PROJECT BASED LEARNING

How many people could Earth support now and 100 years from now?
PROJECT BASED LEARNING AND THE BIG HISTORY PROJECT

Using a Project Based Learning (PBL) approach, Big History Project students invent a species, ask how many people the Earth could support now and 100 years from now, and anticipate the next threshold of increasing complexity.

Why PBL & BHP?
The goals of the Big History Project include: inciting wonderment in students about the world they inhabit; encouraging them to consider what it means to be human; and instilling in them an interest in lifelong learning about the Universe. PBL embedded in BHP allows students to dive deeply and creatively for solutions to driving questions related to complex interdisciplinary issues. Combining PBL and BHP creates meaningful student-driven learning experiences.

What is Project Based Learning?
PBL is a method of instruction that has students take part in an extended inquiry around a complex question, problem, or challenge. For more information on the PBL method, please see the Buck Institute for Education (BIE) website at http://www.bie.org/. We recommend reading about the “Essential Elements” of PBL, as well as digging into a model PBL lesson from the “Project Search” source on the site’s Home page. You can also view videos of example projects and learn how PBL has been integrated into schools at http://www.bie.org/videos/cat/what_is_pbl.

What are the essential elements of PBL?1
• Focusing on significant content
• Developing 21st-century skills
• Engaging students in in-depth inquiry
• Organizing tasks around a driving question
• Establishing a desire to know
• Incorporating revision and reflection
• Including a public audience

What are the benefits of PBL for your students?
PBL allows for more student voice, choice, and agency than are seen in many curricula. Research has repeatedly shown that when students are given this autonomy, engagement and learning increase. In PBL, learning is made personally relevant when students are given license to be creative with the project outcome and drive their own progress toward that outcome.

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1 Adapted from the Buck Institute for Education.
Where are the projects in the BHP units?

- In Unit 5, LIFE, students respond to the prompt “Invent a species” by inventing a species that could adapt and evolve from the current tree of life.

- In Unit 7, AGRICULTURE & CIVILIZATION, students calculate and support their answer to the question “How many people could Earth support now and 100 years from now?” They also write narratives describing the conditions needed to support their calculations.

- In Unit 10, THE FUTURE, students predict and describe the next threshold of increasing complexity the world will cross.

What does it take to facilitate a BHP PBL project?

- Each project requires about two weeks (including in-class and out-of-class work time).

- You will need five to seven instructional days for the project. This includes kick off, project introduction and mini-activities, checkpoints, and a culmination day. However, if your students have difficulty meeting outside of class you’ll need to provide additional in-class work time.

- Students will need to spend an additional five to 15 hours outside of class to produce quality projects.

- Be prepared to:
  - Prioritize project-related homework for the duration of the project.
  - Devote extra class time for student group work.
  - Support students in learning project-management skills, such as planning, setting group norms and expectations, adhering to deadlines, and sharing work equally.
  - Invite family, community members, other teachers, and administrators to view the student projects and attend the culminating presentations.
TEACHER DIRECTIONS

Introduction

Project Question
How many people could Earth support now and 100 years from now? What conditions would be necessary to support those numbers?

Project Objective
Your students will work in pairs to determine, based on sound scientific evidence and reasoning, how many people Earth could support today and how many people Earth could support 100 years from today. Your students must also describe the conditions that would have to be present for Earth to support those numbers of people. In their projects, students must define what they mean by “support.”

Student Deliverables
A. An infographic
B. A narrative of each condition
C. A poster session presentation

Pacing
This is intended to be a unit that lasts approximately two weeks or 10 school days. However, the project provides a structure that is loose enough to be made shorter or longer. We do suggest a particular instructional sequence, which is outlined below. The instructional sequence gives ideas for facilitating the major checkpoints in the project. You can decide whether or not students are given in-class time to work between checkpoints.

Standards
Writing 9/10

• CCSS.ELA-Literacy.W.9-10.3 Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

• CCSS.ELA-Literacy.W.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

• CCSS.ELA-Literacy.W.9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
Speaking and listening 9/10

- CCSS.ELA-Literacy.SL.9-10.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9 – 10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

- CCSS.ELA-Literacy.SL.9-10.2 Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.

- CCSS.ELA-Literacy.SL.9-10.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

- CCSS.ELA-Literacy.SL.9-10.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

- CCSS.ELA-Literacy.SL.9-10.6 Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.
Instructional Sequence

I. PROJECT KICKOFF (DAY 1)

Advanced Preparation
- Prepare to show the following three videos to your class:
  - *After Earth* movie trailer: http://www.youtube.com/watch?v=CZIt20emgLY
- Print copies of the sample infographics.
- Post the question "What conditions contributed to the disasters depicted in these videos?"
- Form student working pairs or use another method to pair up students for the project.

