5E Lesson Template

Lesson Author(s)	Joyce Sevast
Lesson Title	Light Emission and Population Density
Lesson Source	
Technology Needs (if any)	ArcGIS explorer with "Earth at night" overlay – focus on the United States
Date/Time Lesson to be Taught	
School	
Supervising Teacher	
Math or Science?	Math and Science – population density
Lesson Concepts	Students will develop an understanding of population density.
Objectives	Students will calculate density of large city populations in the United States using the polygon and measuring tools in ArcGIS as well as current population estimates from internet sources.
CO State Standards	Math 6th grade standard 1.1.c.iii. Solve unit rate problems including those involving unit pricing and constant speed. (In this case, people per square mile, population density) Social Studies 6th grade standard 2.1.a Use longitude, latitude, and scale on maps and globes to solve problems
Materials List and Advanced Preparation	Have ArcGIS loaded on all computers and logged on to base screen. Worksheet to calculate population density.
Safety	No concerns
Accommodations for Learners with Special Needs	None needed, working in partnerships.

5Es

1. ENGAGEMENT		Time: 10 Minutes
What the Teacher Will Do	**Probing/Eliciting Questions**	**Student Responses and Misconceptions**
Introduce the idea of city life. Have a discussion about how a city feels different than living in the country. Also, talk about different cities, e.g., New York City vs. Denver.	How do we know how many people live in a city? (census, generally) How might you measure the area of a city? Is it true that some cities have HUGE populations, while others do not? What makes one city feel "cramped" while another city feels "open?" (density of population – which leads to the exploration part…)	Students with little experience with cities may think that all cities are huge and cramped, while others may believe they are all like Denver (for example). Students may come up with extreme ways to measure the area of a city. This is most often done om maps.
Evaluation/Decision Point Assessment		**Student Outcomes**
Student participation.		Students will understand how both area and population are measured.

2. EXPLORATION		Time: 5-10 Minutes
What the Teacher Will Do	**Probing/Eliciting Questions**	**Student Responses and Misconceptions**
Have the students open ArcGIS with a topo base layer and overlay the "Earth at Night." Have the students make observations.	What do you notice? Why are some places completely black? Why are there concentrations of white?	The white is artificial light. Students may equate lack of white to no population, when in reality, people may live there, just not in great concentrations.
Evaluation/Decision Point Assessment		**Student Outcomes**
Student participation.		Students will conclude that the white on the map is from concentrations of population -- large city areas.

3. EXPLANATION	**Time: 30-40 Minutes**	
What the Teacher Will Do	**Probing/Eliciting Questions**	**Student Responses and Misconceptions**
Work through the worksheet on population density with the students. 1. Work through problems 1 through 4 with the students. These are self-explanatory. 2. With ArcGIS loaded with the "Earth at Night" overlay and the topo base, introduce the area tool. (Click on the ruler and choose the polygon ruler – click once to place each marker and twice to end the polygon. Make sure the menu is set to the correct unit of measure (km^2 or mi^2).) Students should zoom in on the city areas and create irregular polygons around the "edge" of the lights for each city. 3. Have students work in partners to construct polygons around each large city in the chart (I have chosen cities for which the "edges" are a bit more distinct and which do not generally merge with other large cities) and record the area of each city in the chosen unit. **Please note – once a new polygon is begun, the last one made will disappear. 4. Using a predetermined search engine, have the students search the internet for the metro area population for each city. Record this population on the worksheet. 5. Next, have students calculate the population density by dividing the population by the area of each city. 6. Have students rank the density of each city from greatest to least.	Answer student questions as they are posed. See worksheet for questions. (Worksheet is copied at the bottom of this lesson plan) Are the results of your calculations what you expected? How do your calculations compare with other groups? What were you expecting? What may account for the discrepancy? (Both in differences in calculation and unexpected rankings?)	Varied responses and misconceptions due to background knowledge of each student and the precision of their calculations.
Evaluation/Decision Point Assessment		**Student Outcomes**
Completed worksheets with explanations.		Students will be able to accurately calculate densities given the parameters under which they are doing the calculations.

4. ELABORATION		**Time: 15 Minutes**
What the Teacher Will Do	**Probing/Eliciting Questions**	**Student Responses and Misconceptions**
Elicit discussion.	What may be some problems with the way we calculated population density? What may be a better way to estimate average density?	• Our calculation is the average, whereas population density varies within city limits. • Area may be imprecise due to different edge detection and precision of light boundaries (pixels). • Population numbers are estimates. • Better calculations with housing data and maps with a higher zoom. • Light emittance does not necessarily determine city boundaries.
Evaluation/Decision Point Assessment		**Student Outcomes**
Student participation.		Students should understand the concept of population density, know that we have approaches it somewhat scientifically, but not in the most precise way.

5. EVALUATION		**Time: 20 Minutes**
What the Teacher Will Do	**Probing/Eliciting Questions**	**Student Responses and Misconceptions**
Given a topo map with distinct city boundaries, have students use ArcGIS technology with the area tool, and the internet to find metropolitan population figures for a few US cities to compute average population density. This can be done on regular notebook paper.		
Differentiation		**Time: N/A**
Students who are behind or need support	For advanced or gifted students	
Have these students work in pairs.	Have these students compare their calculations with internet estimates of density. Pose the question, what could account for differences in density figures?	

Population Density Calculation Name: _____

Do problems 1-4 with a partner and in conjunction with teacher instructions

1. Write a definition of population density in your own words using "Webster" as a source:
   _____
   _____
2. Calculate the area of our classroom. Show your work.

3. How many students are in the classroom? _____
4. Calculate the population density. Show your work. Round to the nearest tenth.

Follow the class instructions to complete the following questions.

5. How can light emission (visible from space) be used to determine area of a metropolitan population?
   _____
6. Using ArcGIS as a tool, calculate the density of the following metropolitan areas within the United States.

City	Area	Population	Density	Rank
Chicago				
Los Angeles				
Denver				
Seattle				
Houston				
Minneapolis/St Paul				

Salt Lake City				
One of your choice:				

7. On the back of this sheet, write the step-by-step instructions for calculating population density based on light emission in complete sentences.