct and compare confidence intervals of different models to make conclusions about reliability given a margin of error.	Develop confidence intervals using simulations and technology, including statistical applets. Apply the concept of margin of error to make conclusions about the reliability of statistical results. Students should not be required to calculate margin of error.
SM.DPSR.1.5 Summarize and evaluate reports based on data for appropriateness of study design, analysis methods, and statistical measures used.	Students should communicate statistical information, verbally, and in writing.

SM.DPSR.2. Formulate investigative statistical questions that can be answered using data.

Indicator	*Indicator Insight*
SM.DPSR.2.1 Formulate investigative statistical questions about a population using samples taken from the population.	Distinguish statistical questions from other types of questions. Identify when situations use an entire population (census) and a part of the population (sample).

Indicator	*Indicator Insight*
SM.DPSR.2.2 Formulate comparative and associative investigative statistical questions for surveys and observational studies to compare two or more groups or to investigate the association of two or more variables.	Compose statistical questions to collect and analyze appropriate data to answer the statistical investigative question.
SM.DPSR.2.3 Formulate comparative and associative investigative statistical questions for experiments to compare two or more groups or to investigate the association of two or more variables.	Compose statistical questions to collect and analyze appropriate data to answer the statistical investigative question.
SM.DPSR.2.4 Formulate inferential investigative statistical questions regarding association and prediction.	Pose statistical investigative questions for a particular sample to determine any association of the variables of interest for that sample.
SM.DPSR.2.5 Formulate investigative statistical questions for two variables.	Expand the types of statistical investigation questions to include questions concerning association and prediction.

SM.DPSR.3. Design and implement a plan to collect data to address the investigative statistical question.

Indicator	*Indicator Insight*
SM.DPSR.3.1 Apply an appropriate data-collection plan when collecting data for the investigative statistical question of interest.	Use appropriate sampling techniques, such as random, simple random, stratified, cluster, or systematic. Critique poorly-constructed surveys and suggest good questions. Consider whether the population is well-defined, the sampling procedure is random or non-random, and whether the objectivity or bias of questions will result in valid/invalid answers.
SM.DPSR.3.2 Distinguish between sample surveys, observational studies, and experiments.	Understand there are advantages and disadvantages of each data collection method for specific statistical questions.
SM.DPSR.3.3 Design sample surveys, experiments, and observational studies using statistical methods.	Identify, discuss, and explain the aspects of best statistical practice for designing an experimental study including clearly identifying: • the statistical question being investigated; • the variables being investigated; and • random selection of experimental units and/or the random assignment of treatments to the experimental units.

Indicator	*Indicator Insight*
SM.DPSR.3.4 Differentiate between random selection and random assignment and identify their impact on generalizing.	Design and conduct comparative experiments using random assignment and demonstrate correct methods for planning data collection for comparison of treatments. Randomly assign treatments to experimental units.
SM.DPSR.3.5 Examine potential sources and effects of bias and confounding variables.	Design and conduct surveys from both non-random and randomly selected participants. Students could explain why random samples can provide more unbiased information about a population than other types of samples, such as convenience samples or self-selected samples. Identify bias including response bias, under coverage, nonresponse bias, selection bias, and experimenter bias.
SM.DPSR.3.6 Describe and comply with the ethical use of data.	Practices for handling data that enhance reproducibility and ensure ethical use include providing descriptions of alterations to collected data, proper treatment of sensitive information, maintaining the confidentiality of data and experimental units, and using Institutional Review Boards to review study designs. Describe the ethical consequences of their experiments and analyses.
SM.DPSR.3.7 Identify when data can be generalized to a target population.	Make generalizations to an implied population that extend beyond the collected sample data, samples must be randomly selected from the implied population. Sampling procedures that are not random may be biased; therefore, these samples cannot be used to make generalizations to the sampled population.

SM.DPSR.4. Use appropriate graphical and numerical methods to analyze data.