Sequence
1. Tell students that you are beginning a project about people on Earth. Let them know that they’ll work in pairs. They’ll be tasked with the following: exploring a big question; producing multiple artifacts; guiding their own investigations; getting creative; and having fun.
2. To kick off, ask students to think about the conditions that contributed to the disasters that they’ll see in the videos. Play the *Pandemic* Spanish flu and tsunami videos for your students.
3. Have a five-minute class discussion reflecting on the conditions that supported these disasters.
4. For the next video, have students think about what conditions might be present in an *After Earth*-like setting (e.g., what would happen if humans left Earth and then returned 1,000 years later). Play the *After Earth* movie trailer.
5. Have a short class discussion about the conditions that led to the world that Will Smith’s character finds.
6. Ask students to get into their pairs for the project.
7. Introduce the project’s driving question: How many people could Earth support now and 100 years from now? What conditions would be necessary to support those numbers?
8. In pairs, have students spend the rest of class brainstorming ideas about the project question.
9. Stop class five minutes before the end for students to share their initial ideas about the numbers of people Earth could support now and 100 years from now.
II. GROUP FORMATION AND PROJECT DIRECTIONS (DAY 2)

Advanced Preparation
- A copy of the How Many People Group Directions document for each student.
- Copies of each rubric:
  - Infographic Score Sheet
  - Writing Rubric
  - Collaboration Rubric
- Copies of the sample infographics.
- Decide on checkpoint due dates as well as final presentation date.
- We highly recommend inviting family members, friends, or other classes to the final presentations. If you have contacts with experts in any of these fields you might also invite them to the final presentations to act as “judges.”

Sequence
1. Before students get started on the project, have them think about the videos they watched in the previous class. Split the class into six groups. Give two groups the Life Cycles of Stars infographic; give two groups the Tree of Life infographic; and give two groups the Agriculture & Civilization infographic.
2. Ask groups to inspect the infographics and to be ready to explain how the infographics address the following components:
   a. Topic: The topic of the infographic is specific in nature and is intended to inform or convince the viewer.
   b. Type: The type of infographic chosen (e.g., timeline or informational) highly supports the content being presented.
   c. Objects: The objects included in the infographic are relevant and support the topic of the infographic.
   d. Data visualizations: The data visualizations present accurate data and are easy to understand.
   e. Style: Fonts, colors, and organization are aesthetically pleasing, appropriate to the content, and enhance the viewer’s understanding of the information in the infographic.
   f. Citations: Full bibliographic citations for all sources used are included.
3. Assign each group three of the above criteria that they will briefly present to the class. Each group will then present those criteria in the context of explaining their infographic to the class.
4. Tell students that they’ll be making infographics as part of the project and need to be familiar with the criteria. Remind them of the project question and hand out the How Many People Group Directions document.
5. Walk students through the handout. Give due dates and describe the project (have the Group Directions in hand to read from if needed). Inform students that each member of the pair will receive the same grade for the infographic and poster session, and each individual will also receive points for his/her narrative and collaboration (see: Collaboration Rubric).

6. Ask students if they have any questions about the project.

7. Use the rest of the class time for students to work and plan in pairs. Remind students that Checkpoint 1: Draft Number Calculations will occur in about two days.

III. CHECKPOINT 1: DRAFT NUMBER CALCULATIONS (~DAY 4)

Advanced Preparation
- Make sure your class is aware of your checkpoint dates, especially if they’ve been moved for any reason.

Sequence
1. On checkpoint days, remind students that the objective is to ensure that they are on track and making progress. Allow students to work on their projects as you check in with each group.

2. Make sure to check in with all groups to field questions, gauge progress, and provide guidance and feedback as needed.
   • If students have completed Checkpoint 1: Draft Number Calculations, sign off on one of their Group Directions documents.
   • Consider having students ask another group to evaluate their draft calculations before you evaluate and approve their calculations yourself.

3. Remind students that Checkpoint 2: Draft Infographic, will occur in about two days. The draft infographic should include both numbers (for now and 100 years from now); the conditions needed to support those numbers; and evidence for why those numbers make sense.

IV. CHECKPOINT 2: DRAFT INFOGRAPHIC (~DAY 6)

Advanced Preparation
- Make sure class is aware of your checkpoint dates, especially if they’ve been moved for any reason.

- A copy of the Infographic Score Sheet for each pair.

Sequence
1. This should be a working class period but remind students that they should have a draft infographic complete and ready to be approved.

2. As students are working, make sure to check in with each pair, walk through the Infographic Score Sheet with them to discuss their draft, and sign off on their draft or suggest revisions before signing off. The draft infographic should include both numbers (for now and 100 years from now); the conditions needed to support those numbers; and evidence for why those numbers make sense.
• Consider having students ask another group to evaluate their draft infographic before you evaluate and approve their infographic yourself.

3. Remind students that their next checkpoint will be a complete draft of both narratives for peer review in about two days.

V. CHECKPOINT 3: DRAFT OF EACH NARRATIVE (~DAY 8)

Advanced Preparation
- Make copies of the Narrative Writing Rubric and the Feedback Table for each student.
- Review the Sample Peer-Review Processes document and decide how you will facilitate peer review.

