IndianaMap Puzzles

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Introduction and Purpose: In order to familiarize students with Earth (Indiana) surface aerial photography/ imagery (multiple representations and visualizations) and GIS (geographic information systems/sciences), *IndianaMap*, the state's interactive GIS data, will be utilized to create aerial photography puzzles. For educators … this is a good way to collect IN aerial imagery map puzzles!

Grade Levels: 4-9 following the *NatGeo GeoInquiry* model: ask, collect, visualize, create, act.

Indiana Geography Standards: Social Studies 2020 https://www.doe.in.gov/standards/social-studies
Fourth Grade: 4.3.1, 4.3.2, 4.3.6, 4.3.8, 4.3.14 **(modify lesson slightly to incorporate more academic standards)**
Fifth Grade: 5.3.1, 5.3.12; Sixth Grade: 6.3.4, 6.3.5, 6.3.9, 6.3.11; Seventh Grade: 7.3.2 (apply to Asia & Africa; see Extension #2); Eighth Grade: 8.3.1, 8.3.3, 8.3.7, 8.3.8, 8.3.9 (see Extension #2)
High School: (see Extension #2)
World Geography: 1.1, 1.4, 1.5 (modify lesson to incorporate more standards, global applications)
Geography & History of the World: (modify lesson to incorporate more standards, global applications)

Objectives: Students will be able to
1. locate aerial imagery (photography) of Indiana on *IndianaMap* (https://indianamap.org) or *IndianaView* (https://www.indianaview.org/glovis/IN_County_Landsat_Data.html),
2. select an aerial image of interest and create aerial image map puzzles,
3. make 3 observations about the image,
3. determine the season and time of day the photograph was taken,
4. locate sport facilities on the campus of DePauw University in Greencastle, IN using the aerial photo map puzzle,
5. estimate the height of a tree or building using shadows, and
6. research the locations/places utilized in the map puzzles.

Materials:
- IN ADVANCE: Construct your own map puzzle using an 8.5" x 11" color copy of the aerial photo of an interesting place in your community (use DePauw University in Greencastle, IN as an initial example as a class) that is glued onto foam board (or laminated) and cut into various shapes; create 5-6 pieces for each puzzle. (ACCESS TO:) You can locate the aerial photo of DePauw University by going on-line to IndianaMap https://indianamap.org, search for Greencastle, Indiana, southwest side of the city; zoom in or out to the extent that the user prefers. You can also locate the historic satellite imagery of Putnam County by going on-line to IndianaView https://www.indianaview.org/glovis/Putnam_County.html.
- Copies of the *INMap Puzzle Student Learning Sheet* and the *Scale Determination Guide Sheet* (or make available virtually or classroom white board/screen).
- Exacto Knives (or other cutting device) OR lamination machine
- Foam Board, cardboard, recycled folders…, color printer (with extra ink), sandwich baggies
- An organizational NOTE: number each puzzle and letter each puzzle piece. For example, DePauw University might be puzzle number 12, and it might have six puzzle pieces. So, 12A, 12B, 12C, 12D, 12E, and 12F. Each puzzle should have its own container (plastic baggie) that also has the puzzle name and puzzle number on the bag. Over time, quite an interesting collection of IN aerial imagery puzzles can be aggregated; students choose some of the most unexpected aerial images! These are a great teaching tool for older students to use with younger students, parents/guardians, guests and colleagues.

Insert location of aerial photo:
Anticipatory set: Show your students an example of aerial photograph (look at your school) from ***IndianaMap***. Ask them to make observations about the image. What do they see? How do they think the photograph was taken? Ask the students why this type of photography might be valuable?

Airphoto interpretation background information:

Basic tasks of an air photo interpreter are to:

1) detect 2) identify 3) delineate (measure boundaries of an object or size)
4) classify 5) enumerate (basic counting of features) 6) correlate (using statistics to interpret repeatability)

The main recognition elements within a photo include:

1) shape 2) size 3) pattern 4) shadow 5) tone/color 6) texture
7) association 8) site 9) features 10) time 11) experience

Procedure:

ASK

1) As a class, (do not tell the students) view the DePauw University campus on IndianaMap https://indianamap.org (Greencastle, IN; Putnam County; west of Indianapolis along I-70). ASK the students: What are you looking at and why is it valuable? EXPLAIN that an aerial or satellite image of a place can tell a story, and we are glimpsing a small part of the DePauw University story. This image is part of an overall collection of data about this place. Much of the data that we use to answer questions and solve problems is managed by a GIS (geographic information system), a 21st century (mapping) tool that stores data that we can manipulate to answer questions, solve problems, and plan for the future. For example, this image is one type of data that can be combined with other types of data to plan for expansion of the football stadium or to add one more tennis court. 21st century data is not only numbers but can mean satellite images, interviews, videos, pie charts, bar graphs, line graphs, sounds, written documents and much more.

