NEW MEXICO
Public Education Department

HS: GEOMETRY-MODELING WITH GEOMETRY

Cluster Statement: A: Apply geometric concepts in modeling situations

Standard Text	Standard for Mathematical Practices	Students who demonstrate understanding can:
HSG.MG.A.1 **Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).**	SMP 1 Students make sense of problems and persevere in solving them by analyzing a scenario to determine a geometric shape that fits the context. SMP 4 Students model with mathematics by applying an appropriate geometric formula to solve a contextual problem.	• Recognize the geometric shape that corresponds to a real object. • Utilize geometric shapes, measures, and properties to describe objects. **Webb's Depth of Knowledge: 1-2** **Bloom's Taxonomy:** understand, apply
Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
HSG.MG.A.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).	SMP 1 Students make sense of problems and persevere in solving them by analyzing a scenario to determine a geometric shape that fits the context. SMP 4 Students model with mathematics by applying an appropriate geometric formula to solve a contextual problem.	• Construct the different volume and area formulas for shapes and figures. • Explain how to find density for different types of information. • Apply formulas to find density for different types of information. **Webb's Depth of Knowledge:** 1-2 **Bloom's Taxonomy:** understand, apply

Standard Text	Standard for Mathematical Practices	Students who demonstrate understanding can:
HSG.MG.A.3 **Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).**	SMP 1 Students make sense of problems and persevere in solving them by analyzing a scenario to determine a geometric shape that fits the context. SMP 4 Students model with mathematics by applying an appropriate geometric formula to solve a contextual problem.	• Determine which geometric concepts/figures best model a given situation. • Apply an array of formulas to determine the appropriate geometric solutions. • Design a model of a real-life object using geometric figures. **Webb's Depth of Knowledge:** 1-3 **Bloom's Taxonomy: understand, apply, create**
Previous Learning Connections	**Current Learning Connections**	**Future Learning Connections**
• In grades 7 and 8, learners worked with formulas for area, perimeter, surface area and volume, solving real world and mathematical problems.	• Students have been modeling throughout the Geometry course with many of the clusters with focus on using skills to model the real-world situations in this cluster.	• More complex modeling will be used in statistics, physics, trigonometry, and calculus when approaching real-world problems analytically.

Clarification Statement

Modeling is the process of choosing and using appropriate mathematics to analyze situations, to understand them better, and to improve decisions. Modeling links classroom mathematics to everyday life, work, and decision making. Mathematical objects that represent a situation from outside mathematics can be used to model and solve problems. Modeling often involves making simplifying assumptions and sometimes minimizes or disregards some features of the situation being modeled. Modeling is best interpreted not as a collection of isolated topics, but in relation to other standards as well.

Common Misconceptions

Students may struggle identifying approximate shapes to model scenarios.
Students may struggle breaking complex shapes into a combination of simpler shapes.
Students may struggle applying concepts like volume and surface area to language and contexts such as "has a capacity of" or "wraps around."

Multi-Layered System of Supports (MLSS)/Suggested Instructional Strategies

Pre-Teach

Pre-teach (targeted): *What pre-teaching will prepare students to productively struggle with the mathematics for this cluster within your HQIM?*

- For example, some learners may benefit from targeted pre-teaching that introduces new representations when studying applications of geometric concepts in modeling situation because students need a strong foundation on geometric methods such as solving for the area and volume and use the area and volume to solve for the density of a given geometric shape.

Pre-teach (intensive): *What critical understandings will prepare students to access the mathematics for this cluster?*

- 7.G.B.4 Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle. This standard provides a foundation for work with applications of geometric concepts in modeling situation because students need to have a strong foundation on basic formulas and how to properly use it to solve problems and use it to justify their answers. If students have unfinished learning within this standard, based on assessment data, consider ways to provide intensive pre-teaching support prior to the start of the unit to ensure students are ready to access grade level instruction and assignments.

