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| **TEAM Lesson Plan Template** | |
| Teacher: Dr. Amanda Niedzialomski | |
| Subject/Grade: High School Geometry | |
| Lesson Title: Three bird nests outside Martin, TN | |
| **STANDARDS** | **Identify what you intend to teach.** State, Common Core, ACT College Readiness Standards and/or State Competencies; Enduring Understandings and Essential Questions. |
| **SMP 1**. Make sense of problems and persevere in solving them  **SMP 4**. Model with mathematics  **SMP 5**. Use appropriate tools strategically  **G.C.A.3** Construct the incenter and circumcenter of a triangle and use their properties to solve problems in context.  **G.GPE.B.2** Use coordinates to prove simple geometric theorems algebraically. | |
| **OBJECTIVE(s)/Sub-Objectives** | **Connect prior learning to new learning.** Clear, Specific, Observable, Demanding, High Quality, Measurable, Aligned to Standard(s), and Integrated with other subjects, build on prior student knowledge  Student-Friendly (I Can Statement) |
| I can use geometry to solve practical problems.  I can use a ruler, protractor, compass, and grid coordinates to solve problems.  I can make connections between equations (algebra) and geometry (lines and points). | |
| **MATERIALS AND RESOURCES** | **Content-related:** Clearly supports lesson objective(s); rigorous & relevant; Incorporates multimedia & resources beyond the textbook. |
| **Activities & Materials**  \_x\_ Laptop/Computer; \_x\_ Projector;  \_x\_Internet Resource (Desmos <https://www.desmos.com/> or GeoGebra <https://www.geogebra.org/> )  \_x\_Calculators; \_x\_Protractors; \_x\_Rulers; \_x\_Compasses; \_x\_ Bird nest map without grid; \_x\_ Bird nest map with grid; \_x\_ White board and marker per student.  **What if the technology is not working?** Skip the toucan video; Desmos and GeoGebra are optional for this activity. A calculator of some form will be helpful, but the required calculations can be done by hand.  **Routine for distributing materials.** Pass out worksheets as described in the instructional procedures. Students use the map without grid first, then the map with grid. | |
| **ACCOMMODATIONS/ADAPTATIONS** | **Learning styles and interests.** Anticipate learning difficulties, regularly incorporate student interests & cultural heritage; differentiate instructional methods. |
| **Modifications/Plans for Diverse Learners**  **Differentiation**  **----- Content** The points do not have to represent bird nests. They can be campsites (find a central location for a water source), or drone launch sites (find a central location for a recharging station) or some other locations of interest to a student.  **----- Process** Have a transparency or blank paper available. If a student is distracted by the picture of the trees, trace the three nest locations onto the transparency (or paper). Have the student find the point for the bird feeder without the picture of trees, then transfer the location back to the picture using the point of the compass.  It is also possible to import a digital image of the bird nests into GeoGebra and find a location for the feeder in GeoGebra.  **-----Product** Students will produce a picture showing a dot where the feeder should go, showing a coordinate system, and showing coordinates for each of the nests and the feeder. Students will also produce written work algebraically verifying that the coordinates for the feeder are reasonable. Different students in the group may contribute differently to the picture than to the algebra and vice versa.  **----- Tiered Assignments**  **Accommodations**  **\_x\_ Preferential Seating** All students will require adequate lighting to see their work. Consider allowing students to sit near a window to use natural light, or provide a lamp if one is available.  **\_x\_\_ Extended Time** Some students will require significantly more time than others to work with compasses, rulers, and/or protractors. The point is not to be fast, but to find a central location for the bird feeder.  **\_x\_\_ Peer Tutoring** The small group setting for this assignment lends itself well to peer tutoring.  **Early Finishers:** There are two suggested techniques to algebraically verify that the coordinates of the circumcenter are correct. The first is to use the distance formula, and the second is to use equations of lines to find the point of intersection of the perpendicular bisectors of the sides of the triangle formed by the bird nests. Early finishers will have done one of these. Have them do the other. | |

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| **MOTIVATING STUDENTS/ANTICIPATORY SET** | **“Hook”: Engage students’ attention and focus on learning.** Personally meaningful and relevant. |
