Answer Key

for introductory activities and questions for reading comprehension, reflection, and discussion.

Unit 1: GIS Provides a Common Visual Language

Transforming our understanding of the world

Activity: Map Book Gallery

As you look at the maps in the map books, select three maps and for each map record the following:

- *Organization that produced the map*
- *Reason or problem for the map*
- *Layers included in the map*

Answers will vary.

Lesson 1-1: Working with GIS layers

How many different layers do you see represented?
There are seven layers represented on the map.

What data is represented by the World Imagery Layer?
USDA FSA (NAIP 2015) aerial imagery is represented.

What information is available?
The type of image, date, and resolution are provided.

Record the date, resolution, and accuracy of the imagery.
The image was taken by USDA FSA (NAIP 2015) on Tuesday, September 8, 2015. The image has a resolution of 1 meter and an accuracy of 6 meters.

Using the item details, write a sentence explaining the resolution and accuracy of the World Imagery Layer.
A resolution of 6 meters means that you can zoom into the image until the area measure is about 6 meters before the image starts to be blurred. The accuracy of 1 meter means that is the difference between the image and the true value on the ground.

Describe two types of landscapes that you can distinguish with the digital elevation model of the US.
Answers will vary, including Rocky Mountains, Appalachian Mountains, etc.
Complete this chart:

Layer Name	Vector Type	Two attributes
USA States	Polygon	Population and region
USA Freeway System	Line	Road number and length in sq. mi.
USA Parks	Polygon	National Forests, State Parks, and National Parks
USA Major Cities	Point	City Name and population

What cities were located by their longitude and latitude?
Pierre, South Dakota
Atlanta, Georgia
Phoenix, Arizona

Why are some of the numbers negative?
The numbers are negative because they are to the west of the Prime Meridian, which is expressed as negative numbers in the Cartesian map coordinate system.

Explain the meaning of the following words:

raster:	A data file that consists of a rectangular grid of pixels.
attribute:	Information appended in tabular format to spatial features.
georeferenced:	Something is associated with locations on Earth.
geocoding:	The computational process of transforming a postal address description to a location on Earth's surface (spatial representation in numerical coordinates).
accuracy:	The degree to which a measurement conforms to the true value.
resolution:	The measurement of an image where the values are seen as true.
vector:	A representation of the world using points, lines, and polygons.

Lesson 1-2: Mapping US Population Change 2000–2010

What is the first spatial component that you see?
Counties are the first spatial component seen.

What is the second spatial component that you see as you zoom in?
Census tracts are the second spatial component seen.

What does a census tract represent?
"Census tract," a concept established by the US Census Bureau to facilitate analyzing populations, refers to an area roughly equivalent to a neighborhood. In general, a census tract encompasses a population of anywhere between 2,500 and 8,000 people. Census tracts are described as "relatively permanent," but they change over time.

Examine the legend and write a description of the legend in your own words.
The US government takes a census count of the population every decade. Here, percent change is a measure (in percentages) of the difference in values between the population sizes of counties in 2010 compared with 2000. In the case, the difference between the numbers of people by county shows both increase (+) and decrease (-).

What formula was used to calculate the percent change in population from 2000 to 2010?
Percent change = (2010-2000)/2000 * 100.

Write a description of the spatial distribution of the US by county by population change from 2000 to 2010.
The Midwestern states show a decrease in population, while Florida, Arizona, Southern California, and southern Nevada show an increase in population.

Zoom in to your state and write a description of the spatial distribution of your state by population change from 2000 to 2010.
Answers will vary.

Zoom in to your county and write a description of the spatial distribution of the census tracts by population change in your county.
Answers will vary.

How could other state and county agencies use this information?
State and county agencies can and do use this information to predict where schools, fire departments, hospitals, and other public facilities should be built. Infrastructure is another area in which this data is useful for advanced planning.

Lesson 1-3: Analyzing Nepal earthquake epicenters

What does the legend show about the population?
The legend shows the population in a color gradation, with the darker shades indicating more people and the lighter indicating fewer. The most populated districts are on the southern edge of Nepal.

Where on the map are the earthquakes with a high magnitude in relationship to a district with a high population?
Most of the earthquakes are to the north of Nepal, and the population is heavier in the south.

What would make rescue efforts difficult in the northern districts?
The terrain is rough.

Lesson 1-5: Mapping US Population Change 2000–2015

Build and publish a web app

Write a description of the spatial distribution of the US by state population from 2000 to 2010.
The Northeast and Louisiana show a decline in population over the 2000 to 2010 time period. The western states, particularly Nevada, show a gain in population.

Lesson 1-6: Analyzing the opioid crisis in America

Symbolize data and calculate with Arcade

Write a paragraph comparing the data of opioid claims in 2014 with the opioid claims normalized (divided by the total claims) in 2014.
The opioid claims map in 2014 shows, as would be expected, the counties with the most population to have the most opioid claims. When the data is normalized, the spatial distribution is much more relevant because the data has been standardized by the total claims, which gives a percentage instead of a raw number.