Sequence
1. Make sure students have two copies of the narrative draft to share during peer review.
2. Remind students of the importance and process of peer review: to respectfully give and gain feedback and constructive criticism on their project from other students. Students will use the Narrative Writing Rubric to evaluate another person’s draft narrative, and the Feedback Table to give written feedback, and then discuss. Remind students that if they don’t take peer review seriously, it will negatively impact their individual grades.
3. After the peer-review process, have the reviewer sign off on the writer’s checkpoint.
4. Remind students to revise their narratives following peer review and remind them that their infographics and elevator pitches must be ready to present.

VI. PRESENTATIONS

Advanced Preparation
- Make two or three copies of the Infographic Score Sheet for each student.
- Make copies of the Collaboration Rubric for each student.
- Make copies of the Infographic Score Sheet (one for each group) for your teacher scoring.
- Predetermine the order of elevator pitches.
- Optional: Have a video camera or regular camera to document student presentations.

Sequence
1. Facilitate elevator pitch presentations according to class norms. Students should get no more than two minutes per pair — set a timer.
2. Make a rule in which each person has to evaluate two or three infographics and complete the Presentation Rubric. Everyone must also ask the presenting pair a thoughtful question during the poster session and document that question on the back of the Presentation Rubric.
3. Have half of the class (one person per pair) spend 10 minutes visiting and evaluating the other infographics, while the other half (the second person of each pair) stays and explains the infographic. Then have them switch.
4. Have students complete the Collaboration Rubric.
• The Collaboration Rubric is for gauging individual participation in and contribution to the group project work. This helps avoid negative group dynamics and reduces the possibility of unbalanced participation.

• On the Collaboration Rubric, each student evaluates him/herself and his/her group member.

• Use this rubric to adjust individual grades for the project.

• Stress to students that although they are given a project grade, this grade can be impacted by individual participation within the group.
PBL: HOW MANY PEOPLE COULD EARTH SUPPORT NOW AND 100 YEARS FROM NOW?

Group directions

Group Name

Group Members

Project Question
How many people could Earth support now and in 100 years? What conditions would be necessary to support those numbers?

Task
In pairs, you and your partner must determine, based on sound scientific evidence and reasoning, how many people Earth could support today and how many people Earth could support 100 years from today. To complete this project, you must accomplish the following: Describe the conditions that have to be present for Earth to support those numbers of people; define what is meant by “support”; consider how current trends in the following categories are important (see Resources for helpful links):

- Water availability
- Human lifespan
- Food, agriculture, and land use
- Education
- War and conflict
- Disease and medicine
- Natural disaster
- Social structures, family, and lifestyle

Final deliverables are due on: ____________________

Deliverables
A. Infographic
B. Narrative of each condition
C. Structured poster session presentation
A. Infographic
The infographic will demonstrate your assertions about how many people Earth can support now and will be able to support 100 years from now. It will also display data and data visualizations that provide evidence for your assertions. Your infographic must describe the conditions that have to be present for Earth to support those numbers of people now and 100 years from now. It must also define what is mean by “support.” In addition, your infographic will include attention to the following:

- **Topic:** The topic of the infographic is specific in nature and is intended to inform or convince the viewer.
- **Type:** The type of infographic chosen (for example, timeline or informational) highly supports the content being presented.
- **Objects:** The objects included in the infographic are relevant and support the topic of the infographic.
- **Data visualizations:** The data visualizations present accurate data and are easy to understand.
- **Style:** Fonts, colors, and organization are aesthetically pleasing and appropriate to the content, and enhance the viewer’s understanding of the information in the infographic.
- **Citations:** Full bibliographic citations for all sources used are included.

B. Narrative of each condition
Each student in your pair will be responsible for writing a narrative that describes the conditions required for Earth to support your calculated numbers of people. One student will write the narrative for now and one student will write the narrative for 100 years from now. Draw from your infographic and collaborate on ideas for each narrative. Your narrative should include the following elements:

- **Exposition and development:** The text sets up a story by introducing the event or conflict, characters, and setting. The story is developed using pacing, description, and reflection.
- **Organization and cohesion:** The text follows a logical sequence of events.
- **Style and conventions:** The text uses sensory language and details to create a vivid picture of the events, setting, and characters.
- **Conclusion:** The text provides a conclusion that follows from the course of the narrative. The conclusion provides a reflection on or resolution of the events.

C. Structured poster session presentation and “elevator pitch”
You will present your infographic as part of a structured poster session. A structured poster session is a particular presentation format that starts with participants giving an “elevator pitch” about their work. An elevator pitch is a quick and concise summary of your work that you could deliver over the course of an elevator ride (that is, 30 seconds to two minutes). This pitch will include:

- **Numbers:** Your final calculations of how many people Earth can support now and will be able to support 100 years from now.
• **Definition:** A statement describing what is meant by “support.”

• **Summary:** An explanation of how you calculated those numbers and the necessary conditions for them to be logically supported.

• **Insights:** Two major insights that came from this work. For example, insights might be interesting and surprising things you learned, reflections on your place or impact on Earth now and in the future, or a way your thinking or behavior has changed as a result of the project.