| Watch the video of a Toucan feeding station at <https://www.youtube.com/watch?v=LNcnVSjK1SM> .  Where should we place the bird feeder so that wild birds can find it? What if there is more than one family of birds that need access to the feeder? | |
| **INSTRUCTIONAL PROCEDURES** | **Step-by-Step Procedures-Lesson Sequence: Basic to Complex.** Lesson includes visuals, modeling, logical sequencing and segmenting (beginning, middle, ending); essential information; concise communication; grouping strategies; differentiated instructional strategies to provide intervention & extension; seamless routines; varied instructional strategies; key concepts & ideas highlighted regularly. |
| ***Introductio*n** Yesterday we found incenters of triangles and then drew smaller triangles inside the first. We noticed that the incenter of the large triangle was the circumcenter of the smaller triangle. Today we will try to use our knowledge of triangle centers to find an ideal location for a bird feeder.  Place students in groups of 3 or 4.Pass out one copy of the map without grid to each student. Tell the following story, “At each of the points labeled on the map, there is a bird nest. In each nest there is a mother bird and some newly-hatched chicks. The mother birds are tagged with GPS tags, and some ornithologists are studying them. These scientists would like to introduce a new food source (a bird feeder) and observe how each of the mother birds interacts with it. The scientists would like the new food source to be equidistant from each of the nests. This way the distance between the nests and the food source is a controlled variable. That is, if one bird goes to the food more than the others, it is not because it is closer to her nest.”  **Motivating Students**  \_x\_ Verbal Reinforcement throughout the activity; \_x\_ Relate to Real World  **Presenting Instructional Content**  \_x\_ Hands-On Students will have to find a circumcenter using rulers, compasses, and/or protractors  \_x\_ Discussion Students will have to discuss strategies for algebraically verifying the location of the circumcenter. They will have to decide where to place the coordinate axes.  \_x\_Maps The map is used to portray actual locations as points. The map allows students to apply geometry to solve a real world problem.  \_x\_ Modeling This activity models a real world situation with geometry and algebra.  ***Instructional strategies:***  **Modeling and Guided Practice *–***  After telling the story of the birds and the feeder, continue the lesson by prompting the groups. Ask,  Can we estimate where the food source should be placed?  Where are some places on the map that we are very confident are not good locations for the feeder? [*three obvious places are the three bird nests*]  Each group should discuss answers to these questions. Each group should mark its map with a boundary enclosing a region where they are confident that they will find the ideal spot for the bird feeder. This is done without measuring.  Now ask, Can we use some math we know to make the location more precise? Can we use the geometric constructions we have been learning about to find the location on the map where the feeder will be equidistant from all three nests? Draw a dot on the map where the bird feeder should go.  Monitor groups for progress. Their discussion should lead them to realize that they need to find the circumcenter of the triangle whose vertices are at the three nests. Use questions to prompt them to this realization if needed. Once they realize that they need to find the circumcenter, then each student should find the circumcenter. Each student in the group should compare the spot found to the spots found by the other students in the group.  Once a group has agreed on the feeder location based on the circumcenter, ask:  How can the scientists use the map to find the actual physical location for the food source? What additional information could you use?  What tools would be helpful for you to answer this question?  What tools would the scientists need to execute your instructions?  Students should discuss the answers to these questions within their groups and then with the whole group. Once the class has reached some consensus, pass out the map with grid, one per student. Have students orient the map so that the “Google” watermark is right side up at the bottom of the picture. Then north is toward the top of the page. Each student should write his or her name in the upper right hand corner of the map sheet.  North.  The word “Google” is at the bottom.  One way to communicate about locations on a map is to use a coordinate system. Here we have a grid drawn on the map. Have students locate the circumcenter on the grid. Do not tell them how to find the circumcenter. They might complete the construction again. Another legitimate way to find the circumcenter is to lay the grid picture on top of the no-grid picture, hold them to the light to align the bird nests, and then mark the correct spot on the grid picture.  