Core Instruction

Access

Perception: *How will the learning for students provide multiple formats to reduce barriers to learning, such as providing the same information through different modalities (e.g., through vision, hearing, or touch) and providing information in a format that will allow for adjustability by the user?*

- For example, learners engaging with modeling with Geometry will have the chance to link geometry to everyday life, work and decision making. In this specific cluster where students have to apply geometric concepts in modeling situations, students can choose several ways to model geometric concepts, such as, identifying different geometric shapes around them and discuss the use of the said shape benefit when learning experiences ensure information is accessible to learners with sensory and perceptual disabilities, but also easier to access and comprehend for many others such as displaying information in a flexible format to vary perceptual features. Integration of this cluster to Science, Engineering and Technology, where you can challenge your students to design a bridge, building or any other structure using geometric shapes will allow students to see the use of geometry in real world and so that students can also relate. because letting our students be engaged in analyzing and applying their understanding through projects, illustrations and computations, we are encouraging them to make ways in solving real world problems. You can access different tasks on this link: https://achievethecore.org/coherence-map/HS/M/tasks

Build

Effort and Persistence: *How will the learning for students provide options for sustaining effort and persistence?*

- For example, learners engaging with modelling with geometry benefit when learning experiences attend to students attention and affect to support sustained effort and concentration such as encouraging and supporting opportunities for peer interactions and supports (e.g., peer-tutors) because students will benefit from hearing the perspectives of their peers, whether said perspective is a solution or a point of frustration. Establishing appropriate guidelines for these interactions will ensure that students are encouraged and supported by their peers. Consider grouping strategies based on student current level of understanding (homogenous or heterogeneous), native language (homogenous or heterogeneous), as well as student self-selected groups. Discuss and model appropriate guidelines for these interactions so that students have structure within their interactions.

Language and Symbols: *How will the learning for students provide alternative representations to ensure accessibility, clarity and comprehensibility for all learners? (e.g., a graph illustrating the relationship between two variables may be informative to one learner and inaccessible or puzzling to another; picture or image may carry very different meanings for learners from differing cultural or familial backgrounds)*

- For example, learners engaging with modelling with geometry benefit when learning experiences attend to the linguistic and nonlinguistic representations of mathematics to ensure clarity can comprehensibility for all learners such as making explicit links between information provided in texts and any accompanying representation of that information in illustrations, equations, charts, or diagrams because students can often identify key information but may struggle with what to do next. Encouraging students to link information they know to formulas they know and/or creating sketches to show what is happening in the problem can help students make progress in solving the problem.

Expression and Communication: *How will the learning provide multiple modalities for students to easily express knowledge, ideas, and concepts in the learning environment?*

- For example, learners engaging with modelling with geometry benefit when learning experiences attend to the multiple ways students can express knowledge, ideas, and concepts such as providing multiple examples of ways to solve a problem (i.e. examples that demonstrate the same outcomes but use differing approaches, strategies, skills, etc.) because students may see solution methods in different ways. Showing students multiple perspectives, whether correct or incorrect, encourages students to think critically about their thinking and the reasoning of others. Further, showing the connections between the different solution methods can encourage students to think about mathematics in a variety of ways.

Internalize

Self-Regulation: *How will the design of the learning strategically support students to effectively cope and engage with the environment?*

- For example, learners engaging with modelling with geometry benefit when learning experiences set personal goals that increase ownership of learning goals and support healthy responses and interactions (e.g., learning from mistakes), such as supporting students with metacognitive approaches to frustration when working on mathematics because the solution path is often not explicit. Students will need to pull from their background knowledge and determine what information is useful and how they can apply geometric concepts to arrive at a solution. Because this thinking process is abstract and vague, modelling strategies to persevere through frustration can benefit students. Consider strategies such as providing students with questions they can ask themselves (What do I know? What do I want to solve? etc.), encouraging students to draw/sketch a visual of the problem scenario, code the text of the problem. If students get stuck, help them to verbalize their "sticking point" and work with peers to get "unstuck". Each of these strategies teaches students to think about their thinking and encourages them to make progress in problem solving.

Re-teach

Re-teach (targeted): *What formative assessment data (e.g., tasks, exit tickets, observations) will help identify content needing to be revisiting during a unit?*

- For example, students may benefit from re-engaging with content during a unit on applications of geometric concepts in modeling situations by critiquing student approaches/solutions to make connections through a short mini-lesson because you want to highlight and model how to decompose a problem and/or image to the apply characteristics of geometric figures. This initial step may be the hardest for students in solving real world problems.

