Geometry and Spatial Sense

CTY Sample Course Syllabus

Days	Activities
Day 1: Monday	**Class Roster** **Icebreaker** **CTY Honor Code** ➢ Dissect the honor code and extract key words and ideas to construct classroom rules and procedures together. ➢ Scholars are broken up into 3 groups of 4 to create student friendly version of 1) Honor Code 2) Non-negotiable 3) Rules and procedures. **Administer Pre Assessment** **Scale Drawing Project** ➢ Scholars are given a small grid picture and asked to enlarge the image onto a full sized sheet of paper, using coordinates as a guide. When scholars finish their enlargement the tape their section onto a premade grid on the wall creating an enlarged version of the original picture when everyone's piece is completed. **Introduce the infamous Word Wall** ➢ Add a copy of words to the word wall **HW:** In your own words, explain to a friend the importance of scale drawing. Define key words if necessary.
Day 2: Tuesday	Do now: Scale factor exercise Continue discussion of scale drawings and scale factors. **Geometric Glossary** ➢ Scholars use index cards to create a geometric glossary. ➢ Add the words from day 1 to the glossary **Review vocabulary of geometric building blocks** ➢ Add vocabulary to glossary. **Classify angles (Straight, Obtuse, Right, Acute)** **Triangle Inequality Theorem** ➢ Scholars are given sets raw pasta noodles cut to various sizes and color coded. Scholars measure the noodles and try to arrange them into triangles. (some sets of sides make triangles while others do not) ➢ Explore the different types of angles making posters with pipe cleaner angles ➢ Copy definitions into Geometry Glossary ➢ Scholars receive sets of straws cut to various sizes and color coded. Scholars measure the straws and try to arrange them into triangles. ➢ Formalize the Triangle Inequality Theorem after proof with noodles ➢ Practice problems. **Around the world** (station review activity) ➢ Check for understanding using white boards **Geometry of Bicycle Designs** ➢ The diagram identifies the various parts of a bicycle: the frame size, chain stay, seat angle, head angle, and back angle. On the pages that follow, measure the different

	parts for bicycles that have been designed for different purposes (racing, riding on trials, and performing tricks). You can measure the parts on the pictures provided on each page. **Scale Drawing (Continued)**
Day 3: Wednesday	Do now (measuring angles and classifying them) ***Classify Triangles (by angle and by sides)*** ➢ Instructor gives scholars several examples of different triangles cut out of colored paper. Scholars work in pairs to sort the triangles into different groups. Scholars paste/tape the groups on easel paper and then post the easel paper to the walls ➢ Scholars do a gallery walk, examining the different groups and writing notes on the posters to explain the reasoning for the various groupings. ➢ Instructor facilitates a large group discussion of the various groupings, then, using the groupings as examples, defines Equilateral, Isosceles, Scalene, Equiangular, Acute, Obtuse and Right Triangles. Scholars copy definitions into their Geometry Glossaries. ***Define Congruent*** ➢ Copy into Geometry Glossary ➢ Working in groups, Scholars use rulers, protractors and paddy paper to check if various line segments, angles, and polygons are congruent. ***Define Vertical Angles and Linear Pairs*** ➢ Copy into Geometry Glossary ➢ Use post-it notes to mark as many vertical angles and linear pairs they can find in the room in a certain amount of time. After time is up, the class discusses if the Vertical Angle Theorem and Linear Pair's are supplementary. ➢ Scholars choose to investigate either vertical angles or linear pairs for their special properties. Instructor encourages Scholars to create many different examples of vertical angles (or linear pairs) on a piece of paper using a ruler and then using paddy paper to trace the angles. Instructor and PA go from group to group to encourage and offer suggestions/hint. ➢ Scholars present their findings to the class. Practice problems and check for understanding using White Boards ***Triangle Angle Sum Theorem*** ➢ Scholars cut out a variety of triangles from construction paper. ➢ Scholars tear off the corners of their triangles and rearrange the angles to make a straight line. Scholars compare their angles to other Scholars in the class. ➢ Scholars copy the Triangle Angle Sum Theorem into their notes and move on to practice problems.