Write a sentence about the spatial display (normalized) of the data. Which states have the most opioid claims? Which have the least?
There is a concentration of opioid claims in Nevada, California, and along the Gulf of Mexico.

Write a brief paragraph about the spatial display of the data within your state. Is there a pattern?
Answers will vary.

What are the advantages of using color symbolization? Size symbolization?
The color symbolization makes it easier to pick out patterns at a county level. The size symbolization makes it easier to interpret at the state level.

Which states have decreased in deaths?
Deaths have decreased in North Dakota, Nebraska, Maine, Vermont, Iowa, Arkansas, Mississippi, Hawaii, and Alaska.

Which states seem to have the most increase in deaths?
Deaths have increased in all the other states.

The ArcGIS Book, chapter 1

Questions for reading comprehension, reflection, and discussion

Thought leader: Jack Dangermond
GIS: Understanding The Science of Where
Write an explanation of The Science of Where. Include in your explanation thoughts on data integration and GIS as a platform.
GIS can provide a platform for integrating data about anything. This platform can understand, take action, and communicate on challenging issues for problem solving and decision making.

Enabling a smarter world

GIS provides a framework and process

List the different parts of the GIS framework with a brief explanation of each part.

The GIS framework consists of data management and integration, visualization and mapping, analysis and modeling, action, decision making, and finally planning and design.

Web GIS is collaborative

Geography is the key, the web is the platform

What is meant by geography is the key*?*

Geography is the organizing key; information in web GIS is sorted by location. Because all these layers share this common key, any theme of data can be overlaid and analyzed in relation to all other layers that share the same geographic space.

What does georeferenced *mean?*

Georeferencing data means associating it with a specific, physical place.

How has web GIS changed and expanded our use of georeferenced data?

Web GIS means that suddenly you have much more than just your and your colleagues' data layers available to you. Web GIS puts nearly everything that anyone has ever published and shared about any particular geographic area within your reach. Web GIS exponentially expands the potential of your data visualization and analysis capabilities.

How GIS works and ArcGIS information items

The science of geography

Layers

List five different types of layers that can be represented on a map.

Buildings, demographic data, satellite imagery, vegetation health, and trees are all layers that can be represented on a map.

What is the difference between a map and a scene?

A web map consists of a basemap and a set of data layers presented as a two-dimensional map. A scene combines basemap layers with operational overlays but displays them in the third dimension or in the z axis.

Investigate the maps. Pick one map and write about the information it portrays.

Answers will vary.

Investigate the scenes. Pick one scene and write about the information it portrays.

Answers will vary.

Geospatial analysis yields insights

Explain geospatial analysis.

Geospatial analysis is applying analytical techniques to data that has a geographic or spatial component.

Apps extend the reach of GIS

What is an app and what is its purpose?

An app is an interface that gives a user experience for putting a map to use.

Unit 2: Mapping Is for Everyone

New ways to make, see, and use maps

Activity 2-1: Scale and resolution

Mastering the difference between them

Where is the scale shown on the map?
The map scale is shown in the lower left corner of the map.

Are there different zoom restrictions?
Yes. Some zoom to 4 ft. and others to 6 ft.
Are the images clear at the last zoom?
When zoomed to the full extent, visibility is not clear.

In one or two sentences summarize what the resolution is after reading this description.
The resolution of the imagery depends on the satellite or aerial imagery provider, and the resolution refers to the number of pixels in an image. The resolution is calculated by the width and the height of a pixel and the total number of pixels the image contains.

Verbalize to a small group the difference between scale and resolution. Feel free to use the maps as visualizations.

Activity 2-2: Predominant Mapping

US county crops 2007

What is dominant in the Midwest and why?
Corn, wheat, and soybean are dominant in the Midwest.

Why does the West Coast have a majority of vegetable production?
The climate of the West Coast of California is conducive to vegetable production.

List the advantages and disadvantages of the two predominant category styles.
Predominant category maps by color can show predominance and strength. Predominant category by size and color can show predominance, sum, and strength.

List the three variables displayed in predominant category and size maps.
The three variables that are shown are as follows:

- Color shows the predominant category.
- Size shows the sum of the categories.
- Transparency shows the relative strength of the predominance.

Lesson 2-2: Displaying crime data with heat maps

Washington, DC, July 2016

How many total crimes are there?
There are 3,429 crimes.

How many wards?
There are eight wards.

Write a description of where the crime is concentrated.
The crime is concentrated in the center with a streak going straight north.

Does the heat map change as you zoom in and out?
Yes, the heat map is multiscale, which allows it to change as you zoom in and out.