Re-teach (intensive): *What assessment data will help identify content needing to be revisited for intensive interventions?*

- For example, some students may benefit from intensive extra time during and after a unit on applications of geometric concepts in modeling situations by offering opportunities to understand and explore different strategies because it is very important that before moving to the next lesson, students must demonstrate understanding on the wide range of application of geometric shape and use in real world, such as solving for volume, area, and density specifically population density of a given area.

Extension

What type of extension will offer additional challenges to 'broaden' your student's knowledge of the mathematics developed within your HQIM?

- For example, some learners may benefit from an extension such as the opportunity to understand concepts more quickly and explore them in greater depth than other students when studying applications of geometric concepts in modeling situations because students will have the opportunity to use their own foundation on solving geometric shapes the way they understand it as long as they can justify it mathematically.

Culturally and Linguistically Responsive Instruction:

Validate/Affirm: How can you design your mathematics classroom to intentionally and purposefully legitimize the home culture and languages of students and reverse the negative stereotypes regarding the mathematical abilities of students of marginalized cultures and languages?

Build/Bridge: How can you create connections between the cultural and linguistic behaviors of your students' home culture and language the culture and language of school mathematics to support students in creating mathematical identities as capable mathematicians that can use mathematics within school and society?

Using and Connecting Mathematical Representations: The standard for mathematical practice, use appropriate tools strategically, provides a strong foundation to validate and bridge for students. Mathematical representations are mathematical tools. The linguistic and cultural experiences of students provide different and varied types of representations for solving mathematical problems. By explicitly encouraging students to use multiple mathematical representations students can draw on their "mathematical, social, and cultural competence". By valuing these representations and discussing them we can connect student representations to the representations of school mathematics and build a bridge for students to position them as competent and capable mathematicians. For example, when studying applications of geometric concepts in modeling situations the use of mathematical representations within the classroom is critical because of the diverse cultural representation of every single student, however, if we let our students draw their own understanding on specific problems, where students can relate and they can justify their claim mathematically then we can say that learning took place by making connections.

Standards Aligned Instructionally Embedded Formative Assessment Resources:

SAT Item #: 1053899 The linked assessment question addresses G-MG.A., specifically the question requires students to use the surface area given for a cube to find volume

CollegeBoard	Question ID 1053899						
SAT	Math	Additional Topics in Math	Medium	Additional Topics in Math	Area and volume	1. Solve real-world and mathematical problems about a geometric figure or an object that can be modeled by a geometric figure using given information such as length, area, surface area, or volume.	No Calculator

A cube has a surface area of 54 square meters. What is the volume, in cubic meters, of the cube?

Question Difficulty: Medium

A. 18

B. 27

C. 36

D. 81

Choice B is correct. The surface area of a cube with side length s is equal to $6s^2$. Since the surface area is given as 54 square meters, the equation $54 = 6s^2$ can be used to solve for s. Dividing both sides of the equation by 6 yields $9 = s^2$. Taking the square root of both sides of this equation yields $3 = s$ and $-3 = s$. Since the side length of a cube must be a positive value, $s = -3$ can be discarded as a possible solution, leaving $s = 3$. The volume of a cube with side length s is equal to s^3. Therefore, the volume of this cube, in cubic meters, is 3^3, or 27.

Choices A, C, and D are incorrect and may result from calculation errors.

Additional Assessment:
http://tasks.illustrativemathematics.org/content-standards/HSG/MG/A/2/tasks/1146
The linked assessment question addresses G-MG.A, specifically the question requires students to apply the relationship among density, volume and mass to reasonably estimate the number of cells in a human body. In this approach, we assume that a cell is a sphere and use that fact, along with the provided density of a cell to determine the mass of a cell. We then divide an individual's mass by the mass of a single cell. This assessment should be given to students after they've had opportunity to work with this relationship as well as had time to work with numbers in scientific notation. Students will engage in SMP 1 and SMP 6.

Relevance to families and communities:	Cross-Curricular Connections:
During a unit focused on applications of geometric concepts in modeling situation, consider options for learning from your families and communities the cultural and linguistic ways this mathematics exists outside of school to create stronger home to school connections for students, for example, learning the different geometric shape in school, home, and community can be a great way to connect school task with home task, such as letting the students identify geometric shape around them in school, home, or community. Let them describe the use and how helpful that shape is to the structure or building.	Business: Connect to minimizing waste, maximizing volume. Social Studies: Connect to census data/population density