Following elevator pitches from all pairs in your class, your teacher will allow for time for both you and your partner to discuss your infographic with others in the poster session. You will also have time to explore other students’ posters. In addition, if your teacher has invited guests, they will be able to explore the infographics as well.

**Timeline and Checkpoints**
As a pair, use the template below to plan how you’ll complete all the deliverables by each due date. Your teacher will sign off on each checkpoint. Successful completion of each checkpoint will be factored into your final grade. You and your partner will receive the same grade for the infographic and poster session. Each individual will also receive points for his/her narrative.

1. Draft number calculations — now and in 100 years (show your work) Date due: ________
2. Draft infographic, including numbers, conditions, and evidence Date due: ________
3. A draft of each narrative Date due: ________

**Resources**
Remember to use claim testers (logic, evidence, authority, intuition) to validate each source.

**Data (these examples will help you ask your own questions to get data to support your work)**
1. Food Consumption Patterns — Wolfram Alpha

2. Health Indicators — Wolfram Alpha

3. More Heath Indicator Examples — Wolfram Alpha
   [http://www.wolframalpha.com/input/?i=health+indicator+examples](http://www.wolframalpha.com/input/?i=health+indicator+examples)

4. Education Statistics — Wolfram Alpha

5. Population Data — Wolfram Alpha

6. Energy Examples — Wolfram Alpha
   [http://www.wolframalpha.com/input/?i=energy+examples](http://www.wolframalpha.com/input/?i=energy+examples)

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2 You may draw from any Big History Project resources, the resources provided here, or any resources that you find in your own research.
7. Climate Examples — Wolfram Alpha
   http://www.wolframalpha.com/examples/Climate.html

8. Socioeconomic Data Examples — Wolfram Alpha
   http://www.wolframalpha.com/examples/SocioeconomicData.html

Books
1. *The View From Lazy Point: A Natural Year in an Unnatural World*, by Carl Safina

Articles
   http://www.huffingtonpost.com/carl-safina/population-growth_b_1499281.html
2. “How Many People Can Earth Support?”
3. “Freshwater Crisis”
4. “When Will Earth Run Out of Food?”
5. “How Are Humans Going to Become Extinct?”
   http://www.bbc.co.uk/news/business-22002530

Videos
1. “Paul Gilding: The Earth Is Full”
   http://www.ted.com/talks/paul_gilding_the_earth_is_full.html
2. “Yann Arthus-Bertrand Captures Fragile Earth in Wide-Angle”
3. “John Doerr Sees Salvation and Profit in Greentech”
   http://www.ted.com/talks/john_doerr_sees_salvation_and_profit_in_greentech.html
4. “Alex Steffen: The Route to a Sustainable Future”
   http://www.ted.com/talks/alex_steffen_sees_a_sustainable_future.html

Podcasts
1. “How Many People Can Earth Hold? Well…”
   http://www.scientificamerican.com/podcast/episode.cfm?id=how-many-people-can-the-earth-hold-11-02-21

Scientific Journal Articles
1. “How Many People Can Earth Support?”
2. “How Many People Can Earth Feed?”

3. “Agricultural Sustainability and Intensive Production Practices”
   http://www.nature.com/nature/journal/v418/n6898/abs/nature01014.html

4. “Population Growth and Earth’s Human Carrying Capacity”
   http://ehsapes.pbworks.com/f/Population%2BGrowth%26%26%2BEarth's%26%2BCarrying%26%2BCapacity.pdf


6. “Policy: Sustainable Development Goals for People and Planet”
   http://www.nature.com/nature/journal/v495/n7441/full/495305a.html

   http://muse.jhu.edu/login?auth=0&type=summary&url=/journals/yearbook_of_the_association_of_pacific_coast_geographers/v074/74.peters.html

Interviews
1. Earthwatch interview with Edward O. Wilson
   http://www.earthwatch.org/aboutus/research/voices_of_science/future_life_interview_e_wilson/

Resources for Infographics

Websites
1. I Love Charts
   http://ilovecharts.tumblr.com/

2. Pinterest boards of infographics
   http://pinterest.com/enolal/infographics/
   http://pinterest.com/mattleopold/infographics/
   http://pinterest.com/nroses/infographics/
   http://pinterest.com/thisisdanni/infographics/
   http://pinterest.com/mashable/infographics/

3. Tools for making infographics
   http://piktochart.com/
   http://www.easel.ly/
   http://infogr.am/
   http://www.tableausoftware.com/public/how-it-works
   http://timeline.verite.co/
   http://www.dipity.com/

4. Tips for designing infographics
   http://naldzgraphics.net/tips/infographics-designing-tips/
High-mass stars live for one to two million years, while low-mass stars live for tens of millions to trillions of years.