COLLECT

2) Distribute the DePauw University image, the *INMap Puzzle Student Learning Sheet*, and the *Scale Determination Guide Sheet* to the students in small groups or working as individuals.
3) Work through the INMap Puzzle Student Learning Sheet as a class or in small groups or as individuals.
4) Students should make 3 observations of specific objects on the DePauw University's campus. For instance, they may take note of the sports fields, vegetation, building shapes, parking lots, air conditioner units on top of buildings, trees, time of year/season, etc.
5) Determine the location of the tennis courts and football stadium. Students can determine the image resolution using the known distance within the football stadium line markers (10 yards between the lines).
6) Ask students to suggest ways that they could estimate the height of the trees/buildings.
7) Determine the height of the tree circled in red utilizing the *Scale Determination Guide Sheet*.
8) Students as individuals or in small groups should visit the **IndianaMap** web site and should look through the aerial imagery; they should find an image that is of interest to them. Print the image in color. If possible, visit the **IndianaView Landsat Images for Indiana Counties** and select the appropriate county in which the INMap image resides (https://www.indianaview.org/glovis/IN_County_Landsat_Data.html).

VISUALIZE

9) Glue the image onto (donated) foam board/cardboard/folders…. Cut the image into 5-6 puzzle pieces with an Exacto knife CAREFULLY!!! Number the puzzle and each puzzle piece. Label a plastic baggie with the puzzle number and the name of the location/place of the image. A label of the name of the location/place can also be printed and glued onto an edge of the puzzle.
10) Students work through the *INMap Puzzle Student Learning Sheet* for their chosen image … skipping some of the items not relevant to their puzzle image. They could provide a verbal report sharing a few facts about the location/place of their chosen puzzle image: what does the image depict, where the location/place is located, why they found the image interesting, height of any significant buildings or trees or towers…

CREATE

11) Students can swap puzzles with other groups (AFTER they are all numbered).
12) Students can create an interactive school display with the puzzles or can work with younger students/parents/guardians/citizen visitors/local & state decision-makers, teaching them about aerial imagery.

ACT

Assessments:

- *INMap Puzzle Student Learning Sheet* for self-selected imagery
- Verbal report of the image (if educator requires)
- Build puzzle(s)

Extensions:

1. Another fun aspect of aerial imagery is researching human-environment interaction. Students can locate an interesting feature of the physical environment, research the feature (how it developed, cultural significance, manner in which it engages with human systems…); this is a great way to learn how Indiana evolved physically (geology, topography, karst, water systems…): Orange County flatter terrain has dimples that are sink holes in formation (highest sink hole density); southern shore of Lake Michigan along Indiana Dunes National Lakeshore (marinas, power plant, steel mills, bogs, marshes); Falls of the Ohio State Park maintaining the fossil beds while humans visit the Park; IKEC electric utilities in Madison; Big Oaks National Wildlife Area; Whitewater & Delphi historic canals; all surface water bodies in the state need protection from pollution; managing landfills and quarries…and MANY more possibilities.
2. Look at aerial imagery for different places around the globe relative to grade-level region(s) of study. Existing on-line aerial/satellite global and United States imagery map puzzles from the United States Geological Survey (USGS) can be found at https://www.indianaview.org/image_puzzle.html. The existing on-line Indiana Map Puzzle can be found at https://www.indianaview.org/image_puzzle/puzzle.html?image=images/puzzle/Indiana_LM_537x800.png&code=02001.
3. Create a massive puzzle collage of places around the world, community, state, upper Midwest, watersheds…
4. Read the on-line book "***Lindsey the GIS Professional***" https://www.bolton-menk.com/books/lindsey/Lindsey.html
    a. Explore further at-home activities with Lindsey for primary/elementary grade students at https://learn.arcgis.com/en/esripress/lindsey/ .
5. OR read more spatial/geographic on-line books sponsored by Bolton & Menk - https://www.bolton-menk.com/Resources/childrens-library/ : (relate how valuable aerial imagery is in each of the stories)
    i. *Parker the Planner: An Urban Planning Story*
        1. Activities at https://learn.arcgis.com/en/esripress/parker/#explore
    ii. *Larry the Land Surveyor: A Surveying Story*
    iii. *Green Trees and Sam: A Landscape Architect Story*
    iv. *Will Learns About Civil Engineering in the World Around Him*
    v. *Doug the Waterdrop: A Wastewater Story*
    vi. *Ned the Natural Resource Specialist: An Environmental Planning Story*
        1. **Reading a Natural Resources Map; National Geographic** lesson plan https://www.nationalgeographic.org/activity/reading-resource-map/
    vii. *Walter the Raindrop: A Water Cycle Story*
6. Work through the online activity *Down to the Last Drop*, within ESRI's GeoInquiries Collection for Environmental Sciences https://www.esri.com/en-us/industries/education/schools/geoinquiries-environmental-science.