Why is a heat map effective to display this crime data?
Heat maps are effective to display crime because they are multiscale and can show concentrations at different scale levels.

How many crime incidents are theft auto?
1,002 crimes are theft auto.

Where would you direct your personnel to crack down on auto theft?
Personnel needs to be assigned to the locations where auto theft is most concentrated as shown by the map.

How many crime incidents are burglary?
109 crimes are burglary.

Where would you direct your personnel to crack down on burglary?
There is some concentration of burglaries in the middle of the city; however, it is dispersed throughout the city except in the northern tip.

How many auto thefts are there in ward 8?
There are 70 auto thefts in ward 8.

Where is the auto theft most concentrated in ward 8?
There are concentrations around Washington Highlands and Douglas Dwellings; however, the thefts are also widely dispersed.

How many burglaries are there in ward 8?
There are 23 burglaries in ward 8.

Where are burglaries most concentrated in ward 8?
The burglaries do not have a discernable pattern.

Lesson 2-3: Educational levels in the USA

A closer look

What states have the highest percentages of students with no degree?
Texas, Kentucky, Louisiana, Mississippi, and Alabama have a high percentage of students with no degree.

Do you see any regional trends?
The southern part of the US seems to have the highest percentage of students with no degree.

What is represented along the Mississippi River from Minnesota to Mississippi?
There is a band of students with no degree along the southern part of the Mississippi River.

Explain the spatial distribution in Texas.
There is a concentration of students with no degrees on the border between Texas and Mexico.

What is the spatial distribution of counties with the highest percentage of college degrees? Of lowest?
Vermont, New Hampshire, Connecticut, Massachusetts, New Jersey, Maryland, and Colorado all have high concentrations of college degrees.

Do you see any regional trends?
The Northeast has a high concentration of college degrees and also western Montana and Colorado.

What states have more than two counties with above 50 percent college degrees? Hint: you might want to show the table.
Virginia and Colorado have two or more counties with 50 percent college degrees.

What states have the greatest number of counties with 20 percent with no degrees?
Texas, Georgia, and Mississippi all have a large number of counties with 20 percent with no degrees.

Is there a regional trend?
The states that have more counties with more than 20 percent without degrees are in the South and Southern California.

Describe the spatial distribution of academic achievement within your state.
Answers will vary.

The ArcGIS Book, chapter 2

Questions for reading comprehension, reflection, and discussion

Online mapping is transforming GIs

What are three advantages of online maps over traditional printed maps?
Online maps can be created by anyone, updated, and shared on any mobile device.

Basemaps and operational layers

What is the difference between a basemap and an operational layer?
A basemap is a map that provides a background or a geographic palette to display your map. Esri provides several basemaps, each with a different focus. An operational layer consists of the user's own subject matter that will be overlaid on the basemap.

Web map properties

Besides being scalable and fluid, name two other advantages of online maps.
Online maps can be continuously updated and simple pop-ups can be added to contain a wealth of information.

Learning to smart map

What does smart mapping give to the online user?
Smart mapping is designed to quickly suggest pleasing and effective cartography based on the data being used.

Map design 101

Drawing your audience into the story you're telling

What makes looking at maps a rewarding experience?
Maps that are interactive and reward the user with information are great maps.

Maps into the third and fourth dimensions

What are the third and fourth dimensions?
The third dimension is vertical or 3D and the fourth dimension is temporal or time.

Unit 3: Tell Your Story Using a Map

Inform, engage, and inspire people with story maps

The ArcGIS Book, chapter 3

Questions for reading comprehension, reflection, and discussion

Story maps: The fusion of maps and stories come to life

List components that can be incorporated into a story map.

Interactive maps, text, photos, video, and audio

[Story maps] "use the tools of GIS, and often present the results of spatial analysis, but don't require their users to have any special knowledge or skills in GIS." Identify two maps from the Story Maps Gallery *that illustrate this idea.*

Answers will vary.

Maps tell stories. What kinds of stories can you tell?

This section identifies eight kinds of stories that might be told with a story map. List and describe two more possibilities for this format.

Answers will vary.

Thought leader: Allen Carroll: Why maps are so interesting

Maps organize information spatially. What does this mean?

Maps arrange information according to its location by latitude/longitude coordinates, zip code, street address, etc. This enables us to see patterns and relationships and provides context for our explorations.

What kind of story do you want to tell?

Based on your own interests and knowledge, briefly describe two or more "stories" you'd like to tell with a story map.

Answers will vary.

QuickStart: Things to consider when creating a story map

Planning is very important when creating a story map. Pick one of the stories you just indicated you would like to tell with a story map and develop a plan for creating it by briefly writing the answers to the following questions:

- *What is your purpose and goal in telling the story and who is your audience?*
- *Go to the Story Maps Gallery* and identify two or more story maps whose subject matter is similar to the story you'd like to tell.