**High Mass Stars**
- **Main Sequence**
  - Composition: 90% hydrogen and helium
  - Type: Sun, Altair
- **Giant/Supergiant**
  - Massive stars capable of producing heavy elements, like iron, through fusion
  - Almost 98% hydrogen and helium, 1% helium, 0.6% hydrogen

**Low Mass Stars**
- **Main Sequence**
  - Composition: 90% hydrogen and helium
  - Type: Sun, Aldebaran
- **Red Giant**
  - Expanding hydrogen in their cores, these stars extend their outer layers and can grow to 1–10 times their main sequence size
  - 90% of original mass
  - 5% of original mass
  - Aldebaran, Antares
- **Planetary Nebula**
  - The outer layers of gas are expelled, while the star continues to live as a white dwarf
  - 1% of original mass
  - 5% of original mass
  - M27, NGC 40
- **White Dwarf**
  - Hypothetical remnant of a star less massive than the Sun
  - 5% of original mass
  - 80%–90% of original mass
  - Mira B, Sirius B

**Black Hole**
- A star's core collapses into an infinitely dense object
  - Type: Spica, Theta Orionis C, Betelgeuse, Rigel

**Neutron Star**
- A star's core collapses into dense matter
  - Type: Cassiopeia A, Kepler's Supernova, Cygnus X-1, Sagittarius A

**Supernova**
- Outer layers of hydrogen and helium are ejected along with some heavier elements
  - Type: 50% of original mass
  - 5% of original mass
  - C, K, and O

**Black Hole**
- A star's core collapses into an infinitely dense object
  - Type: 5% of original mass
  - 5% of original mass
  - C, K, and O
BIG HISTORY PROJECT / PROJECT BASED LEARNING (PBL)
A CLOSER LOOK AT FARMING IN SOME OF THE EARLIEST AGRARIAN CIVILIZATIONS

The Fertile Crescent

The Fertile Crescent is a region of the Near East stretching from the Persian Gulf to the Mediterranean Sea, and even into the Nile River Valley by some definitions. The area is famed for its "cradle of civilization," the first sites of agricultural development, urbanization, and some definitions. Often described as a late Pleistocene megadrought, conditions were favorable for early human settlement and agricultural development. The region includes modern-day Iraq and the Levant, as well as Turkey, Syria, and Israel. The Fertile Crescent is known for its rich soils, which supported the cultivation of crops such as wheat and barley, and for its location on the Tigris and Euphrates Rivers, providing transportation routes and access to the Persian Gulf trade routes.

The Indus River Valley

The Indus River Valley, also known as the Indus Valley or Indus Civilization, is a series of ancient cities and urban settlements that flourished in what is now Pakistan. The civilization thrived between 2600 BCE and 1900 BCE, and is known for its advanced urban planning, including standardized systems of weights and measures, and the use of terracotta tiles, brick, and other building materials. Although the exact origins of the civilization are still a matter of debate, it is believed to have been a significant influence on later Indian civilizations.

The Yellow & Yangtze River Valleys

The Yellow River and the Yangtze River are two of the most important river systems in China, providing water and fertile land for agriculture. The first farmers in these regions, known as the "earliest Chinese farmers," are thought to have emerged in the area around 7000 BCE. These farmers developed a system of slash-and-burn agriculture, using the land for a few years before moving on to new land. Over time, these early farmers developed more permanent methods of agriculture, including irrigation and the cultivation of rice. By 4000 BCE, the region was home to a number of small communities, and by 2500 BCE, the first settle sedentary communities began to emerge. These early settlements eventually developed into the first Chinese civilizations, including the Shang and Zhou dynasties.

Papua New Guinea

The first agricultural economies in Papua New Guinea emerged around 10,000 BCE, with the domestication of crops such as yams and sweet potatoes. These early agricultural communities developed complex irrigation systems to support the cultivation of crops. By 5000 BCE, the region was home to a number of small farming communities, and by 3500 BCE, the first settled agricultural communities began to emerge. These early communities developed complex irrigation systems and traded and exchanged goods with neighboring communities.

Mesoamerica

The first agricultural economies in Mesoamerica emerged around 8000 BCE, with the domestication of crops such as corn, squash, and beans. These early agricultural communities developed complex irrigation systems to support the cultivation of crops. By 3000 BCE, the region was home to a number of small farming communities, and by 2000 BCE, the first settled agricultural communities began to emerge. These early communities developed complex irrigation systems and traded and exchanged goods with neighboring communities.

Andes

The first agricultural economies in the Andes emerged around 10,000 BCE, with the domestication of crops such as potatoes and quinoa. These early agricultural communities developed complex irrigation systems to support the cultivation of crops. By 3000 BCE, the region was home to a number of small farming communities, and by 2000 BCE, the first settled agricultural communities began to emerge. These early communities developed complex irrigation systems and traded and exchanged goods with neighboring communities.

Wheat

Wheat is grown in more countries and on more land than any other cereal grain.約

Rice

Rice is one of the most important crops in the world, providing food for over half of the world's population.約

Maize

Maize, also known as corn, is a staple crop in many regions of the world, providing food for over a billion people.約

Biography

The first agricultural economies in the world emerged around 10,000 BCE, with the domestication of crops such as wheat, barley, and rice. These early agricultural communities developed complex irrigation systems to support the cultivation of crops. By 3000 BCE, the region was home to a number of small farming communities, and by 2000 BCE, the first settled agricultural communities began to emerge. These early communities developed complex irrigation systems and traded and exchanged goods with neighboring communities.