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Day 4: Thursday	**Do now** (classify triangles by angles and sides) **Regular polygons** ➢ Scholars will identify the relationship between the number of sides in a regular polygon and the number of struts (diagonals) needed to make each polygon grip. ➢ *Using the finding of the previous activity, Scholars are asked to derive the formula for calculating the measure of an individual angle in a regular polygon.* ***Two-dimensional shapes (connect the dot)*** ➢ In this learning activity, Scholars use dynamic geometry software to construct and measure angles. They develop their understanding of benchmark angles, and they construct polygons, given side length and angle restrictions. ***Geoboard*** ➢ Scholars use geoboards to construct polygons, look for patterns, and find a general rules. **Interior Angle Sum Theorem** ➢ Scholars record the number of sides of all their toothpick polygons and then measure all of the angles using a protractor. ➢ Scholars should make the connection between the number of sides and the sum of the interior angles. ➢ Scholars are given sheet with polygons from 3 to 10 sides. Scholars are asked to find the number of triangles in each and the sum of the interior angles. Class formalizes the interior Angle Sum Theorem Scholars practice problems
Day 5: Friday	***Exterior Angles of a Triangle*** ➢ Scholars cut out a variety of triangles from construction paper and trace them onto white paper. They then use a ruler to draw exterior angles on the tracings. Scholars number their triangles' angles (both on the triangles and the tracings). ➢ Scholars tear off the corners of their triangles and, moving the corners around on the tracings, examine how the interior angles relate to the exterior angles White board problems on Triangle Angle Sum Theorem and Exterior Angles of a triangle. **Area of a triangle** ➢ Scholars construct a rectangle using only whole numbers for the dimensions ➢ Scholars find the area of the rectangles ➢ Scholars then cut rectangles in half ➢ Derive formula for area of a triangle using prior knowledge of area of a rectangle **Pythagorean Theorem** ➢ Scholars are given a chance to construct a diagram containing two square pieces ➢ One square is able to fit within the other creating 4 separate triangles with its tilt. ➢ Within groups Scholars are asked to analyze the area of all shapes created by both diagrams ➢ Scholars then analyze the proof to formalize the Pythagorean Theorem **Popsicle Pythagorean** ➢ Conclude lesson with activity using 12 and 30 popsicles.

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	➢ Scholars are asked to create triangles with the given sets of popsicles ➢ Only legit results are the 3, 4, 5 and 5, 12, 13 triangles. ➢ Use S.O.L.V.E foldable to real world applications involving the Pythagorean Thm. • **S: State what the problem is asking** • **O: Organize the relevant facts** • **L: Line up a plan** • **V: Verify with action** • **E: Examine your results**
Day 6: Monday	Check in quiz – covering all topics learned so far. **Perimeter and area** ➢ Scholars discuss prior knowledge of perimeter **Geoboards** ➢ In this follow-up activity, Scholars use rubber bands on geoboards to create shapes with different perimeters that I have written on the board. For example, I'll ask them to make a square with a perimeter of 16, a triangle with a perimeter of 12, etc. To wrap up this activity, I ask Scholars to create four different polygons and record the perimeter of each on their small dry erase boards. As I walk around, it is easy to see who has grasped the idea and who needs more time and practice. **Perimeter Is Here, There, and Everywhere** ➢ While my Scholars are out of the room, I use tape to craft seven large polygons. Each side is marked with a letter. Working in groups of three, Scholars use yardsticks and tape measures to record the length of each side, and then they add them together. This activity really helps cement the notion that perimeter is the sum of individual sides added together. After measuring the floor polygons, Scholars move about the room measuring the perimeter of everyday items such as rugs, cabinet doors, their desks, etc., and recording them in their math journals along with an annotated diagram **Use Math Cubes** ➢ When students' knowledge of perimeter is quite solid, introduce area. Using connecting math cubes or building blocks are great ways to have Scholars create closed shapes that can be used to introduce area. The square-shaped blocks help Scholars understand the notion of "square units" as we calculate the total number of blocks, or area, of their shapes. **Name Banners** ➢ First they use the square centimeter graph paper to write out their names. Next they find the area and perimeter of each letter and add those together to find the area and perimeter of their entire name. Scholars love to compare the sizes of their letters and names. Having your Scholars in cooperative groups for this is key