Browse story map templates on the Story Maps Apps and identify the one that seems best for your story map project.

Answers will vary.

Unitv 4: Great Maps Need Great Data

The Living Atlas of the World provides the foundation

Lesson 4-1: Exploring and creating basemaps

Introduction to more, better, and unique basemaps

Create a custom historical, ocean, and emergency map.

Maps will vary.

Lesson 4-2: Deriving accessibility

Can you stroll to the farmers' market?

Write a brief description of the map's content.

The map has four layers: a topographic basemap, state and county political boundaries, and point data for farmers' market locations.

Are the drive-time areas different when live traffic feed is added?

The drive-times are the most different if you use the traveling to and from work during rush hours.

How does this live traffic feed help you make decisions about market accessibility?

If you were going to the market during rush hour, it would take longer.

Lesson 4-3: Helping restore a watershed

Chesapeake Bay states land-use enrichment

Write several spatial observations about the Chesapeake Bay watershed. Include in your observations a discussion of political vs natural boundaries. The observations that are written here will be used later in the exercise when you construct your story map.

In this map, you see that political boundaries represent the boundaries of the states and a natural boundary that represents a physical boundary, in this case, the Chesapeake Bay Watershed. The bay's watershed is irregularly shaped; the northern part of the watershed is narrower than the southern part. The bay's watershed includes parts of seven states, with Virginia and Pennsylvania having the most land area and Maryland and Virginia having the most coastline.

The ArcGIS Book, chapter 4

Questions for reading comprehension, reflection, and discussion

The Living Atlas: The ArcGIS platform provides rich content

How have open data repositories such as the Living Atlas changed the way GIS users plan and implement projects?

By providing ready-made basemaps and authenticated data, GIS users can spend less time assembling the components for their projects and more time performing analysis, answering questions, and solving real-world problems.

The ArcGIS data community: A global network for creating and sharing authoritative geographic information resources

The work of organizations that make up the global GIS community has changed with the emergence of web GIS. Explain how this GIS work has changed.

During the early days of GIS, the compilation of relevant data layers was one of the primary tasks of each organization. Today, this data is increasingly available to everyone via the web, providing these organizations with access to a continuous coverage of geographic information worldwide.

What kind of data is available? Definitive, authoritative basemaps

There are several key concepts to understand about basemaps; they are multiscale, provide global coverage, and are continuous. In your own words, briefly define each of these concepts:

multiscale: The amount that detail changes as you zoom in or out.
global coverage: Refers to maps that cover the entire surface of Earth.
continuous: These basemaps seamlessly wrap around Earth.

Demographics

Explain the concept of data enrichment.

Data enrichment is the ability to add to your map relevant demographic data to the problem or issue under investigation.

Opening data to the world of possibilities

What are open data sites and what benefits do they provide?

Citizens can directly access thousands of open government datasets, which they can search, download, filter, and visualize through their web browsers or mobile devices.
These open data sites enhance government transparency and foster collaboration among community groups.

Imagery

In your own words, briefly compare these types of imagery: photographic, satellite, and multispectral.

photographic: Aerial photography and videos taken from airplanes and, increasingly, drones.
satellite: Imagery created from data collected by Landsat satellites.
multispectral: Imagery created by combining visible and invisible light collected remotely by satellites or planes.

Landscapes: Landscape analysis layers

What are ELUs?

Ecological land units (ELUs) are areas of distinct bioclimates, landforms, lithology, and land cover that form the basic components of terrestrial ecosystem structure.

Thought leader: Richard Saul Wurman

A map is a pattern made understandable

In your own words, explain what the phrase "understanding precedes action" means to you.
Explore the Urban Observatory and explain how it reflects the concept that "understanding precedes action."

Answers will vary.

Exploring and analyzing relevant data are essential before you attempt to address a problem or issue.

Unit 5: The Power of Where

How spatial analysis leads to insight

Activity

Discover your local green infrastructure assets using the Green Infrastructure app.

Complete this table:

Place/State	% Intact Habitat Core Area	Roads vs Streams (more roads than streams)	National Average (more roads than streams)
Phoenix, AZ	89%	8.4	5.5
Richmond, VA	49%	7.0	5.5
Albany, NY	53%	5.4	5.5
San Diego, CA	74%	7.0	5.5

Which of the designated states has the most intact core habitats? The least?
Arizona has the most intact core habitats and Virginia has the least.

Why do you think Arizona has 8.4 times more roads than streams?
There are relatively few streams in Arizona.

Compare two counties within your state.
Answers will vary.

Write a description for the distribution of land in your state. What is the dominant land cover: Agriculture? Urban? Forest?
Answers will vary.

What are the dimensions of a core habitat area?
A core habitat area should be at least 200 acres and at least 200 meters wide.

