NEW MEXICO
Public Education Department

HS: GEOMETRY-GEOMETRIC MEASUREMENT & DIMENSION

Cluster Statement: B: Visualize relationships between two-dimensional and three-dimensional objects

Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
HSG.GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.	SMP 1 Students make sense of problems and persevere in solving them by using visual representations and or 3D manipulatives to make sense of unfolding a 3D object.	• Explain why a cross section is a two-dimensional representation of a slice of a three-dimensional object. • Realize that the cross section can be different depending on location and angle where the three-dimensional object is cut. • Identify possible cross sections in a given object • Identify three-dimensional objects generated by the rotations of two-dimensional objects
		Webb's Depth Of Knowledge: 1-2
		Bloom's Taxonomy: apply, analyze
Previous Learning Connections In 6th grade, students represented three-dimensional figures using nets made up of rectangles and triangles to calculate surface area. In 7th grade students moved on to describe the two-dimensional figures that result from slicing three-dimensional figures, focusing on right rectangular prisms and pyramids. These skills prepare students to address the content within this cluster.	**Current Learning Connections** Students use cross section dimensions in volume calculations (i.e. the height of the triangle when calculating the volume of the cone)	**Future Learning Connections** In later courses, students study conic sections which can be described as cross sections of a cone. Calculus concepts will build on the volume of solids of rotation.

Clarification Statement
The focus of this cluster is to reinforce the relationship between a three-dimensional object and the dimensions of its two-dimensional cross section. Focusing on the two-dimensional cross-sections helps learners visualize dimensions needed later for finding volume and surface area of solids. For example, the height of the triangle in the cross section of a cone.

Common Misconceptions

Students may struggle to visualize cross sections and rotations.
Students may need support with the concept of "slicing" a three-dimensional figure.

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 uses images/resources (especially those being used the first time) when studying visualize relationships between two-dimensional and three-dimensional objects because students need to have a visual representation of the object. As much as possible use objects that are familiar to students.

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

- 7.G.A.3: Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids. This standard provides a foundation for work with visualize relationships between two-dimensional and three-dimensional objects because students need to visualize how it looks like when a three-dimensional object is being cut. What are the different products after cutting? 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

Physical Action: *How will the learning for students provide a variety of methods for navigation to support access?*

- For example, learners engaging with visualize relationships between 2-d and 3-d representations benefit when learning experiences ensure information is accessible to learners through a variety of methods for navigation, such as varying methods for response and navigation by providing alternatives to hand-drawn cross-sections because students may struggle to visualize these cross-sections. Providing hands-on manipulatives to rotate and/or using geometric software can aide students in visualizing and creating 2-d cross-sections for 3-d objects.

Build

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

- For example, learners engaging with visualize relationships between 2-d and 3-d representation benefit when learning experiences attend to student attention and affect to support sustained effort and concentration such as providing alternatives in the mathematics representations and scaffolds because students learn in various ways. Attend to visual, auditory, kinesthetic, interpersonal, intrapersonal, etc. learning modalities by offering opportunities for structured learning and/or independent learning, and allow students to demonstrate their understanding using a variety of tools strategically.

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 visualize relationships between 2-d and 3-d representation benefit when learning experiences attend to the linguistic and nonlinguistic representations of mathematics to ensure clarity can comprehensibility for all learners such as linking key vocabulary words to definitions and pronunciations in both dominant and heritage languages because terms like circumscribed and inscribed can be seen as cognates between Spanish/English. Drawing the connection between languages can help students whose first language is not English.

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 visualize relationships between 2-d and 3-d representation benefit when learning experiences attend to the multiple ways students can express knowledge, ideas, and concepts such as providing sentence starters or sentence strips because the cluster requires students to communicate (in writing and/or orally) about circles. Students may struggle with a starting point in stating a proof, or describing a characteristic they see. Students may also struggle with using the vocabulary of this cluster.

Internalize

Comprehension: *How will the learning for students support transforming accessible information into usable knowledge, knowledge that is accessible for future learning and decision-making?*

- For example, learners engaging with visualize relationships between 2-d and 3-d representation benefit when learning experiences attend to students by intentionally building connections to prior understandings and experiences; relating important information to the learning goals; providing a process for meaning making of new learning; and, applying learning to new contexts such as using multiple examples and non-examples to emphasize critical features because the terminology of this cluster can be easy for students to mix up (circumscribed V inscribed, radius V diameter, etc.). Providing regular pictorial examples and non-examples of these can help to solidify student conceptual understanding and allow them to apply this knowledge in communication and 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 visualize relationships between two-dimensional and three-dimensional objects by providing specific feedback to students on their work through a short mini-lesson because students have to properly visualize the object, it's movement to the plane so students can accurate use the object to solve 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 visualize relationships between two-dimensional and three-dimensional objects by offering opportunities to understand and explore different strategies because offering students different ways of visualizing two-dimensional and three-dimensional objects will give them the opportunity to express their thinking through illustrations and analysis.

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 application of and development of abstract thinking skills when studying visualizing relationships between two-dimensional and three-dimensional objects because students will deepen their understanding of the topic and they can use this in real-world. Challenge the students to do frustum of a two-dimensional and three-dimensional objects.

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 visualize relationships between two-dimensional and three-dimensional objects the use of mathematical representations within the classroom is critical because students need to critically think about the relationship of two-dimensional and three-dimensional objects. We can help our students by presenting them the actual image and image that they can relate to, like a ball, car tires, cellphone and any other object that is visible to them.

Standards Aligned Instructionally Embedded Formative Assessment Resources:
Source: http://tasks.illustrativemathematics.org/content-standards/HSG/GMD/B/4/tasks/512
The linked assessment question addresses G-GMD.B, specifically the question requires students to consider an object being passed through an x-ray machine. Students are describing the shapes they would see. Later parts of this example approach more complex connections to future work in calculus as students are applying Cavalieri's principle. The first 3 parts of this assessment should be given to students after they've had opportunity to practice visualizing cross sections and possibly after use of tools to create cross sections. Students will engage in SMP 1 and SMP 3. If tools are used, SMP 5 may be addressed as well.

Relevance to families and communities:
During a unit focused on visualize relationships between two-dimensional and three-dimensional objects, 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, let the students identify two-dimensional and three-dimensional objects and let them discuss the difference and relate it to the question "what if this two-dimensional object is not present to the three-dimensional object, what will happen to the image?"

Cross-Curricular Connections:
Students can produce interesting pieces of art by rotating a two-dimensional object that has been dipped in ink. This can also link to Language Arts and Science by having students verbally describe a conjecture of what they think an end result may be and then experimentally verifying and reflecting upon their initial thoughts. Stressing the importance of precise language in writing descriptions deepens the connection between ELA and math.