Indicator	***Indicator Insight***
SM.DPSR.4.1 Describe quantitative and categorical data.	Identify types of displays that are appropriate for categorical data, such as pie charts, bar charts, pareto charts, versus quantitative data, such as histograms, stem plots, box plots, dot plots. Use tables, including relative frequency tables, graphical displays, including histograms and modified box plots, and numerical summary statistics.
SM.DPSR.4.2 Summarize and describe relationships between two variables.	Use tables, including two-way tables, graphical displays, including scatter plots, and numerical summary statistics. Identify situations where change in one attribute may be related to change in another attribute. When describing quantitative relationships include direction, form, strength, and unusual features such as outliers, gaps, clusters, etc. Strength of association is demonstrated by degree of spread about the line of best fit in a scatter plot.
SM.DPSR.4.3 Describe the relationship between two quantitative variables by interpreting correlation (r) and a least-square regression line (using technology).	Provide a reasonable estimate of the *Pearson's correlation coefficient* (r) for a scatter plot (r = -0.82 and r = 0.82 indicate the same strength with opposite direction). Interpret the strength of a linear relationship based on r. Understand that the magnitude of the correlation coefficient, r, represents the strength of linear association only.
SM.DPSR.4.4 Assess the fit of a linear model by plotting and analyzing residuals, including the squares of the residuals, to improve its fit.	Calculate and understand a residual as the difference between what is observed and what is predicted.
SM.DPSR.4.5 Calculate and interpret the p-value for a population proportion and/or population mean.	Approximate p-values using simulation or simulation results, especially for the difference in two means or two proportions. Convert a p-value into a statement about their confidence that the observed data was produced by the treatment rather than by random chance.

Indicator	*Indicator Insight*
SM.DPSR.4.6 Use simulated sampling distributions to describe the sample-to-sample variability of sample statistics.	Understand that repeated samples reveal variability, and sampling variability is influenced by sample size. Interpret the sampling variability in a summary statistic: sample mean, sample proportion, median, IQR, and standard deviation. Interpret the sampling variability from simulation studies of statistics.
SM.DPSR.4.7 Use simulations to investigate associations between two categorical variables and to compare groups.	Interpret measures of association to determine if there is a relationship between variables. Understand that association does not imply cause-and-effect.

SM.DPSR.5. Interpret the results of the analysis by making connections to the investigative statistical question.

Indicator	*Indicator Insight*
SM.DPSR.5.1 Use statistical evidence from analyses to answer investigative statistical questions.	Decide whether an observed difference is something that would be likely to be observed by chance and whether this difference has any practical meaning. Recognize that significance is demonstrated by a result that is unlikely to occur by chance. Recognize that statistical, but not practical, significance is influenced by sample size.
SM.DPSR.5.2 Determine the possible impact of extreme data points, missing values, or incorrect values on the results.	Describe how the presence of outliers contributes to overestimate or underestimate population estimates. Describe how missing or imprecise values can lead to biased or inaccurate estimations.
SM.DPSR.5.3 Use and interpret the p-value to determine whether the estimate for a population parameter is reasonable.	Interpret a p-value to make an inference in the context of a study. Interpret the p-value as the probability of observing the statistic, given the population parameter is true.
SM.DPSR.5.4 Interpret a given margin of error corresponding to an estimate of a population parameter.	Interpret the confidence interval(s) in relation to the situation being examined. Understand that sampling variability is associated with summary statistics and uses the margin of error to form an interval (confidence interval) to estimate the characteristic.

Indicator	*Indicator Insight*
SM.DPSR.5.5 Explain the impact of multiple variables on one another.	Provide or select appropriate interpretations of graphical displays and numerical summaries when comparing two or more groups in the context of a study.

Discrete Mathematics Standards

Discrete Mathematics is a collection of methods for studying big data analytics. It includes the study of the principles of number theory; classification and comparison of objects; use of matrices to model and solve problems; use of recursion model; analysis of numbers with different bases; data probability and statistical reasoning in real-world situations; use of graph theory; and the principles of logic theory.

Discrete Mathematics stresses the connections between contemporary mathematics and their applications to our daily lives. It provides tools for understanding and using inference systems for drawing reasonable conclusions, algorithms for scaling computations, and managing large scale data. Topics addressed in this course are applicable to real-world career fields such as the field of computer science and situations which include management sciences, statistics, voting and social choice, fairness and game theory, size and growth, and money and resources. Environmental and economic decisions dominate modern life, and behind these decisions are fundamental principles of science, technology, and mathematics.