What are other parameters to consider when defining core habitats?
A core with larger volume and smaller perimeter is better than one that is long and skinny.
Cores with water bodies, perennial streams and rivers, and wetlands are considered better than those without.

Write a paragraph or give an oral report about reasons that the core habitat area that you picked is appropriate.
Answers will vary.

Lesson 5-3: Creating thematic maps with hexagons

Analyze Toxic Release Inventory

Analyze health insurance

Which states seem to have the highest concentrations of TRI sites?
Texas, Ohio, Indiana, and Pennsylvania have high concentrations of TRI sites.

What layers could you add to enhance your observations?
Adding urban areas and rivers would enhance observations.

What parts of South Carolina have the largest percentage of people with insurance?
Along the coast and around Columbia are areas with the largest percentage of people with insurance.

Lesson 5-4: Introducing ArcGIS Arcade expressions

Calculate percentage unemployment

Show population increase and decrease 2010–2017

What attributes are available to use?
Total population in 2017, 2010, and the number of unemployed in 2017 are the attributes available.

Is there a spatial pattern of unemployment?
Unemployment is higher in the South, particularly along the Mississippi delta, and the Southwest. Unemployment is low in the western states of North and South Dakota, Montana, and Oregon.

Do you see any correlation between the counties that have the highest percentage of unemployment and the counties that have lost population?
There is a high correlation between the location of the counties with high unemployment that have also lost population since 2017.

Lesson 5-5: Siting a new hospital in Loudoun County, VA

Use GIS to create new knowledge

Write a paragraph defending your site selection.
Answers will vary.

The ArcGIS Book, chapter 5

Questions for reading comprehension, reflection, and discussion

Geographic analysis

Write a paragraph explaining this statement: GIS is more than a map.

The first step of any spatial problem is to put the data on a map; however, maps are more than locational information. They are the production and storage of analytical spatial information. This spatial information allows the user to solve problems using a particular suite of geospatial tools.

Give at least three examples where spatial analysis tools have been used to solve problems.
Spatial analysis tools have been used to determine relationships of storm events, detect patterns of crime, and find best locations and paths for public transportation.

Visualization
What can my map show me?
Visualization shows the area you're investigating and the data affected.

Insights
Real-time exploration and analysis of maps and data
What is Insights for ArcGIS workflow?
ArcGIS Insights is a browser-based analytic workbench that enables you to interactively explore and analyze data from many sources.

Modeling
Using the language of spatial analysis
What is a typical modeling sequence?
Data is input and undergoes geoprocessing and is output as a result.

Spatial problem solving
A conceptual framework
What are the steps of spatial problem solving?
The steps of spatial problem solving are as follows:
- Ask and explore.
- Model and compute.
- Examine and interpret.
- Make decisions.
- Share results.

Thought leader: Linda Beale
The challenge is making complex data understandable
Explain the specific role GIS plays in health analysis.
Health outcomes are spatial and characterized by human and physical geographies. GIS offers the technology to explore, manipulate, and analyze data from multiple sources. The ability of doctors, researchers, and the public to access multiscale interactive web maps during a time of crisis makes GIS so useful and valuable in these situations.

Unit 6: Mapping the Third Dimension

A change in perspective

Activity

Vocabulary match game

E___1. 2D map
D___2. 3D crime visualization
F___3. local scene
C___4. photorealistic
B___5. fixed symbols
A___6. global scene

A. Map 1
B. Map 2
C. Map 3
D. Map 4
E. Map 6
F. Map 7

Lesson 6-1: Understanding current events in 3D

Use a virtual globe to broadcast the news

Why is it dangerous to go through Greece without going through Turkey?
If the refugees don't go through Greece, they have to go through the Mediterranean Sea.

What routes either by land or water would the refugees have to take to get to Germany? Name the countries and water bodies.
To get to Germany, the refugees have to go either through the Mediterranean or the Black Sea and Romania, Bulgaria, Hungary, Austria, and Czech Republic.

Hungary and Austria have shown signs of resistance to the refugees and are closing or threatening to close their borders. How would this affect the routes the refugees would have to take?
That would make the distance the refugees have to travel much greater.

When Hurricane Irma made landfall at Cudjoe Key, what was the hurricane strength? Category and sustained winds?
Category 4 hurricane with sustained winds of 130 mph.

What towns are close to Cudjoe Key?
Marathon and Key West

Why is Cudjoe Key particularly vulnerable?
Cudjoe Key is surrounded by water, as is every other part of the Florida Keys.

Is this emergency weather related? How?
Major El Niño storms and high tides have caused the erosion of the cliff.

Will the residents get any financial relief?
The apartment building has been condemned and demolished and both the state and federal governments will help with financial relief for the residents.

Lesson 6-5: Teaching world time zones

Chart the hour for online students

Describe the standard time zones.
There are 24 time zones, each 15 degrees of longitude wide. The same clock time is kept within each zone.

