Lesson #14 Cosmic Timeline

SUBJECT AREA: Physical Science, Life Science
GRADE LEVEL: 6th - 8th
OVERVIEW: Students will visualize large expanses of astronomical and geological time by drawing an analogy between the time scale since the creation of the cosmos and a more familiar stretch of time, one year.
DURATION: 1 hour
MA FRAMEWORK: Hands on activity
INTERDISCIPLINARITY CONNECTIONS: Math

OBJECTIVES:
1. Students will be able to order major events in the history of the universe.
2. Students will be able to grasp the span of time over which the evolution of the universe has taken place.
3. Students will be able to calculate when in the real timeline the events occurred.

MATERIALS & RESOURCES:
- Index cards with events
- Correct answers sheet for counselors/teachers
- Handouts for students
- Calculators
- White board markers
- Very long pieces of butcher paper

TECHNOLOGY TOOLS: N/A

BACKGROUND INFORMATION:
1. Carl Sagan, in his book *The Dragons of Eden*, proposed compressing the history of the universe into one year and then seeing where in that year various events of interest fall. Based on his model, Sagan calculated that if the Big Bang takes place at the first moment of January 1, the origin of our solar system will be in mid-September, and the first appearance of the humans on Earth does not take place until late evening on the 31st of December.
2. You can use ratios to scale events in the history of the universe to one year.

Years ago the event happened  =  x days
Years ago the Big Bang occurred  365 days

LESSON PROCEDURE:
1. The main instructor will present the concept of a time line by drawing one on the board.
2. The main instructor will explain that January 1st of our one-year “Cosmic Calendar” represents the Big Bang, the beginning of time. “Today” is represented by the last possible moment on December 31st.
3. Within groups (groups of 6), students will draw a timeline on big sheets of butcher paper and brainstorm about some of the important events that happened between the Big Bang and now.
4. The within-group instructors will hand out the event cards, one to each student, in random order. Students will attach their event to the timeline in the proposed order of occurrence.
5. A student who disagrees with the order of a certain event may suggest changes. The discussion will continue until a majority of the students within a group agree with each other. The within-group instructor of each group will uncover the correct order of events. Students are responsible for correcting the position of their event on the timeline.
6. Now that the order of events is correct, students have a similar discussion about the timing of the events along the 1-year timeline.
7. Students will use ratios to determine how many years ago the events happened in real time based on when they occurred in the model timeline (see handout for students).
8. If time allows, see “REFLECTION.”

Timeline
- 5 min: Explanation
- 25 minutes: Within group discussion, order and position events within group
• 25 minutes: Event calculations
• 5 min: Debrief with whole group

TEACHING STRATEGY: Discussion, active learning

ASSESSMENT PROCEDURES
ACCOMODATIONS/MODIFICATIONS
REPRODUCIBLE MATERIALS

EXPLORATIONS & EXTENSIONS

LESSON DEVELOPMENT RESOURCES


REFLECTIONS
1. Humans arrived on the scene about 7 minutes before midnight on “New Year’s Eve” according to our model. How does this change your perspective of our importance?
2. How old is the Sun compared to other stars? If there are older stars than the Sun out there (and there are many), might they have older life forms on them?
3. What might we be like today if hominids on Earth had evolved a million years earlier?
4. In textbooks, the history of life is often portrayed as pictures of dinosaurs and humans. What is wrong with this representation of the history of life?
Cosmic Timeline: Cheat Sheet for Instructors and Counselors:

Lesson Outline:

- The main instructor will present the concept of a time line by displaying a 12 month calendar across the room.
- The main instructor will explain that January 1st of our one-year “Cosmic Calendar” represents the Big Bang, the beginning of time. “Today” is represented by the last possible moment on December 31st.
- Within groups (3 groups of 16), students will brainstorm about some of the important events that happened between the Big Bang and now.
- The within-group instructors will hand out the event cards, one to each student, in random order. Students will attach their event to the timeline in the proposed order of occurrence.
- A student who disagrees with the order of a certain event may suggest changes. The discussion will continue until a majority of the students within a group agree with each other. The within-group instructor of each group will uncover the appropriate date of each event and the correct order of events. Students are responsible for correcting the position of their event on the timeline.
- Students will use ratios to determine how many years ago the events happened in real time based on when they occurred in the model timeline (see handout for students).
- If time allows, have students discuss in small groups the following questions:
  - Humans arrived on the scene about 7 minutes before midnight on “New Year’s Eve” according to our model. How does this change your perspective of our importance?
  - How old is the Sun compared to other stars? If there are older stars than the Sun out there (and there are many), might they have older life forms on them?
  - What might we be like today if hominids on Earth had evolved a million years earlier?