Prerequisite courses: Geometry > Algebra 1 > Algebra 2

Mathematical Process Standards

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives demonstrating the impact of mathematics. Identify the meaning of a problem, utilize appropriate tools, and clearly articulate the "what" of the question. Draw on prior knowledge, analyze given information including constraints, relationships, and goals to find entry points or pathways to a solution. Employ critical thinking skills to consider analogous problems, using special cases and simpler forms of the problem to gain additional insight into the solution. Explain similarities and differences between equations and expressions, including their graphical and tabular representations. Draw diagrams, graph data to clarify information, show relationships, and search for patterns and trends.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse to explain reasoning and select tools, both physical and electronic, that are helpful to explore, model, and deepen students' understanding of mathematical concepts. Understand and use definitions, verbal, and written information to construct arguments and prove conjectures. Students can actively listen to the mathematical ideas of others while communicating their own, and they can solve problems collaboratively. Compare two arguments, distinguish and explain the difference between correct and flawed logic, and explain what is flawed or correct and why. Present conclusions and results using a variety of ways including, but not limited to, tables, graphs, formulas, diagrams, flowcharts, interactive models, and dynamic software. Collaborative work involves joint thinking among individuals as part of problem solving. Technology tools such as graphing utilities, dynamic geometry, spreadsheets, and computer algebra systems are essential for learning mathematics in high school.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Students can identify relevant quantities and apply what they know to solve problems related to real-world situations. Identify important quantities in real-world situations and create a pathway representing relationships applying appropriate tools, such as diagrams, two-way tables, graphs, flowcharts, and formulas as well as electronic tools such as graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry. Students can confidently apply what they know, making assumptions and approximations to simplify complicated situations. Students can evaluate the reasonableness of their thinking and solution(s) and be willing to make revisions if necessary. Connect and apply the techniques from prior knowledge towards topics such as proportional relationships, rates, and percentages to real-world complex tasks.

STANDARD AREA	INDICATOR	INDICATOR INSIGHT
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Make sense of quantities and their application to relationships in mathematical and real-world representations. Evaluate multiple sources of information from text, charts, tables, graphs, and other diverse media and formats. Students can write explanatory text that conveys their mathematical analyses and thinking. Apply concrete details, relevant facts, and coherent discussions of ideas to support thinking. Decontextualize by pulling information from a given situation, representing it symbolically, then manipulating the representing symbols as if they are their own entities, not necessarily relative to what the symbol stands for. Contextualize by pausing during the manipulation process to explore the meaning of symbols within the given situation.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Examine, discern, and recognize patterns or structures as complex mathematical objects composed of more than one simple object. Students can attend to detail and continually evaluate the reasonableness of their results. Students can transform more complex structures into something they know. Discern and recognize regularity in repeated reasoning.

Data, Probability, and Statistical Reasoning

DM.DPSR.1. Analyze, model, and solve problems involving fair outcomes.

Indicator	*Indicator Insight*
DM.DPSR.1.1 Investigate and describe the results of various election methods.	Include approval and preference voting as well as plurality, majority, run-off, sequential run-off, Borda count, and Condorcet winners.
DM.DPSR.1.2 Explain fairness and equity in relation to the paradoxes of voting.	Possible paradoxes are the Arrow Paradox and the Down Paradox.

Indicator	*Indicator Insight*
DM.DPSR.1.3 Solve apportionment problems using a variety of methods.	Variety of methods includes Hamilton, Hill, Jefferson, and Webster.
DM.DPSR.1.4 Compare voting methods to determine the method most appropriate for the situation.	Methods: • *the Majority Criterion,* • *Condorcet's Criterion,* • *the Independence-of-Irrelevant-Alternatives Criterion, and* • *the Monotonicity Criterion.*
DM.DPSR.1.5 Determine power indexes for weighted voting systems.	Apply to voting methods in 7c insight.

Measurement, Geometry, and Spatial Reasoning

DM.MGSR.1. Use graph theory to model relationships and solve problems.

Indicator	*Indicator Insight*
DM.MGSR.1.1 Distinguish between inductive and deductive reasoning.	Use this reasoning to set the stage for logic theory.
DM.MGSR.1.2 Determine statements and rephrase them symbolically.	Include connectives and quantifiers.
DM.MGSR.1.3 Use negation, disjunction, and conjunction to determine if statements are logically equivalent.	Include Venn Diagrams and truth tables.
DM.MGSR.1.4 Write statements in words and symbolically using *converse, inverse, and contrapositive.*	Include Venn Diagrams and truth tables.
DM.MGSR.1.5 Verify arguments and syllogism.	Use Euler diagrams to verify syllogisms.
DM.MGSR.1.6 Represent real-world situations using a vertex-edge graph.	Real-world situations include directed and undirected graphs. Examples could include but are not limited to a cake recipe, a social network, airline scheduling, and map directions.
DM.MGSR.1.7 Test graphs and digraphs for paths and circuits.	Paths and circuits to explore should include but are not limited to Euler paths, Euler circuits, Hamiltonian paths, and Hamiltonian circuits.