	because when one student has trouble visualizing how a letter *m* can be made out of squares, a group member is always there willing to lend a hand Scholars receive enough information to then describe the area of the object in the classroom. In their own words explain the difference between the two concepts. Apply words to geometry glossary and to word wall. **Tracking down distance** ➢ Athletes at the Summer Olympics run, ride, practice and compete on many different tracks, surfaces and courses. Calculate how far it is around the outside edge (perimeter) of each of these sports surfaces. ***Places and Spaces*** ➢ The settings where Olympic athletes compete include spaces and places of all sizes and shapes. Many of them are quadrilaterals (4 sided figures). You can learn something about these spaces by solving the following problems about their areas. ***Smooth Sailing*** ➢ In the early days of yachting, the sails were no more than bedspreads that were attached by clothesline. Now the main type of sail on yachting vessels is triangular. Look at the sails below and determine the area of each. ➢ Homework From Home – Friends back home decided to surprise Eric with some homework from his school. They decided he shouldn't get behind on the math they were doing in class. So they sent him postcards at the Olympic Village. These postcards asked him to find the area of trapezoids. But, in choosing the correct answer for each problem, he was also solving a puzzle that sent him a message. Can you figure out the message his friends sent?
Day 7: Tuesday	**Do Now:** "Whose Room Is Roomier" – When the US team arrived at the Olympic Village, they were surprised by their accommodations. Some of the rooms were very large and roomy. Others seemed really small. Given out are scale drawings of their rooms. You can compare the sizes of the rooms by doing some measuring. **Area of a Trapezoid** ➢ Scholars receive copy of trapezoid and analyze the shape to decide best way to dissect it. ➢ A rectangle and 2 triangles should be the most obvious option. ➢ Scholars find the area of each of the individual shapes then combine the formulas to derive area of a trapezoid ➢ Practice area of a trapezoid **Area of a rhombus** ➢ Hand Scholars copy of rhombus to analyze ➢ Allow Scholars to cut the rhombus in half using diagonals ➢ Label them x and y (notice x and y are perpendicular) ➢ Cut the rhombus into two equal triangles and begin to find the area of each ➢ Notice base of triangles are now x and y diagonals from before. Height should be x/2 and y/2 for the respective triangles.

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	➢ Area of triangle is 1/2bh. Allow Scholars to play with the area and the dimensions to derive 1/2XY. ➢ Half of the product of the diagonals. ➢ Practice area of a trapezoid. **Area of Parallelogram** ➢ Scholars are given examples of varied rectangles. ➢ Scholars lead brief discussion on properties of a rectangle ➢ Cut a right triangle from any side of the rectangle and attached it to the opposite side to form a parallelogram. **Think. Pair. Share.** It should be observed that the same formula for a rectangle can be applied to the dimensions of a parallelogram. ➢ Formalize area of parallelogram. ➢ Practice area of parallelogram.
Day 8: Wednesday	**Quiz Corrections** ➢ Scholars are given a quiz that Alan (a fictional student) "took" and are asked to correct Alan's mistakes. Many of Alan's "mistakes" are mistakes that Scholars actually made during the Check in Quiz on Friday. The entire class discusses the quiz corrections once everyone is done. **Compass and Straight Edge Constructions** ➢ Scholars are each assigned a construction to learn how to do by viewing a website. ➢ -Scholars practice their construction until they can do it without instructions ➢ -Scholars teach each other the constructions they learned from the website. **Largest angle across from longest side (etc.)** ➢ Scholars are given a sheet with many triangles already drawn on it. Scholars use a ruler and protractor to measure the sides and angles of the triangle ➢ Scholars copy the measurements into a table and are asked to look for a relationship between the side lengths and the angle measures of the triangles. ➢ Think. Pair. Share. ➢ **Practice problems** **Origami** ➢ Ask for student volunteers to assist and eventually facilitate the process of origami. ➢ Have students feel comfortable presenting to/Instructing a larger group. **Bucky Ball** ➢ Cut out the pentagon and hexagon shapes. ➢ Trace enough copies so that you have 12 pentagons and 20 hexagons. ➢ Use transparent tape to attach the shapes together and build a model Bucky- ball. Each pentagon should be surrounded by 5 hexagons. Hexagons should be surrounded by three hexagons and three pentagons placed next to each other alternately. ➢ When you are finished, try to create other types of three-dimensional shapes based on hexagons and pentagons. ➢ Scholars are allowed to fill the ball with cotton to make it less hollow.