Correct order/timing of events (with answers to student handout in parentheses):

365 days ago / January 1: The Big Bang occurred. (1.4 x 10¹⁰ years ago)

365 days ago / January 1: The universe has increased in size by a factor of 10³⁰, decreasing the Universe’s temperature allowing protons and neutrons to come together to form atomic nuclei. (1.4 x 10¹⁰ years ago).

365 days ago / January 1: Atoms form. Free negative electrons are now captured by the positive nuclei because of the electromagnetic force. Space is now transparent, and photons that were trapped in a sea of electrons now travel in every direction. These photons of light are what we know as the cosmic microwave background (1.4 x 10¹⁰ years ago).

357 days ago / January 8: Stars and galaxies form: atoms come together to form stars, and clusters of stars known as galaxies. (1.37 x 10¹⁰ years ago).

346 days ago / January 19: The First quasar: the first “quasi-stellar object” forms. It is possible that a quasar is a galaxy, with a super massive black hole at its center, early in life. (1.33 x 10¹⁰ years ago).

125 days ago / August 31: Our solar system forms: as a huge cloud of matter condenses, the sun forms. From the disc of matter orbiting the sun come the planets and other satellites. (4.79 x 10⁹ years ago).

124 days ago / September 1: The Earth forms: the chunk of debris orbiting the sun, which we know as the earth, forms. (4.76 x 10⁹ years ago).

104 days ago / September 21: Life on Earth begins: the first single celled organisms come into existence. (3.99 x 10⁹ years ago).

14 days ago / December 17: The first vertebrates appear. (5.37 x 10⁸ years ago).
13 days ago / December 18: The first land plants appear. (4.99 x 10^5 years ago).

10 days ago / December 21: Insect populations begin to grow in large numbers. (3.84 x 10^4 years ago).

7 days ago / December 24: The first dinosaurs appear. (2.68 x 10^6 years ago).

4 days ago / December 27: The first birds appear. (1.53 x 10^6 years ago).

2 days ago / December 29: Dinosaurs become extinct. (7.67 x 10^7 years ago).

0.004 days ago / December 31, 11:54 pm: Modern humans evolve. (1.53 x 10^5 years ago).

0 days ago / December 31, 11:59 pm: Human kind has entered the information age. (0 years ago).
# How many years ago did these cosmic events really happen?

You will use the following ratio to figure out how many years ago each event occurred based on our timeline model (rounded to the nearest 38 million years). Plug in the known value for the number of days ago (x) and use cross multiplication to solve for the number of years ago (X):

\[
\frac{X \text{ years ago}}{1.4 \times 10^{10} \text{ years since the Big Bang}} = \frac{x \text{ days ago}}{365 \text{ days since the Big Bang}}
\]

<table>
<thead>
<tr>
<th>Number of days ago (x)</th>
<th>Cosmic Event</th>
<th>Number of years ago (X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>365</td>
<td>The Big Bang occurred</td>
<td></td>
</tr>
<tr>
<td>365</td>
<td>The universe increases</td>
<td></td>
</tr>
<tr>
<td>365</td>
<td>Atoms form</td>
<td></td>
</tr>
<tr>
<td>357</td>
<td>Stars/galaxies form</td>
<td></td>
</tr>
<tr>
<td>346</td>
<td>The first quasar forms</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>Our solar system forms</td>
<td></td>
</tr>
<tr>
<td>124</td>
<td>The Earth forms</td>
<td></td>
</tr>
<tr>
<td>104</td>
<td>Life on Earth begins</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>First vertebrates</td>
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</tr>
<tr>
<td>7</td>
<td>First dinosaurs</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>First birds</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Dinosaurs become extinct</td>
<td></td>
</tr>
<tr>
<td>0.004</td>
<td>Modern humans</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Information age</td>
<td></td>
</tr>
</tbody>
</table>
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Atoms form. Free negative electrons are now captured by the positive nuclei because of the electromagnetic force. Space is now transparent, and photons that were trapped in a sea of electrons now travel in every direction.

Stars and galaxies form. Atoms come together to form stars, and clusters of stars known as galaxies.
The First quasar, or “quasi-stellar object,” forms. It is possible that a quasar is a galaxy, with a super massive black hole at its center, early in life.

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The Earth forms. The chunk of debris orbiting the sun, which we know as the earth, forms.

Life on Earth begins. The first single celled organisms come into existence.
The first vertebrates appear on Earth.

The first land plants appear.
Insect populations begin to grow in large numbers.

The first dinosaurs appear.
The first birds appear.

Dinosaurs become extinct.
Modern humans evolve.

Human kind has entered the information age.