Numerical Reasoning

DM.NR.1. Investigate principles of set theory.

Indicator	***Indicator Insight***
DM.NR.1.1 Define basic terms and concepts in set theory.	Discussions should include the terms *set element, well defined, empty/null set,* and *cardinal number.*
DM.NR.1.2 Compare sets with appropriate language and notation.	Compare using equality, subset, proper subset, equivalence, and power sets.
DM.NR.1.3 Determine and explain the cardinality of sets.	Distinguish between finite and infinite cardinality of sets.

DM.NR.2. Analyze numbers with different bases in real-world situations.

Indicator	*Indicator Insight*
DM.NR.2.1 Perform arithmetic operations using modular arithmetic properties.	Define module, modulus, and integers.
DM.NR.2.2 Solve problems involving modular arithmetic in real-world situations.	Real-world applications can include clocks, ISBNs, cryptosystems, coding, etc.
DM.NR.2.3 Explain and apply binary and hexadecimal number systems.	Make connections of number systems to computer applications such as machine language and coding of colors.

DM.NR.3. Determine the number of ways an event can occur.

Indicator	*Indicator Insight*
DM.NR.3.1 Calculate combinations and permutations.	Consider applying combinations and permutations using set notation.

Patterns, Algebra, and Functional Reasoning

DM.PAFR.1. Classify and compare objects using estimation and sets for real-world situations.

Indicator	*Indicator Insight*
DM.PAFR.1.1 Use estimation to get an approximate answer in real-world situations.	Include distance, money, time, cost of gas, etc.
DM.PAFR.1.2 Perform operations on sets.	Operations include union, intersection, complement, and difference with and without Venn Diagrams.

DM.PAFR.2. Develop an understanding of and carry out proofs by mathematical induction using the Principle of Mathematical Induction.

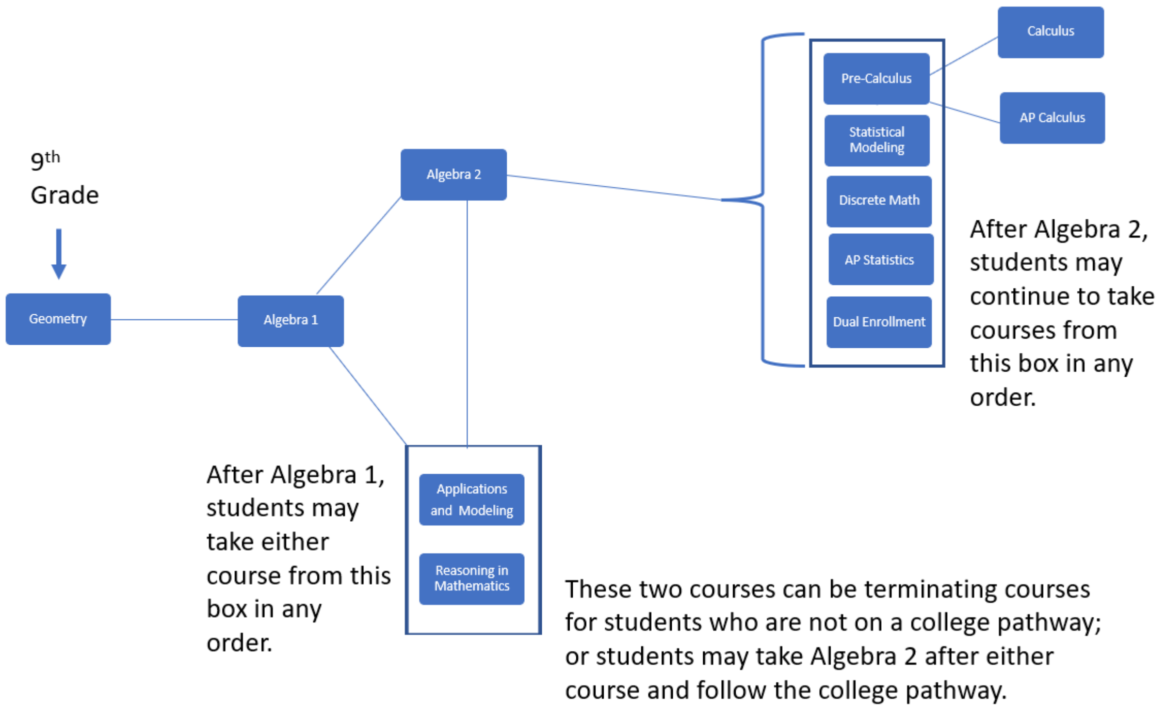
Indicator	*Indicator Insight*
DM.PAFR.2.1 Create mathematical induction proofs using the Principle of Mathematical Induction.	Possible proofs include sum of integers, product of numbers, divisibility, and other properties of rational and irrational numbers.