We would like to use algebra to check our result. We must locate the axes. We are used to being given the axes, but here we need to create a coordinate system. Where will you place the origin? Which way should the positive x-axis point?  Monitor groups as they locate the axes. Each group should use one coordinate system, but different groups may have different coordinate systems.  After each group has labeled their coordinate systems, hold some whole-group discussion. How can we use algebra to verify our geometry? That is, how can we find numbers or equations that show us that the bird feeder is in the right spot? ( *The bird feeder should be equidistant from each nest. We could use the distance formula to verify that each of these distances is the same. Another technique is to find equations of the perpendicular bisectors of the sides of the triangle with nests at its vertices. Then find where two of these lines intersect. Do the coordinates match the coordinates of the nest? )* Once students have chosen a strategy, have them carry it out. They should use the back of the map to record their calculations.  Make sure that students have put their names on the maps with grids. They should turn these in. They may keep the map without grid worksheet.  **Check for Understanding (CFU) –**  ***What am I doing for students that progress at different rates?*** Monitor student work within groups and provide prompts where required. Members of a group should help each other to ensure that the group has finished each stage of the project before moving on.  ***What do I do if they get it?*** Give students the latitude and longitude for each of the nests and have them calculate the latitude and longitude for the circumcenter.  ***What do I do if they don’t get it?*** Review techniques for finding midpoints of line segments and perpendicular bisectors. Review how to use the distance formula. | |
| **QUESTIONING/THINKING/PROBLEM SOLVING (embedded throughout)** | **Balanced mix of question types.** Utilizes Blooms Taxonomy/Webb’s Depth of Knowledge; high frequency; purposeful & coherent; require active responses; balance based on volunteers/non-volunteers, ability, & gender; lead to further inquiry & self-directed learning.  **Implement four types of thinking (Analytical, Practical, Creative, & Research-based) & Teach/Reinforce problem-solving types**. Provide opportunities for students to generate ideas & alternatives; analyze, evaluate & explain information from multiple perspectives& viewpoints. |
| **Questioning (Asking these questions out of order could give students answers to questions that come later. The asterisks here indicate the chronological order in which to ask questions, regardless of the depth of the question. That is, do not ask a group a \*\* question until they have found the answer, on their own or through prompting, to the \* questions).**    **\*to prompt students to realize that they need to find the circumcenter**  **\*\*to help students remember how to find the circumcenter**  **\*\*\*to help students more deeply understand the connections between geometry, algebra, and locations on the map**  **Knowledge:**  \*If we connect the three nests with line segments, what type of figure do we get?  \*\*How do we find the circumcenter of a triangle?  \*\*What are some different lines we have constructed on a triangle? (*angle bisectors, altitudes, perpendicular bisectors of sides*)  \*\*\*What is the distance formula? ( )  **Comprehension:**  \*What type of point have we studied that is the same distance from each vertex of a triangle?(*circumcenter*)  \*\*\*How do we translate between the geometric and algebraic interpretations of a line? (*Use the slope-intercept form for the equation to convert geometric slope and intercept into an algebraic form*)  \*\*\*If we find the distance from the feeder to a nest, and then find the distance from the feeder to a second nest, how should these distances compare? ( *should be approximately same* )  **Application:**  \*\*\*What tool or idea could we use to explain to the scientists where to put the bird feeder?  \*\*\*What are the coordinates of the spot where we should place the bird feeder?  **Analysis:**  \*\*\*Where should we put the origin of our coordinate system? (*There is no wrong answer. Aligning the origin with the western-most and southern-most nests provides some convenient zero coordinates and avoids negative coordinates. Placing the origin at the circumcenter simplifies distance formula calculations, but if the circumcenter is not at a point of the grid, then finding coordinates of the nests is more difficult due to fractional distances)*.  \*\*\*Where can we place the origin so that we do not have to use negative values for coordinates of points that we are interested in?  \*\*\*Which way should the positive y-axis point? What about the positive x-axis? (*conventional answers are north and east*)  \*\*\*How can you use algebra to verify that you found the correct spot for the feeder?  \*\*\*Does each group agree on the coordinates for the spot where we should place the bird feeder? If not, why not? Did the two groups have different maps? ( *groups with different coordinates for the bird feeder probably chose different origins for their coordinates systems.* )  **Synthesis:**  Why does it matter that we have birds in this problem? ( *By flying, birds may travel in a straight line from the nest to the feeder. Our normal geometric notion of distance measured along a straight line is meaningful. Other animals would bump into trees if they traveled in straight lines, so our normal notion of distance would not actually give the distance on the ground).*  **Evaluation:**  **Thinking**    \_x\_ **Practical** –This activity is based on a realistic scenario.  \_x\_ **Analytical** – Students have to figure out which algebraic tools to use, and then use them to explain how they know that the point the found for the feeder is equidistant from each of the nests.  **\*What am I going to do to give students an opportunity to?**  **1. Generate variety of ideas:** Students can find the circumcenter using compass and straightedge techniques or using a ruler and protractor. Students can find the circumcenter on the grid by repeating their earlier construction or by tracing the original circumcenter.  **2. Analyze problems from multiple viewpoints:** Students can choose a technique to algebraically verify that they have the correct spot for the bird feeder.  **Problem Solving**  **\_x\_ Drawing conclusions/Justifying Solutions** Students use algebra to verify geometric solution  **\_x\_ Generating Ideas** Students work as a group to develop a strategy to use algebra to verify their geometric solution  **\_x\_ Creating and Designing** Students must create a coordinate system to solve this problem. They must choose the origin. | |

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| **GROUPING** | **Maximize student understanding & learning** Varied group composition (race, gender, ability, & age); clearly understood roles, responsibilities & group work expectations; accountability for group & individual work; student opportunities for goal setting, reflection & evaluation of learning. |
| * Students will work in heterogeneous groups of 4. * Each student will complete an individual worksheet. Members of a group will help each other. Each group will have a designated reporter who will share the group’s work with the whole group. * Verbal instructions and whole group discussion will let each student know what is expected. * Each student will produce 1) a dot on the map with grid showing the correct location of the bird feeder, 2) a list of coordinates for the feeder and each of the nests, and 3) algebraic verification that the location of the feeder is correct. | |
| **ASSESSMENT** | **Formative and/or summative assessment.** A variety of assessments, including rubrics, measure achievement of objectives and informs instruction. |
| ***Assessments:***  **\_x\_\_ Worksheet** For each student, is the bird feeder location marked correctly? Does the algebra show that the location is correct?  **\_x\_\_ Exit Ticket**  **\_x\_\_ Questions/Answers** Answers to questions throughout the activity will provide formative assessment to indicate whether students understand the significance of a circumcenter and how to find it. | |
| **CLOSURE** | **Reflection/Wrap Up.** Summarizing, reminding, reflecting, restarting, connecting. |
| * ***Review/Summary:*** All of us found coordinates for the bird feeder. Do all of us have the same coordinates? Do all of us have the same location for the bird feeder?   Different choices for the origin will give different coordinates for the same location. That is OK. We saw that a circumcenter can have a practical use. We made connections between algebra (distance formula) and geometry (points, perpendicular bisectors, intersection of lines).   * ***Preview for next lesson: link what they did to day with where they are going next.*** * ***Upcoming assignments: remind them of any upcoming assignments.***   **Here is your exit ticket for today…..**  **Fill in the blanks. Write the words on your white board and hold it up.**The circumcenter of a triangle is at the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ of the sides of the triangle.  ***Reflection:*** | |

**NOTES:**

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