Why do some of the standard time zones have irregular boundaries on land?
There are irregular boundaries on land to avoid having a time change at an inconvenient location.

Explain the need for an International Date Line.
The International Date Line identifies where the date changes for travelers.

How many time zones are in the continental US?
There are four times zones in the continental US: Eastern, Central, Mountain, and Pacific.

What cities are represented?
The cities are London, Paris, Denver, Minneapolis, Rio de Janeiro, and Tokyo.
Use the constructed Scene to complete this chart:

Start City	Day/Time	Travel Direction	End City	Day/Time	# Time Zones Crossed
London	Mon 11 AM	West	Denver	Mon 4 AM	7
London	Mon 11 AM	East	Denver	Mon 4 PM	17
Paris	Wed 1 AM	West	Minneapolis	Tues 6 PM	6
Paris	Wed 1 AM	East	Minneapolis	Tues 6 PM	18
Rio de Janeiro	Friday 10 PM	West	Tokyo	Sat 10 AM	12
Rio de Janeiro	Friday 10 PM	East	Tokyo	Sat 10 AM	12

The ArcGIS Book, chapter 6

Questions for reading comprehension, reflection, and discussion

The evolution of 3D mapping

Advantages of 3D

What advantage does vertical information give?
Maps that contain vertical information can show hill shading, contours, and volumetric information.

What is human-style navigation?
When data is presented in 3D, the viewer intuitively understands the size and relative positions of objects.

Important 3D terminology:
Getting the z-terminology straight
Explain these terms (including the difference between them where appropriate):
maps and scenes: Exemplified 2D or 3D views.
local and global: This represents two different scene environments: Global scenes extend across large distances, and local scenes have a fixed study area.
surfaces: All surface data includes an x,y, and x value for any point on it.
real size and screen size: There is value in having some symbols remain the same, both in the scene and on screen.

Representing the world in 3D
Define photorealistic.
A photorealistic view recreates reality by using textures.

What makes 3D cartography powerful?
3D cartography takes 2D thematic mapping techniques and moves them into 3D.

What two factors are involved to create a feeling of virtual reality?
A 3D view feels like virtual reality when photorealistic and thematic techniques are used in combination.

What makes a great scene?
What is meant by implying a 3D scene is designed to be immersive?
A 3D view allows people to see space in 3D. A 3D view is immersive because it invites people to imagine themselves within the scene.

What are the three choices of styling 3D content?
Fully photorealistic, fully thematic, and a combination of photorealistic and thematic.

List two ways to illustrate thematic views.
Thematic 3D views use common 2D cartographic techniques such as classifications. Authors of 3D scenes also create thematic, simplified representations to more effectively convey information.

Thought leader: Nathan Shephard
The rise of the 3D cartographic scene
What does Nathan discuss?
Nathan talks about the benefits of communicating spatial data in 3D and the fact that cartographers are no longer limited to two dimensions.

Who uses 3D cartography? Go to ArcGIS Web Scenes Gallery and investigate three of the maps.
Answers will vary.

Unit 7: The Power of Apps

Focused tools that get the work done

Activity

What is marketplace?
The ArcGIS Marketplace is a destination that allows ArcGIS Online organizations to search, discover, and get apps, data, and additional capabilities from qualified providers (Esri Business Partners, Esri Distributors, Esri Startups, and Esri) for use within their organization.

Who can use the apps?
ArcGIS organizational members can use the marketplace.

Select two apps and explain why you would want to use them. Download them to your mobile device and enjoy.
Answers will vary.

Lesson 7-2: Assessing risk of inundation

Use STORMTOOLS

Consider the answers to each of these questions as you compare Properties A, B, and C:
How will potential levels of future sea level rise affect the property?
Answers will vary.

Is the property vulnerable to storm surge during a 100-year coastal storm (for example, 1938 hurricane)?
Answers will vary.

How deep will the water be during a 100-year coastal storm on the property?
Answers will vary.

How will the property's vulnerability to 100-year coastal storms change by 2050?
Answers will vary.

Based on your analysis with the STORMTOOLS data, identify the property that seems to be the least vulnerable to flooding from sea level rise and/or storm events and which one seems the most vulnerable. Which one would you like to purchase? Why?
Answers will vary.

Lesson 7-3: Exhibiting changes over time

Use the USGS Historical Topographic Map Explorer app

Explore and compare the maps to identify ones that tell the clearest story of changes around the Lanier Middle School from 1915 to the present. Note that you can download any of these maps as a geopdf. The download link is next to the map thumbnail in the table of contents.

Answers will vary.78

The ArcGIS Book, chapter 7

Questions for reading comprehension, reflection, and discussion

The rise of spatially intelligent apps

What is an app?

Apps are lightweight computer programs designed to run on the web, smartphones, tables, and other mobile devices

How is a GIS app unique?

