**M&M’s Community Map and GeoSpatial Thinking: Points, Layers, GPS, and GIS**

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**Purpose:** To teach the students the basic concepts of geo-spatial thinking, an activity utilizing a white sheet and M&M’s will engage interest and make a connection between existing knowledge and real-life geo-technology possibilities: points (locations), common points (map layers), GPS (global positioning systems), and GIS (geographic information systems/sciences).

**Grade Level(s):** 4-12

**National Geography Standards:**

1. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

18. How to apply geography to interpret the present and plan for the future.

**National Geographic GeoInquiry Process:** <https://www.nationalgeographic.org/education/programs/geo-inquiry/>

**ASK** a geographic question; **COLLECT** geographic data; **VISUALIZE** the geographic issue and possible solutions; **CREATE** a geographic method to solve the problem and/or plan for the future; **ACT** by sharing the knowledge about the problem and the possible solution.

**National Geographic Learning Framework:** <https://www.nationalgeographic.org/education/about/learning-framework/>

 Attitudes: Curious, Empowered

 Skills: Observe, Communicate, Problem Solver

 Knowledge: Human Journey, Changing Planet

**Indiana Social Studies Academic Standards:**

*Sixth Grade:* Geography – 6.3.2.

*Seventh Grade:* Geography – 7.3.3; Individuals, Society, and Culture – 7.5.4 (focusing on geo-spatial technologies in the late 20th century and the 21st century).

*Eighth Grade:* Geography – 8.3.11 (expand this activity to focus on specific standard goals); Individuals, Society, and Culture - 8.5.7.

*High School:* World Geography – 1.3 and 1.4.

 Geography and History of the World - 5.4 and 5.5.

**Objectives:**

Upon completion of this activity, students will be able to...

1. create a two-dimensional map highlighting at least four layers of data (layers of information),
2. discuss the relationship between hand-cartography and 21st century cartography specifically comparing data collection, data manipulation, and data presentation,
3. give examples of geographic (spatially distributed) data (layers of information); ie., sewer lines, street lights, schools, grocery stores, libraries, bus stops,…),
4. explain what a GPS (global positioning systems) is and how the system works,
5. give examples of human-related systems that utilize a GPS (cell phones, trucks transporting goods, airplanes, shipping…),
6. identify GIS (Geographic Information Systems) and briefly explain the term: information technology systems (software) used to store, analyze, manipulate, and display a wide range of geographic (spatial) information,
7. provide one example of where to find Indiana geographic data (GIS – IndianaMap, IndianaView),
8. state at least one way in which GIS has impacted society in the 21st century (ie-economic efficiency and development, emergency services, disaster recovery, epidemiology, natural hazards, etc.), and
9. give one example in which GIS may facilitate problem solving in the near future.

 **Materials Required:**

* + One (or one-half of a) white twin sheet or large white paper (butcher or bulletin board paper)
	+ One large bag of multi-colored M&M’s/Skittles/Bingo chips/Legos or other candies/figures
		- Divide into small baggies each: 8 bodies of water; 3 or 4 green spaces; 10 buildings; 8 areas of trash; 8 neglected areas
	+ Colored pencils for each student
	+ White drawing paper for each student
	+ Clipboards (if desks/tables are unavailable)

**Procedures:**

**ASK: How does your cell phone know where it is at? Do you know how a GPS (global positioning system) works?**

1. Place the white sheet onto the floor of the classroom.
2. Hand each bag of sorted candies/blocks/chips to a student.
3. Discuss with the students that they will be gathering geographic (spatial) information about a community. Six pieces of information have been requested: bodies of water, parks/green spaces, buildings, areas of trash, and neglected spaces. The students will “create” the community, obtain the data requested about the community, and briefly map the data obtained.
4. The student with the blue candies/blocks/chips will gently “toss” the blue pieces onto the white sheet. Ask: According to this map Legend, what do the blue pieces represent? Hopefully, someone will answer water, streams/creeks, lakes and ponds. State: Each blue piece represents ONE location on the map. All of the blue locations together represent a map layer (bodies of water). A map layer is a collection of locations with a common theme. Ask: Do you notice any patterns or relationships among the blue locations?
5. The student with the green candies/blocks/chips will follow, gently “tossing” the green pieces onto the map. Ask: According to this map legend, what do the green pieces represent? State: Each green piece represents ONE location on the map. All of the green pieces together represent a map layer: green spaces. A map layer is a collection of locations with a common theme. Ask: How many map layers are visible on the map now? (hopefully, they will answer 2: bodies of water and green spaces). Ask: Do you notice any patterns or relationships among the green locations? Do you notice any patterns or relationships between the blue (bodies of water) and green (green spaces) locations? State: We know that this map depicts random places, but imagine a map of the school grounds and neighborhood. The concept of points (GPS is used to find the exact location) and layers is how a GIS (geographic information systems/sciences/software) works. GIS is like a nervous system connecting people and places; GIS is the science of where. Think of your cell ‘phone, thousands of points letting you know where things are located as you move.
6. Continue with the red, yellow, and brown candies/blocks/chips… gently toss onto the map. Ask: According to the map Legend, what do the (red, yellow, brown) pieces on this map represent? How many map layers are now visible? Do you notice any patterns and relationships among the (red, yellow, brown) locations? Do you notice any patterns or relationships between the map layers? Work through all of the candies, asking about and observing the patterns/distribution/relationships of the candies on the white sheet. The candies/blocks/chips represent the following, or the students could select the item that will be represented.