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**PBL: HOW MANY PEOPLE COULD EARTH SUPPORT NOW AND 100 YEARS FROM NOW?**

### Project Checklist

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<th>Project Component</th>
<th>Notes</th>
<th>Score</th>
<th>Possible Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Checkpoint:</strong> Draft number calculations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Checkpoint:</strong> Draft infographic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Checkpoint:</strong> Draft of each narrative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infographic Score Sheet Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Narrative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation Score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration Score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Narrative Writing Rubric

<table>
<thead>
<tr>
<th>Description</th>
<th>Below Standard (1)</th>
<th>Approaching Standard (2)</th>
<th>At Standard (3)</th>
<th>Above Standard (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exposition &amp; Development</strong></td>
<td>• Provides a setting that is unclear with a vague conflict, situation, or observation. • Has an unclear point of view and an underdeveloped narrator and/or characters. • Lacks narrative techniques and merely retells events and/or experiences.</td>
<td>• Provides a setting with a vague conflict, situation, or observation. • Has an unclear point of view. • Uses some narrative techniques and merely retells events and/or experiences.</td>
<td>• Orient the reader by setting out a conflict, situation, or observation. • Establishes one point of view and introduces a narrator and/or developed characters. • Uses narrative techniques such as description and reflection that illustrate events and/or characters.</td>
<td>• Engages and orients the reader by setting out a conflict, situation, or observation. • Establishes one or multiple points of view and introduces a narrator and/or well-developed characters. • Demonstrates deliberate use of narrative techniques such as pacing, description, reflection to develop experiences, events, and/or characters.</td>
</tr>
<tr>
<td><strong>Organization &amp; Cohesion</strong></td>
<td>• Lacks a sequence or progression of experiences or events or presents an illogical sequence of events.</td>
<td>• Creates a sequence or progression of experiences or events.</td>
<td>• Creates a logical progression of experiences or events using some techniques — such as chronology, flashback, foreshadowing, suspense, etc. — to sequence events so that they build on one another to create a coherent whole.</td>
<td>• Creates a smooth progression of experiences or events using a variety of techniques — such as chronology, flashback, foreshadowing, suspense, etc. — to sequence events so that they build on one another to create a coherent whole.</td>
</tr>
<tr>
<td><strong>Style &amp; Conventions</strong></td>
<td>• Tells only about experiences, events, settings, and/or characters.</td>
<td>• Uses words and phrases and telling details to convey experiences, events, settings, and/or characters.</td>
<td>• Uses words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.</td>
<td>• Uses precise words and phrases, showing details and controlled sensory language and mood to convey a realistic picture of the experiences, events, setting, and/or characters.</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td>• May provide a conclusion to the events of the narrative.</td>
<td>• Provides a conclusion that follows from what is experienced, observed, or resolved over the course of the narrative.</td>
<td>• Provides a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.</td>
<td>• Builds to a conclusion that logically follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.</td>
</tr>
</tbody>
</table>
## Presentation Rubric

