NEW MEXICO
Public Education Department

HS: GEOMETRY-CONGRUENCE

Cluster Statement: D: Make geometric constructions

Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
HSG.CO.D.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). *Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.*	SMP 1 Students make sense of problems and persevere in solving them by making constructions of situations. Students reason and experiment with rigid motions, determining a correct sequence of transformations with perseverance. SMP 4 Students will apply ideas about transformations to model real-world contexts SMP 5 Students use appropriate tools strategically by using dynamic geometry tools to solve problems. These tools might include pencil and paper, concrete models, rulers, protractors, compasses, software, apps, and calculators. SMP 6 Students attend to precision by using precise geometric mathematical language to thoroughly explain the reasoning behind their work and when formalizing definitions. Precision is of crucial importance in constructions, since even small errors in executing a construction may lead to results that don't work.	• Construction techniques (compass, straight edge, software, etc.) are used to create figures. • Perform constructions including: copy a segment, copy an angle, bisect segments and angles, construct perpendicular lines/segments, construct parallel lines. **Webb's Depth of Knowledge: 1-2** **Bloom's Taxonomy:** understand, apply

<table>
<tr>
<td>Standard Text

HSG.CO.D.13
Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.</td>
<td rowspan="2">Standard for Mathematical Practices

SMP 1
Students make sense of problems and persevere in solving them by making constructions of situations. Students reason and experiment with rigid motions, determining a correct sequence of transformations with perseverance.
SMP 4
Students will apply ideas about transformations to model real-world contexts
SMP 5
Students use appropriate tools strategically by using dynamic geometry tools to solve problems. These tools might include pencil and paper, concrete models, rulers, protractors, compasses, software, apps, and calculators.

SMP 6
Students attend to precision by using precise geometric mathematical language to thoroughly explain the reasoning behind their work and when formalizing definitions. Precision is of crucial importance in constructions, since even small errors in executing a construction may lead to results that don't work.</td>
<td>Students who demonstrate understanding can:
• Construct an equilateral triangle inscribed within a circle using construction techniques
• Construct a square inscribed within a circle using construction techniques
• Construct a regular hexagon inscribed within a circle using construction techniques.</td>
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<td>Webb's Depth of Knowledge: 3-4</td>
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<td>Bloom's Taxonomy: apply, create</td>
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<td><u>Previous Learning Connections</u>
• This cluster connects to students previously taught skills from 7th grade when they constructed geometric shapes when given certain conditions in the 7.G.A cluster. Additionally, in 8th grade within the 8.G.A cluster, students worked with two-dimensional figures and verified their properties.</td>
<td><u>Current Learning Connections</u>
• Construction connects and adds on to learning from previous clusters within the Geometry course by building on triangle congruence theorems (SSS, SAS), properties of parallel and perpendicular lines, and polygons and their properties.</td>
<td><u>Future Learning Connections</u>
• Construction techniques could be applied to unit circle, and conic sections in future courses.</td>
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<td colspan="3">Clarification Statement
This cluster focuses on hands-on basic constructions. Students use geometric tools (compass, straightedge, software, etc.) to generate foundational pieces of geometry</td>
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Common Misconceptions

Some students may believe that a construction is the same as a sketch or drawing. Emphasize the need for precision and accuracy when doing constructions. Stress the idea that a compass and straightedge are identical to a protractor and ruler. Explain the difference between measurement and construction.

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 rehearses prior learning when studying making geometric constructions because students should have experience working with geometric construction tools (straight edge, ruler, compass, etc) but may not use them consistently correctly or may need a refresher.

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

- 7.GA.2: This standard provides a foundation for work with making geometric constructions because this standard called for students to use a variety of tools to draw shapes that fit given constraints. This is where they should have mastered use of ruler/straight edge and compass. 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

Interest: *How will the learning for students provide multiple options for recruiting student interest?*

- For example, learners engaging with making geometric constructions benefit when learning experiences include ways to recruit interest such as providing choices in their learning (eg. using rule/straightedge, compass, geometric software, etc) because students may have a varied background knowledge of, and interest in, these construction tools.

Build

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

- For example, learners engaging with making geometric constructions 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 may have different backgrounds in appropriate use of these tools and harnessing student knowledge in said tools can help establish/build/promote a positive learning environment.

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 making geometric constructions benefit when learning experiences attend to the linguistic and nonlinguistic representations of mathematics to ensure clarity can comprehensibility for all learners such as embedding support for vocabulary and symbols within the text (e.g., hyperlinks or footnotes to definitions, explanations, illustrations, previous coverage, translations)

because some students will not have prior experience with using all tools. These supports can help expand students' repertoire of mathematical tools.

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 making geometric constructions benefit when learning experiences attend to the multiple ways students can express knowledge, ideas, and concepts such as using physical manipulatives (e.g., trace paper, compass, straightedge, geometric software) because students may see how to formalize a construction better from one perspective than another. Further, it may allow for students to stretch their comfort from using one explicit tool to using a variety of tools strategically.

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 making geometric constructions 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 incorporating explicit opportunities for review and practice because complex constructions require a firm graphs of basic construction skills. Explicitly and routinely practicing these skills ensures students have entry-points to more complex constructions.

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 making geometric constructions by clarifying mathematical ideas and/or concepts through a short mini-lesson because students may have simple errors (e.g. copying a segment without measurement, etc.) that require short and direct instruction.

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 making geometric constructions by offering opportunities to understand and explore different strategies> because some students may work more efficiently with one consistent tool, while others may benefit from having a variety of tools at their disposal. Further, some students benefit from using geometric software to visualize their constructions rather than pencil and paper.

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 in-depth, self-directed exploration of self-selected topics when studying making geometric constructions because this can challenge students to construct any shape, explaining or showing their methods for each.

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 Making Geometric Constructions the use of mathematical representations within the classroom is critical because students may have a varied background in reading/writing technical written directions and/or using rulers, straightedges, compasses, geometric software, etc. This background could be established in prior schooling or in specific cultural/home usage. Connecting tools they are familiar with to tools that may be new or uncomfortable to them shows the value of their current knowledge at the same time as expanding that knowledge base.

Standards Aligned Instructionally Embedded Formative Assessment Resources:
Source: https://tasks.illustrativemathematics.org/content-standards/HSG/CO/D/12/tasks/966
The linked assessment question addresses G-CO.D, specifically the question requires students to prove that a specific segment is a perpendicular bisector to another segment. Students may use knowledge of corresponding parts of congruent triangles are congruent to form arguments, or may work through explanation using congruence as it follows from rigid motion transformations. This assessment should be given to students after they've been introduced to geometric construction tools and have a firm grasp of congruence. Students will engage in SMP 1, SMP 5 and SMP 6.

Relevance to families and communities:	**Cross-Curricular Connections:**
During a unit focused on Making Geometric Constructions, 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, architects and other technical careers make regular use of the same tools used in geometric constructions. Connecting the use of mathematical tools with the real world can solidify the importance and relevance of material being learned, as well as encourage students to goal-set for future careers and interests.	Art: drafting, geometric shape work