DM.PAFR.3. Use matrices to model and solve mathematical and real-world situations.

Indicator	*Indicator Insight*
DM.PAFR.3.1 Manipulate matrices using addition, subtraction, multiplication, inverse, and power properties.	Consider limiting to three-by-three matrices.
DM.PAFR.3.2 Write and evaluate matrices drawn from real-world situations.	Possible situations to consider include encryption, economics, circuits, and systems of equations. Limit to 3x3 matrices and perform on a calculator or other technology.

Appendix A: High School Course Pathways Graphic

This section provides insight into the possible pathways for students. Four course credits are required for graduation.



Appendix B: Acknowledgements

Standards Writing Committee 2022-2023
The members of the writing committee considered recommendations by the review panel, the Education Oversite Committee, and the vertical alignment team to develop the draft of the revised standards.

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EDUCATION OVERSIGHT COMMITTEE

DATE: October 9, 2023

COMMITTEE:
Education Oversight Committee

ACTION ITEM:
Process for approval of Dual Enrollment for CCR

PURPOSE/AUTHORITY

Section 59-18-900 of the Education Accountability Act (EAA) as amended by Act 94 of 2017 requires the EOC to "determine the criteria for and establish performance ratings of excellent, good, average, below average, and unsatisfactory for schools." Furthermore, "the same categories of performance ratings also must be assigned to individual indicators used to measure a school's performance including, but not limited to, academic achievement, student growth or progress, graduation rate, English language proficiency, and college and career readiness." The EAA also encourages students to earn industry credentials to be career ready. In addition, the state longitudinal data system created by Section 59-18-1950 requires the Revenue and Fiscal Affairs Office to measure the continuous improvement of the state public education system and the college and career readiness and success of its graduates by documenting "working-aged adults in South Carolina by county who possess a postsecondary degree or industry credential."

CRITICAL FACTS

Per the SC accountability system, high schools receive an indicator rating for College/Career Readiness, which is the percentage of high school graduates who are college or career ready. In addition, one-fourth or 25 points of each high school's overall rating is based on this indicator. While there are several metrics that can define both "college ready" and "career ready," students completing at least six credit hours in an approved dual enrollment course with a grade of C or higher are considered "college ready" in the current accountability system. Approved courses should be in English, mathematics, STEM, or social studies. EOC staff is proposing a process be initiated to further refine list of approved courses to include only those courses that meet the associate of science or associate of arts that transfer to a four-year degree, Bachelor of Science, or Bachelor of Arts degree and those that have been approved by CHE's Office of Academic Affairs.

TIMELINE/REVIEW PROCESS

Timelines outlined within process documents.

ECONOMIC IMPACT FOR EOC

none

ACTION REQUEST

☒ **For approval** ☐ **For information**

ACTION TAKEN

☐ **Approved** ☐ **Amended**
☐ **Not Approved** ☐ **Action deferred (explain)**

Process for Dual Enrollment Course Approval for SC Report Card

Action Item	**Person Responsible**	**Deadline[1]**
SCDE submits course(s) to EOC for consideration for approval	Director, SCDE Standards and Assessment Office	August 1
EOC reviews list and submits to Office of Academic Affairs at SC Commission on Higher Education (CHE)	Executive Director, EOC	August 15
CHE conducts review of courses submitted against college credit criteria[2] and confirms courses meet criteria; submits list to EOC	Director, CHE Office Academic Affairs	September 15
EOC submits revisions/final list to SCDE	Executive Director, EOC	October 1

Note 1: The deadline is for the approval of dual credit courses for the school year in which this process is initiated. The dual credit course approval is not retroactive.

EOC staff review of courses includes inclusion of courses that meet the associate of science or associate of arts that transfer to a four-year degree, Bachelor of Science, or Bachelor of Arts degree.

Note 2: In December 2017, the EOC approved the criteria by which dual enrollment courses are approved as College-Ready as defined in the accountability system.
Prior to December 2017, the EOC had approved the following criteria for dual enrollment course inclusion in CCR:

Students completing at least six (6) credit hours in dual enrollment courses in an English or mathematics course or STEM course with a grade of C or higher. STEM is defined as a natural/lab science or computer science course. The SCDE recommended that social studies courses be included in the criteria, and the recommendation was approved in December 2017.