<table>
<thead>
<tr>
<th>Description</th>
<th>Below Standard (1)</th>
<th>Approaching Standard (2)</th>
<th>At Standard (3)</th>
<th>Above Standard (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation of Ideas &amp; Information</strong></td>
<td>• Does not present information, arguments, ideas, or findings clearly, concisely, or logically.</td>
<td>• Presents information, arguments, ideas, or findings in ways that are not always clear, concise, or logical.</td>
<td>• Presents information, arguments, ideas, or findings clearly, concisely, or logically.</td>
<td>• Does an exceptional job presenting information, arguments, ideas, or findings clearly, concisely, and logically.</td>
</tr>
<tr>
<td></td>
<td>• Lacks supporting evidence.</td>
<td>• Argument is supported by partial evidence.</td>
<td>• Is well-supported by evidence.</td>
<td>• Is well-supported with relevant, and interesting evidence.</td>
</tr>
<tr>
<td></td>
<td>• Has a line of reasoning that is difficult to follow.</td>
<td>• Has a line of reasoning that is sometimes difficult to follow.</td>
<td>• Has a line of reasoning that is easy to follow.</td>
<td>• The line of reasoning is logical, easy to follow, well crafted, and uses information that is in line with the overall purpose.</td>
</tr>
<tr>
<td></td>
<td>• Uses information that is not in line with the overall purpose.</td>
<td>• Uses information that is only sometimes in line with the overall purpose.</td>
<td>• Clearly and completely addresses alternative or opposing perspectives.</td>
<td>• Clearly and completely addresses relevant alternative or opposing perspectives.</td>
</tr>
<tr>
<td></td>
<td>• Does not consider alternate perspectives.</td>
<td>• Attempts to consider and address alternative perspectives but does not do so completely.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organization</strong></td>
<td>• Does not meet the presentation guidelines.</td>
<td>• Meets most requirements for the presentation guidelines.</td>
<td>• Meets all presentation guidelines.</td>
<td>• Meets all presentation guidelines and is particularly interesting and thoughtfully organized.</td>
</tr>
<tr>
<td></td>
<td>• Does not have a proper introduction or conclusion.</td>
<td>• Has a proper introduction and conclusion, but they are not clear or interesting.</td>
<td>• Had a proper introduction that is clear and logical.</td>
<td>• Has an introduction that hooks the audience and a conclusion that incites questions and further interest.</td>
</tr>
<tr>
<td></td>
<td>• Does not use time allotted (i.e., too long or too short).</td>
<td>• Uses the time allotted, but does not divide up that time logically (i.e., uses too little or too much time on a topic or idea).</td>
<td>• Uses the time allotted well and has organized the time appropriately.</td>
<td>• Organizes and uses times effectively.</td>
</tr>
<tr>
<td><strong>Eyes, Body, and Voice</strong></td>
<td>• Does not look at the audience or make eye contact.</td>
<td>• Makes infrequent eye contact with the audience.</td>
<td>• Keeps eye contact with the audience most of the time — only glances at notes or slides.</td>
<td>• Keeps eye contact with the audience throughout.</td>
</tr>
<tr>
<td></td>
<td>• Lacks poise (appears nervous, fidgety, slouchy).</td>
<td>• Shows some poise (limited fidgeting, nervousness, etc.).</td>
<td>• Shows poise and confidence.</td>
<td>• Show exceptional poise and confidence.</td>
</tr>
<tr>
<td></td>
<td>• Speaks in a way that is hard to understand.</td>
<td>• Speaks clearly most of the time, but may be difficult to understand or hear at times.</td>
<td>• Speaks clearly and is easy to understand.</td>
<td>• Speaks clearly, and is interesting to listen to.</td>
</tr>
<tr>
<td><strong>Response to Audience Questions</strong></td>
<td>• Does not directly address the questions, goes off topic.</td>
<td>• Answers audience questions, but not always completely and clearly.</td>
<td>• Answers questions clearly and completely.</td>
<td>• Answers clearly and completely and provides relevant details.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Freely admits not knowing the answer to a question.</td>
<td>• Admits not knowing the answer to a question, and provides ideas for finding answers.</td>
</tr>
</tbody>
</table>
## Infographic Score Sheet

<table>
<thead>
<tr>
<th>Infographic Component</th>
<th>Description</th>
<th>Notes</th>
<th>Score</th>
<th>Possible Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic</td>
<td>The topic of the infographic is specific in nature and is intended to inform or convince the viewer.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>The type of infographic chosen (e.g., timeline or informational) highly supports the content being presented.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objects</td>
<td>The objects included in the infographic are relevant and support the topic of the infographic.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Visualizations</td>
<td>The data visualizations present accurate data and are easy to understand.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Style</td>
<td>Fonts, colors, and organization are aesthetically pleasing and appropriate to the content, and they enhance the viewer’s understanding of the information presented.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citations</td>
<td>Full bibliographic citations for all sources used are included.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Subtotal              |                                                                          |       |       |                |

| Elevator Pitch        | **Numbers:** How many people Earth can support now and 100 years from now. |       |       |                |
|                       | Definition of “support.”                                                 |       |       |                |
|                       | **Summary:** How numbers and definition of “support” were derived.         |       |       |                |
|                       | **Insights:** Two major insights that came from this work.                |       |       |                |

| Elevator Pitch Total  |                                                                          |       |       |                |
|                       |                                                                          |       |       |                |

| Total Score           |                                                                          |       |       |                |
## Collaboration Rubric

Directions: Give yourself and each member of your group a score from the Collaboration Rubric. Your teacher will use these scores as part of each group member’s individual score for the project. If you need more rows for additional group members, use the back of this sheet.

<table>
<thead>
<tr>
<th>Below Standard (1)</th>
<th>Approaching Standard (2)</th>
<th>At Standard (3)</th>
<th>Above Standard (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This group member does not complete project tasks or does not complete tasks on time. He/she does not help the group solve problems, give useful feedback, or use feedback from others. The group member does not show respect for group mates (e.g., interrupting, ignoring ideas, being unkind).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This group member is sometimes prepared to work with the group. This group member does project tasks when reminded and sometimes completes tasks on time. He/she sometimes offers to help others, sometimes shares ideas, and is usually polite and kind to group mates.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This group member completes tasks without being reminded and uses feedback from others. He/she helps the group solve problems and stay organized, and listens carefully to group mates. This person is polite and kind.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This group member does more than what is required and asks for feedback to improve his/her work. He/she steps in to help other group members when they are absent or need help, and he/she encourages group mates to share ideas by recognizing and promoting everyone’s strengths.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Score</th>
<th>Why did you choose this score?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your Name:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Member’s Name:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Member’s Name:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Member’s Name:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adapted from the Buck Institute Collaboration Rubric.
SAMPLE PEER-REVIEW PROCESSES

Peer review is a useful tool in the classroom and serves multiple purposes for learning. It can help both you and your students. For you, it helps ensure that you receive a high-quality final product. In addition, peer review helps ensure that you cover CCSS.ELA-Literacy.W.9-10.5.