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Day 9: Thursday	**Introduction to the Coordinate Grid** ➢ Scholars are given a brief introduction to the how the coordinate grid works (the axes, ordered pairs, etc.) ➢ Class moves outside where teacher has used sidewalk chalk to create two giant coordinate grids (use painters tape inside the classroom or other indoor space if bad weather). Instructor and PA divide the class into two groups and run activities for each group ➢ Scholars are each given different ordered pairs to find on the coordinate grid. ➢ Scholars plot points and draw a picture using the coordinate grid **Coordinate geometry** (given a labeled coordinate grid) Start at the intersection of 10th Street and 2nd Avenue. Label the location S. ➢ (First student) Travel 3 blocks west and 4 blocks north. You will find Aunt Agatha's artwork. Label it A. Mark your route, the location of the treasure (7th St and 6th Av), and the number of blocks you have travelled (7). ➢ (Next student) Travel 2 blocks west and 4 blocks south. You will find a beautiful bronze bear. Label it B. Mark your route, the location of the treasure (5th St and 2nd Av), and the number of blocks you have travelled (6). ➢ (Next student) Travel 4 blocks east and 2 blocks north. You will find a cherished china cup. Label it C. Mark your route, the location of the treasure (9th St and 4th Av), and the number of blocks you have travelled (6). ➢ (Next student) Travel 6 blocks west and 3 blocks north. You will find a delicate and delightful diamond. Label it D. Mark your route, the location of the treasure (3rd St and 7th Av), and the number of blocks you have travelled (9). ➢ (Next student) Travel 3 blocks east and 3 blocks south. You will find an empty but enticing envelope. Label it E. Mark your route, the location of the treasure (6th St and 4th Av), and the number of blocks you have travelled (6) ➢ 6) (Next student) Travel 4 blocks west and 5 blocks north to the finish. Label it F. Mark your route, the location of the finish (2nd St and 9th Av), and the number of blocks you have travelled (9). ➢ 7) Ask, "What distance has been travelled in total?" (43 blocks). **Scale Drawing (Continued)**
Day 10: Friday	**Intro to Quadrilaterals** ➢ Instructor facilitates as scholars use properties of quadrilateral to define quadrilateral. ➢ Scholars copy definition into their Geometry **Glossary** ➢ Scholars are given a variety of quadrilaterals cut out of construction paper/tag board. Scholars work in pairs to create groupings for the different quadrilaterals. Scholars then paste/tape their groupings (without labels) onto chart paper and hang around the room.

	➢ Scholars conduct a gallery walk around the room. The pairs try to figure out what reasoning the other groups used when creating the groupings. ➢ Class discussion about the groupings and the various properties they used to group the different quadrilaterals **Quadrilateral Properties** ➢ Scholars investigate properties of quadrilaterals (angles, sides and diagonals) using paper folding, paddy paper and measuring (Think. Pair. Share.). ➢ Practice problems **Catch a Quad** ➢ Scholars are given a set of "crime mysteries." Each mystery can be solved by applying knowledge of the properties of quadrilaterals to three clues which gradually eliminate all of the "innocent" quadrilaterals **Create a Quadrilateral Crime** ➢ Scholars pick a quadrilateral and write their own mystery, including three clues that will gradually reveal the chosen quadrilateral.
Day 11: Monday	**Investigate Properties of Circles** ➢ Define circle vocabulary (radius, diameter, chord, arc, circumference, tangent line, interior angles) and copy into Geometry Glossary **Use paper folding (of paper plates) to investigate properties of circles** **Practice problems (white boards)** **Discovering Pi** ➢ Scholars measure the diameter (ruler) and circumference (string/pipe cleaners/wire and a ruler) of a bunch of pre-drawn circles and objects from home (cans, lids, coins, etc.). ➢ Scholars then are instructed to divide their circumference measurements by their diameter measurements and keep track of the results. Scholars should look for a pattern in the results **Think. Pair. Share.** ➢ Instructor clarifies the concept of Pi and shows Scholars the first 100 decimal places. ➢ Scholars find circumference using pi **Area of circle** ➢ A circle can be cut and rearranged to closely resemble a parallelogram (with height r and base pi times r) of area pi times the square of the radius. By dividing the circle into more than eight slices, the approximation obtained in this manner would be even better. By dividing the circle into more and more slices, the approximating parallelograms approximate the area of the circle arbitrarily close. This gives a geometric justification that the area of a circle really is "pi r squared". **Bubble Mania** ➢ Scholars are given opportunities to practice measurement skills as they examine a soap bubble print. Students follow a recipe to make a soap bubble solution. They use the soapy solution to blow large bubbles with a plastic drinking straw until they pop leaving behind a circular print. Students find the diameter, circumference, and area