EXAMPLE INMap Puzzle, St. Joseph's College:

This is an aerial image of St. Joseph's College in Collegeville, IN (just south of Rensselaer). Note the title of the puzzle in the upper left and the puzzle number (27) and puzzle piece letter (F) in the lower left. Research could include relative & exact location of the institution/image, why did the image capture your attention, importance of the institution historically, why did the institution "recently" close, how did the closure impact the local community/economics and more.

Student Learning Sheet **IndianaMap Puzzle** Name_____

Procedure:

1. Find a partner to work with on the INMap Puzzle.
2. Make 3 observations using the aerial image/photograph:

   a._____

   b._____

   c._____

4. What season is it? _____ How can you tell?

7. What time of day is it? _____ How can you tell?

6. Which was is north on the DePauw University aerial image?

7. Determine the image resolution of the photograph using the known distance within the football stadium line markers.

8. Suggest ways that you could estimate the height of the trees/buildings.

9. Determine the approximate height of the tree circled in red.

Scale Determination

Scale is one of the most important pieces of information for the use of an aerial photograph or a map. Quantitative measurements and interpretation of features on a photograph are highly dependent upon scale. Scale is what determines the relationship between the objects viewed on a photograph and their real world (the ground) size. It is also this information that determines the amount of detail shown on a photograph or a map. The absence of scale makes it impossible to relate the size of or the distance between objects on a photograph to their actual sizes or distances on the ground.

Before a photograph can be used as a map supplement or substitute, it is necessary to know its scale. On a map, the scale is printed as a representative fraction that expresses the ratio of map distance to ground distance, For example:

$$RF = \frac{MD}{GD}$$

On a photograph, the scale is also expressed as a ratio, but is the ratio of the photo distance (***PD***) to ground distance**.** For example:

$$RF = \frac{PD}{GD}$$

The approximate scale or average scale (***RF***) of a vertical aerial photograph is determined by either of two methods; the comparison method or the focal length-flight altitude method.

a. **Comparison Method.** The scale of a vertical aerial photograph is determined by comparing the measured distance between two points on the photograph with the measured ground distance between the same two points.

$$SCALE\ (RF) = \frac{Photo\ Distance}{Ground\ Distance}$$

The ground distance is determined by actual measurement on the ground or by the use of the scale on a map of the same area. The points selected on the photograph must be identifiable on the ground or map of the same area and should be spaced in such a manner that a line connecting them will pass through or nearly through the center of the photograph (from http://www.4orienteering.com/aerial_photos/32/)

Try this example: A soccer field that is 120 meters long measures 15.3 millimeters on a vertical photograph. What is the scale of the photograph?

Suggested Places from which to create additional INMap Puzzles:

1. Falls of the Ohio State Park, Jeffersonville
2. Ball State University, Muncie
3. Indiana Beach, Monticello (Lake Shafer)
4. Delphi Historic Canal, Delphi
5. Indiana State Capitol, Indianapolis
6. Indiana Dunes National Park, Chesterton
7. Indiana State University, Terre Haute
8. Purdue University, West Lafayette
9. Indianapolis Motor Speedway, Speedway/Indianapolis
10. Grand Victoria Casino, Rising Sun
11. Grissom Air Force Base, Bunker Hill (north of Kokomo)
12. O'Reilly Raceway Park, Clermont
13. Indiana University, Bloomington
14. Brookville Reservoir Dam Spillway, Brookville
15. Abe Martin Lodge, Brown County State Park
16. Michigan City Marina
17. Butler University, Indianapolis
18. Parker Auto Salvage, Vincennes
19. Bendix Woods Nature Preserve, New Carlisle
20. Monroe Reservoir, southeast of Bloomington
21. U.S. Steel, Gary
22. Culver Military Academy, Culver
23. West Baden Springs Motel, West Baden Springs
24. War Memorial Coliseum, Fort Wayne
25. University of Notre Dame, South Bend
26. George Rogers Clark National Historic Park, Vincennes
27. Saint Joseph's College, Rensselaer (Collegeville; closed)
28. Jasper-Pulaski Fish and Wildlife Area (Clarks/Radioville; sand hill cranes)
29. Ohio River, southwestern part of the state, Mount Vernon
30. Indiana Downs Racetrack, Fairland
31. Power Plant, Lawrenceburg
32. Bear Run Coal Mine, Carlisle
33. Paoli Peaks, Paoli
34. Wabash River train bridge, Riverton
35. Clear Lake, northeastern corner of the state (IN, MI, OH borders)
36. Temple Quarry, Temple
37. Mobile Home Park, Columbus
38. Indianapolis International Airport
39. Limberlost Swamp, Geneva
40. Archabbey @ Saint Meinrad, St. Meinrad
41. Eagle Marsh Nature Preserve, southwestern Fort Wayne
42. Warsaw High School, Warsaw
43. Earlham College, Richmond
44. Wilbur Wright Birthplace, Hagerstown
45. Riverfront Park, Evansville