Green = parks/green spaces

Red = buildings

Yellow = areas of trash

Brown = neglected spaces

Blue = bodies of water

 Note: Black yarn, string, or even licorice could be used to add streets as another layer.

**COLLECT: Gather the data/information (data in this activity means numbers/locations, words, interviews, satellite and aerial imagery, photography, historic maps and more).**

1. As the class is viewing the newly created “community map”, remind the students that each candy/block/chip represents one location and that each color represents one layer of information or data. All of the layers combined tell a partial story about the community, and the data can be used to answer questions, solve problems, or plan for the future … about the community.
2. Next, have each student draw a map of the “community”. IF time permits, have the students recreate the map on a white letter-sized piece of paper incorporating the six key map features (todals): print their name along the top (**title** of the map), place a compass rose on the map near an edge (**orientation**), sign and date the map along an edge (**date** and **author**), incorporate the **legend** in some fashion on their map, insert a **scale** along the bottom of the map (represents distance on the map, for example, 1 inch = 5 miles). The hand-drawn maps reinforce learning and teach an element of logic, yet still allow for creativity. The maps are not to be graded based on “perfection and neatness” but are to be graded on participation, completion, demonstration of concepts absorption: parts of a map, points/locations, common locations = map layer, multiple map layers = GIS (geographic information system). The “by-hand” map drawing will demonstrate to the students a more traditional method of map-making in a fun way ... with themselves as the Cartographer. State: Imagine before technology, not too long ago, every time spatial data/information needed to used to answer a question, solve a problem, or plan for the future, someone had to go into the field to obtain the data/information … this took time and money (resources). Now, all of the gathered data/information can be held in a GIS software allowing for easier analysis. As humans gather more data and data/information, more mappable data becomes available, thus, enriching our capacity to answer questions, solve problems, and make plans. Of course, with permission, extra candies can be provided for a snack ☺

**VISUALIZE: Are there any patterns in the point/location distribution? What types of relationships can you infer about the data? Are there any connections that the map layers have within the layer or between the map layers?**

1. Follow this activity with a discussion about their community. Have students imagine the time it would take for them to walk the community and to hand-map everything. How could the data collection be performed more quickly? How could mapping be performed faster? This is the time to discuss the use of technology to obtain, manage, and manipulate data to prepare maps, bar graphs, pie charts, and reports to answer questions about a community. Instead of the hand-collection of data, hand-mapping, and slow analysis (which could take weeks), new technology (geo-spatial – of the Earth from a spatial perspective) enables students and users to solve problems more efficiently. Prepare the students for the impending adventure into the 21st century use of geospatial technology.
	1. Introduce the term GPS – global positioning systems. Show an image of the GPS system (<https://spaceplace.nasa.gov/gps/en/>), via NASA’s SpacePlace) and read the descriptions; and/or you can show a quick video that demonstrates how GPS works (<https://spaceplace.nasa.gov/gps/en/>). Stress that almost every thing has a place (latitude and longitude) whether on the Earth’s surface, under the sea, on the Moon/Mars, universe.
	2. Introduce the term GIS. GIS is akin to a nervous system connecting people and places. Discuss a few examples of possible GIS use in the local community. Discuss the future of GIS use to even more rapidly obtain data, analyze data, and devise solutions. Examples: locate areas where a health service facility is needed; identify regions of language barrier access to services; propose a better city bus route for a community that would be attractive to the bus company. To show students how GIS directly impacts them, explain that the school bus routes are determined using GIS data to create the most efficient routes.