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	of the bubble print. **Scale Drawing (Continued)**
Day 12: Tuesday	**Quiz Corrections** ➢ Scholars correct a fictional student's "mistakes" **Own it!** ➢ Scholars use their prior knowledge to create a story, poem or comic strip using triangles or quadrilaterals as their main characters. ➢ Full creative control given to scholars. As long as work is reasonable and presented neatly. ➢ Principles of the shapes MUST be included. ➢ Scholars type their mysteries ➢ Scholars exchange their mysteries with other Scholars in the class and solve. If a mystery has any issues with it, the Scholars work together to fix the mystery. **Nets** ➢ Scholars are given nets and make predictions about what shapes they will ➢ make ➢ Scholars use nets to create models of polyhedrons. ➢ Scholars label the models, making notes of similar characteristics amongst the ➢ different shapes Scholars are challenged to create as many nets as possible that will create a cube (differentiation: advanced Scholars are given more difficult polyhedrons to create) • **Volume of 3D shapes** – Scholars explore the properties of 3d shapes. – Analyze the dimensions to develop the formula for finding the volume of each shape (cylinder, rectangular prism, triangular prism.
Day 13: Wednesday	Compare the cube nets that the Scholars created. **•Area of composite figures.** ➢ Scholars are shown examples using the different formulas. ➢ Scholars work together and on their own to find area, surface area and volume ➢ of different figures **.3D construction** To explore structures and investigate what methods of building can make the tallest and strongest structure. By testing their prototype buildings, students will also have the opportunity to rebuild and alter their designs to improve them, giving an insight into the real-life processes of testing, redevelopment and prototyping that engineers and scientists use. • To set up this investigation you can either have each group working around a table or, if you have access to a school hall, you can use masking tape to mark out an area for each group to work in on the floor. Give out the equipment to each group – using

	chocolate eggs instead of real eggs will probably mean less mess! Remember to make sure that everyone gets the same amount of spaghetti and marshmallows. • Ensure all the students know how much time they have to do the challenge. It can be anything from 15 minutes to an hour depending on the different elements you may choose to include (see extension ideas). • The instruction for every group is that they must build the tallest free-standing tower that will hold the egg for at least 30 seconds, using only the equipment provided. • After the time limit is up, visit each group in turn and ask them to put their egg on their tower. If the tower is still standing after 30 seconds you should measure it and compare it to the other groups' towers. Use a stopwatch or get the group to count out loud to 30 to ensure fair testing. **Tessellations** ➢ Cut an index card in half, creating a 2.5"x3" rectangle. ➢ Draw a line between two adjacent corners on one of the long sides of the rectangle. Your line can be squiggly or made up of straight segments. Whatever its shape, your line must connect two corners that share one of the long sides of the rectangle. ➢ Cut along the line you drew. Take the piece you cut off, flip it over and then slide it across to the opposite long side of the rectangle. Line up the straight edge of the piece with the straight edge of the opposite edge of the rectangle. Tape the piece in place. ➢ Now draw another line that connects two adjacent corners on one of the short sides of the shape. ➢ Cut along this new line. Take the piece you cut off, flip it over and then slide it straight across to the opposite side of the shape. Line up the straight edge of the piece with the straight edge of the shape. Tape the piece in place. ➢ You have created a shape that you can now use as a pattern to make a tessellation. Write the letter 'A' on one side of the pattern, then turn it over and write the letter 'B' on the other side. ➢ On your grid paper, carefully trace around your pattern shape. It may help to position the squared-off corner (formerly the edge of the index card) in one corner of the grid. Can you figure out where to place the pattern piece so that your paper will be covered with repetitions of this shape with no overlapping and with no gaps? Try to cover your whole sheet of paper by tracing the pattern, moving it, then tracing it again. If you start with side A facing up, do you ever have to turn it over to side B to make your tessellation? If you have to flip your piece over, you are making a reflection tessellation. If you also had to move the piece to a new position, you have used translation. ➢ Look for a clever way to color in the resulting design on your sheet of paper.
Day 14: Thursday	**Symmetry** ➢ Look at the letters of our alphabet below. Organize the letters according to which ones have reflection symmetry into three groups: the letters that have reflection

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	symmetry with a vertical line of symmetry (like the letter A), those with a horizontal line of symmetry, and those with both vertical and horizontal lines of symmetry. ABCDEFGHIJKLMNOPQRSTUVWXYZ ➢ A graphic artist uses symmetry to create designs that become the symbol for companies. These are called corporate logos. Look at some of the examples below. Can you tell which ones have reflection, rotation, or translation symmetry? For each logo, describe the symmetry you find and how symmetry might have been used to create the logo.  **Corporate logo** ➢ Design your own logo. Notice that many logos start with a basic shape, a rectangle, a diamond, or an oval, and then the artist uses symmetry to create the design. The Mitsubishi company logo below began with a diamond that was rotated 120 degrees, then another 120 degrees from that. *a. Pick a basic shape from among those given (rectangle, diamond, oval)* *b. Cut out at least three copies and use reflection, rotation, or translation symmetry to create your own logo.* *c. Write a description in our own words of the type or type of symmetry you used to create your logo.*
Day 15: Friday	• Student Evaluations • Post Assessment- Scholars show conceptual understanding of topics covered throughout the session. • Student Presentation – Scholars form groups and decide which group will present what topic to parents and guardians. • Complete finishing touches of scale drawing and tessellation project.