EDUCATION OVERSIGHT COMMITTEE

DATE: **<u>October 9, 2023</u>**

<u>COMMITTEE:</u>
Education Oversight Committee

<u>ACTION ITEM:</u>
Process for approval of Industry Certifications and Credentials

<u>PURPOSE/AUTHORITY</u>

Section 59-18-900 of the Education Accountability Act (EAA) as amended by Act 94 of 2017 requires the EOC to "determine the criteria for and establish performance ratings of excellent, good, average, below average, and unsatisfactory for schools." Furthermore, "the same categories of performance ratings also must be assigned to individual indicators used to measure a school's performance including, but not limited to, academic achievement, student growth or progress, graduation rate, English language proficiency, and college and career readiness." The EAA also encourages students to earn industry credentials to be career ready. In addition, the state longitudinal data system created by Section 59-18-1950 requires the Revenue and Fiscal Affairs Office to measure the continuous improvement of the state public education system and the college and career readiness and success of its graduates by documenting "working-aged adults in South Carolina by county who possess a postsecondary degree or industry credential."

<u>CRITICAL FACTS</u>
Per the SC accountability system, high schools receive an indicator rating for College/Career Readiness, which is the percentage of high school graduates who are college or career ready. In addition, one-fourth or 25 points of each high school's overall rating is based on this indicator. While there are several metrics that can define both "college ready" and "career ready," a student may be deemed "career ready" if the high school graduate is a Career and Technical Education (CTE) completer and, where applicable, has earned a national industry credential (or state if national not available) as determined by the business community. After the business community vets the certifications, the EOC approves those certifications that count toward "career ready" for purposes of accountability. EOC staff is proposing a process for vetting and approving new certifications and credentials for the 2023-24 school year – in advance of the adoption of the tiered credential system.

<u>TIMELINE/REVIEW PROCESS</u>
Timelines outlined within process documents.

<u>ECONOMIC IMPACT FOR EOC</u>
none

<u>ACTION REQUEST</u>

☒ **For approval** ☐ **For information**

<u>ACTION TAKEN</u>

☐ **Approved** ☐ **Amended**
☐ **Not Approved** ☐ **Action deferred (explain)**

Process for Approval of Industry Certifications/Credentials for Inclusion in College and Career-Ready Indicator on SC Report Card School Year 2023-24

Per the SC accountability system, high schools receive an indicator rating for College/Career Readiness, which is the percentage of students in the 9GR who are college- or career-ready. While there are several metrics that can define "career ready," a student may be deemed "career-ready" if the high school graduate is a Career and Technical Education (CTE) completer and, where applicable, has earned a national industry credential (or state if national not available) as determined by the business community.

Following vetting by groups at the SC Chamber of Commerce and the EEDA Coordinating Council, the EOC approved certifications/credentials on the following schedule:

School Year	New Certifications Approved
2017-18	130
2018-19	34
2019-20	80 (approved by EOC April 2019)

No approval of new certifications has occurred for School Years 2020-21, 2021-22, or 2022-23. The combined impact of COVID and the sunset of the EEDA Coordinating Council was an impediment to the process of industry vetting.

The SCDE has submitted a list of 75 certifications/credentials to be submitted for the current school year. EOC staff recommends the process outlined in the table below be used to consider these new certifications.

The EOC is expected to receive the proposed Stackable Credentials system for consideration in February 2024. At that time, the process by which credentials and certifications are vetted prior to EOC receipt is likely to change.

Action Item	Person Responsible	Deadline
SCDE submits certification(s) to EOC for consideration for approval	Director, SCDE Career and Technology Education (CTE) Office	August 1, 2023
EOC reviews list and submits to SC Future Makers and SC Competes for industry personnel review by cluster	Executive Director, EOC	August 15, 2023
SC Future Makers, working with outside industry groups, conducts review of certifications submitted using designated Tiers proposed by SREB in Stackable Credential system (see note 1); submits	Executive Director, SC Future Makers	September 15, 2023

list to EOC staff for additional review		
EOC submits recommendations to ASA/PA Subcommittee for approval	Executive Director, EOC	November 13, 2023
Subcommittee recommendations to full EOC for approval; final approved list sent to SCDE offices	Executive Director, EOC	December 11, 2023

Note 1. SC's Proposed Tiering Language (expected to be considered by EOC in February 2024)