**CREATE: Develop a plan to address any problems or areas of concern that the mapped data conveys. Where? What? Why? How? When?**

1. Possible Assignment: Have students play the role of Entrepreneur. Ask them what business they would like to start in their community and have them make a development plan/list answering key questions like: Where would you locate your business and why there? What type of site/space needs would you have?

Are there zoning issues? Who would your buyers/consumers be? What employee needs would you have? Do you have any transportation needs (ie-for your product)? Where is your primary market? Who would your primary competition be? Have the students make a list of the data they might need for their decision-making process (ie-location of key competitor). How might they use GIS to assist them?

1. Follow with use of the IndianaMap interactive web site, the state’s source of aggregated map data (about 275 layers per county): <http://indianamap.org>; search through the bodies of water, green spaces, abandoned or trash areas and more. Also view your county historical Landsat satellite imagery with IndianaView: <https://www.indianaview.org/glovis/IN_County_Landsat_Data.html>; compare land-use change in place over time/seasons/decades.

**ACT: Initiate actions to share the data results that may lead to a resolution to solve a current problem or create a future plan.**

**Assessment / Evaluation:**

1. Completion of the hand-drawn “M&M Community” map: accuracy and completion indicating (spatial) comprehension, essential parts of a map.
2. Positive interaction within the (small) groups. (If applicable.)
3. Starting their own business activity. (If applicable.)

**Extensions**

1. Read ***Lindsey the GIS Professional***: <https://www.bolton-menk.com/books/lindsey/Lindsey.html> (an online book free to users)
	1. Utilize some of the online activities for the book: <https://learn.arcgis.com/en/esripress/lindsey/>
2. Work with the Indiana GIS data on **IndianaMap**, <https://indianamap.org>.
3. Work with the Indiana Landsat satellite imagery historic archives via **IndianaView**, <https://www.indianaview.org/glovis/IN_County_Landsat_Data.html>.
4. Download a **What is GPS? poster** (pdf) via the United States Government <https://www.gps.gov/multimedia/poster/> . Follow links to other GPS-related videos: GPS and farming, GPS and space, GPS and the future…
5. Work through various GPS/GIS related lessons via the *National Geographic Society*
	1. **GPS: How it Works** <https://www.nationalgeographic.org/encyclopedia/gps/>
	2. **Maps & Apps, Print & Digital**: <https://www.natgeomaps.com/apps>
	3. Introduction to GIS <https://www.nationalgeographic.org/activity/introduction-gis/>
	4. **Exploring with GIS Collection** of resources <https://www.nationalgeographic.org/education/exploring-with-gis/>
	5. **GIS in Action – Maps: Tools for Adventure**: <https://www.nationalgeographic.org/education/interactive/maps-tools-gis-action/>
6. Explore the many ESRI GIS-related videos, blogs, activities, story maps, and more. ESRI is the largest GIS provider at this time. They dedicate many resources supporting PK-12 education:
	1. **Geoinquiries** for all grades and all disciplines; on-line interactive activities involving some type of spatial thinking and applications <https://www.esri.com/en-us/industries/education/schools/geoinquiries-collections>
	2. **Online story map creation** <https://storymaps.arcgis.com/> (free, great for at-home learning)
	3. Online use of ArcGIS, the ESRI GIS software <https://www.esri.com/en-us/industries/education/schools/schools-mapping-software-bundle> (free for PK-12 students, formal/informal educators, public/private/home … as long as the use is for education purposes; scroll down to request a school account/bundle)
7. Use the **iNaturalist** app to gather flora and fauna data on the school property or at a local park.

The app is free to use, and the user is not inundated with e-mails. You can join the website, also, but that is not required to use the app. The web site allows users to view other flora and fauna that citizens and scientists around the globe gather and to better view the data that students have gathered. Scientists around the world evaluate the data every day; so you do not have to fear mis-identifying something! The data can be categorized, analyzed, and manipulated to answer questions, solve problems, and plan for the future. Maps, pie charts, bar graphs can be created comparing your classroom data to data from anywhere else around the world. A great app for casual neighborhood walks or intentional field hikes.

1. Watch the **GeoSpatial Revolution** video series from Penn State University and available via National Geographic; four episodes plus a trailer: <https://www.nationalgeographic.org/media/geospatial-revolution/>