GIS apps are a special breed because they're map centric and spatially aware.

Where do apps come from?

Apps take ArcGIS where you go and where GIS users go.

List some ways to solve a problem with an app.

Telling a story.
Engaging with people.
Taking GIS into the field.
Collecting high-resolution, up-to-the-minute aerial photographs.

Thought leader: Jeff Shaner

On the scene at the Deepwater Horizon oil spill

How did the use of mobile GIS influence the Deepwater Horizon emergency response?

The responders began to share maps, data, videos, and photos, enabling responders to better coordinate with emergency command centers and ensure high levels of situational awareness.

Case study: US Geological Survey

In 2009, the US Geological Survey began the release of a new generation of topographic maps in electronic form and in 2001 complemented them with the release of high-resolution scans of historical topographic maps of the US dating back to 1882. View these using the USGS Historical Topographic Map Explorer. Use the app to do the following:

Find the area you want to explore.
Use the timeline to select the maps.
Compare the maps.
Answers will vary.

List three of Esri's ArcGIS ready-made apps.
Collector
Survey123
Explorer

Unit 8: Imagery Is Visible Intelligence

A geographic Rosetta stone

Activity

Understanding the Landsat program

What is Landsat and when did it begin?

The Landsat program is a series of Earth-observing satellite missions jointly managed by NASA and the US Geological Survey.

What are the orbit paths of the Landsat satellites?

The Landsat 8 and Landsat 7 satellites both maintain a near-polar, sun-synchronous orbit, following the World Reference System. They each make an orbit in about 99 minutes, complete more than 14 orbits per day, and provide complete coverage of Earth every 16 days.

What is the resolution of the spectral bands?

The spectral bands have a resolution of 30 meters.

What is the resolution of the thermal bands?

The thermal bands have a resolution of 60 meters.

What is the difference between the spectral band and the thermal band?

The spectral bands measure reflected light and the thermal bands measure emitted heat.

Lesson 8-1: Using global imagery basemaps

Something for everyone

What objects can be seen at the following resolutions?

Low Resolution 15 meters

Major roads and buildings can be seen at this resolution.

High Resolution 60 cm

You can identify individual buildings.

High Resolution 30 cm

You can count cars in parking lots and parking spaces.

On your own, locate the places in the following table and record the image detail:

Location	Provider	Resolution	Accuracy
O'ahu, Hawaii	Digital Globe	0.31 meters	4.2 meters of true location
Shanghai, China	Digital Globe	0.31 meters	10.2 meters of true location
Oslo, Norway	Digital Globe	0.5 meters	4.2 meters of true location
Abu Dhabi, ARE	Digital Globe	0.5 meters	4.2 meters of true location
Washington, DC	esri	0.08 meters	0.3 meters of true location

Lesson 8-2: Assessing landscape layers in the Living Atlas of the World

A collection of global geographic information

How many drilling platforms are below 1500?
There are 50 drilling platforms in water depth below 1500.

Lesson 8-3: Monitoring fracking in Denton, TX

Use panchromatic Landsat

What is the date of the image that is being viewed?
Answers will vary.

What do you observe about the quantity of fracking wells?
There are many more in 2017 and 2001.

What area within Denton city limits appears to have added the most fracking wells?
The southwestern corner of Denton appears to have added the most fracking wells.

Lesson 8-4: Visualizing La Tuna Canyon fire damage

One of Los Angeles's biggest wildfires in 2017

As you swipe back and forth, can you identify the burn scar?
The burn scar is easily recognized.

What is the burn/post-fire regrowth area?
Answers will vary.

What is the burn/post-fire regrowth area?
Answers will vary.

Lesson 8-5: Assessing Hurricane Maria damage

The browning of Puerto Rico

What are your observations about the before and after Maria images?
The image is much browner, indicating much less vegetation. There is less vegetation because the leaves have been blown off the trees, and some of the trees have been uprooted.

The NDVI shows thick, vigorous vegetation as dark green and sparse vegetation as brown. Write a comparison of the two images.
There is much more dark green, indicating more vigorous vegetation in the before image than in the after image. The after image is much more brown, indicating sparse vegetation.

The color infrared band combination shows healthy vegetation as bright red, whereas stressed vegetation is dull red. Write a comparison of the two images.
The vegetation image shown in the after Maria image is much duller, indicating stressed vegetation.

The ArcGIS Book, chapter 8

Questions for reading comprehension, reflection, and discussion

Write briefly about the historical timeline of imagery. Specifically refer to the following milestones:

- *World War II: Reconnaissance and intelligence gathering*
- *Humans exploring the moon*
- *The Landsat program*
- *The human era of GIS*

During World War II, major advances in the use of imagery for intelligence were developed to identify precise locations. In July 1969, televised images transmitted to Earth from the moon showed that this transferring of imagery was a possibility. The Landsat program, which was began in 1972, has provided a constant observation of Earth for the past 40 years. The human era of GIS began with multiscale online images of the world provided by Google, Microsoft, and other companies.