For your students, it will help them better understand the writing and revision process, as well as orient them to their product requirements.

As you introduce the peer-review process, remind students of the roles that they take as a part of this process:

- **Writer** — as a writer, peer review is a low-risk way to find out how well your writing is working. Are you conveying your message? Are you supporting your assertions with scientific evidence? Are you crafting a clear and cogent argument?

- **Reviewer** — as a reviewer, you have the opportunity to see what someone else is doing in the context of your assignment. Not only does this help remind you of and orient you to the required elements of your assignment, it also helps you critically and constructively evaluate how a writer might improve his or her writing skills.

**Directions**

There are multiple ways to conduct a peer review. If you have class norms established around peer review, feel free to use those. Here are two alternative suggestions:

- Group peer review, which we suggest using in the context of the “Invent a Species” project

- Individual peer review, which is better suited for smaller group or individual writing projects, such as the “How many people could Earth support now and 100 years from now?” project

Remember, these can be altered to fit the needs of your class. There are also a multitude of suggestions online. Two useful search terms are “Peer-Review Processes” and “Writing Workshop Peer Review.”

---

1 CCSS.ELA-Literacy.W.9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 9–10 here.)
I. Group Peer Review

Advanced Preparation

• Make sure each group provides enough copies of its draft to share with another group of students.

• Copies of the Writing Rubric.

• Copies of the Feedback Table (at the end of this document).

• Post the directions somewhere in the room that is highly visible to students.

Process

1. Explain to students that you are going to peer-review one another’s work. Remind them of the importance of their roles.

2. Hand out the Feedback Table and the Writing Rubric and remind students that they will be using both documents to evaluate one another’s work. They will write constructive feedback on the table and they will use the Writing Rubric as a checklist.

3. If needed, have a discussion about respectful evaluation and constructive criticism.

4. Then, pair up the groups.

5. Post the following directions in your classroom and review with the students. It’s helpful if you set a timer to monitor their process and direct them when to move. This will take about 20 to 25 minutes.

   a. Groups A and B work silently to assess each other’s drafts using the Writing Rubric while taking notes on the Feedback table (5 minutes).

   b. Group A shares its feedback. Each person in Group A should share one thing he/she liked and one thing that could use improvement (3 minutes).

   c. Group B asks Group A short clarifying questions about its feedback (3 minutes).

   d. Groups discuss together what Group B might do to improve its final product (5 minutes).

   e. Group B shares its feedback. Each person in Group B should share one thing he/she liked and one thing that could use improvement (3 minutes).

   f. Group A asks Group B short clarifying questions about its feedback (3 minutes).

   g. Groups discuss together what Group A might do to improve its final product (5 minutes).

   h. Groups exchange rubrics.

6. Give the groups the rest of the class period to plan and decide what feedback they’ll incorporate from the peer review.
II. Individual Peer Review

Advanced Preparation

- Make sure each student brings an extra copy of his or her draft to share with a group of students.

- Copies of the Writing Rubric.

- Copies of the Feedback Table (at the end of this document).

- Post the directions somewhere in the room that is highly visible to students.

- If you’re working on the “How many people could Earth support now and 100 years from now?” project, decide in advance if you will keep student pairs together or split them up. Students will likely gain more if they peer-review someone who isn’t their partner.

Process

1. Silent work

   a. In pairs, each reads the other’s draft through once, without taking notes or thinking about the rubrics.

   b. Each student writes a two- to three-sentence summary of the other student’s writing. If the piece is difficult to summarize, knowing this will be helpful to the writer. A well-written piece is fairly easy to summarize.

   c. Then, each student uses the Writing Rubric and the Feedback Table to start providing more pointed feedback. Do not copyedit. This process is intended to focus on the overall ideas and main points in the writing. Be positive AND constructive.

2. Discussion

   a. Student A shares his/her feedback. He/she should share at least two things he/she liked and two things that could use improvement (3 minutes).

   b. Student B asks Student A short clarifying questions about the feedback (3 minutes).

   c. The pair discuss what Student B might do to improve his/her final product (5 minutes).

   d. Student B shares his/her feedback. He/she should share at least two things he/she liked and two things that could use improvement (3 minutes).

   e. Student A asks Student B short clarifying questions about his/her feedback (3 minutes).

   f. The pair discuss what Student A might do to improve his/her final product (5 minutes).

   g. Students A and B exchange rubrics

3. Reconvene in project pairs

   a. If you split up pairs, have them come together to share the feedback they received from the peer reviewers.

   b. Give students the rest of the class period to decide what feedback they will use and what changes they’ll make to their written and project work.
## PBL: Feedback Table

<table>
<thead>
<tr>
<th>What did you like?</th>
<th>What do you think could be improved?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What questions came up?</th>
<th>What ideas did you have?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>