How does imagery expand your perspective?
Imagery allows you to understand patterns, see beyond the visible, forecast and report weather, and see beyond the apparent by peering into the past.

Thought leader: Lawrie Jordan
ArcGIS now includes a complete image processing system.
What does Lawrie Jordan mean when he says "We like to say that the map of the future is an intelligent image"?
He means that if users can see it, they can understand it, and imagery provides that understanding.

List four applications of imagery.
Daily access to new information
A constant look back in time
Meaningful collections
Powerful analytic capabilities

Unit 9: Mapping the Internet of Things

Harnessing the World Wide Web of sensors

Activity

Aspects of a real-time GIS

Write a sentence explaining each of the following aspects of a real-time GIS:

Acquiring real-time data

An organization can visually represent the live status of its network with information captured by sensors in the field about factors such as storm effects, wind speed and direction, temperature, and current positions of police cars or ambulances.

Performing continuous processing

After displaying data in real time, next you want to perform an analysis, such as filtering or detecting patterns.

Communicating the results

Sharing where a storm is hitting and the location of a child who has been left on a school bus are examples of communicating results.

Lesson 9-1: Exploring real-time data sources

Examine at least three of the examples of real-time data sources and write a brief description.

Answers will vary.

Lesson 9-4: Visualizing 2016 presidential election data

Apply predominant mapping, Z-score

What does the map tell you about voting patterns in the 2016 presidential election?

There is a huge divide between rural and urban areas. The cities vote more Democratic and the rural areas vote more Republican.

What does the Z-Score legend represent?

The 1 means that 68 percent of the people voted Democratic.

Lesson 9-5: Clustering to extract information

Analyze 30 years of tornadoes

How many tornadoes are shown?

There are 56,155 tornadoes shown.

How many years of data do the tornadoes represent?
The years represented are 1950 to 2011 or 61 years.

The ArcGIS Book, chapter 9

Questions for reading comprehension, reflection, and discussion

How real is real time?
Real-time dashboards are used by local governments to monitor snowplows and trash trucks, by law enforcement to monitor crime, and by transportation to monitor the flow of traffic. Real-time data is as current as the data source that is updating it, whether that data is being updated every second, minute, hour, or daily. Real-time data is accessible from any source of data captured by sensors.

What are the components of a real-time dashboard?
Real-time dashboards are composed of a map with inserted widgets and can be shared with your organization.

What is the Internet of Things?
The Internet of Things is composed of autonomous vehicles, public safety services, utilities, and telecommunication infrastructure. Sensors are being implemented on our planet.

Unit 10: GIS Is about Community

Web GIS is the GIS of the world

Activity

Building smarter communities

Initiative	Data Collected	Analysis
Reduce Vector-borne Disease	Details, date, status, assignment	Heat map of traps
Reduce Homelessness	Veteran status, sheltered, medical needs, mental health needs, transportation needs, encampment details	Best location for a new shelter, able to provide food and services better
Reducing Opioid Addiction	Location of providers	Opioid death heat map

The ArcGIS Book, chapter 10

Questions for reading comprehension, reflection, and discussion

Identify some of the unique characteristics of the professional GIS community.

GIS is currently used in virtually every segment of society: government, industry, academia, conservation. It is one of the fastest-growing segments in the tech field of our economy. GIS professionals perform a vital role in addressing critical issues, such as access to resources, environmental collapse, and climate change. GIS professionals have a strong bond with local, state, and national networks.

What are some of the opportunities that an ArcGIS organizational account provides to its members and to the organization overall?

To create, organize, and share geographic information with appropriate groups.
To create maps for users and constituents outside the organization and share these online.
To share maps and information layers throughout the organization and beyond.
To organize content by creating and managing groups.

What are the core elements of geodesign as a planning methodology?

Planning is based on a community of collaborators who identify the following:

- Project objectives
- Special resources
- Opportunities for support

Constant feedback loops occur between local citizens and stakeholders (community engagement).

What do the three apps shown under social GIS and citizen science have in common?
All three apps shown under the banner Social GIS and crowdsourcing are interactive, allowing users to input information for an intended purpose. The first two collect information from the user, while the last one provides information to the user.

What does Clint Brown mean when he says GIS is collaborative?
GIS provides a kind of integration engine: As more and more layers of data are amassed and maintained, GIS provides the means for integrating them in countless ways. This global collection of information can be applied to the analysis of virtually any issue, including climate change, the spread of disease, and food production.

What does Lauren Bennett mean when she says spatial analysis is changing everything?
The use of spatial analysis is taking a central role in the way that organizations think about their data and make informed decisions.