modeling the universe

How Old is the Universe?

Goals:

- To introduce the concept of a cosmic timeline as a model for understanding predictable change in the universe over time.
- To create a series of direct connections from the student, to their immediate environment, to their regional surroundings, to the Earth, the Solar System, our galaxy and finally out to the furthest reaches of space.
- To investigate the changing nature of the universe
- To allow students to understand that the very same thought processes they use to determine the relative ages of common objects (like a weathered picnic bench, a tarnished coin, and a crumbling bridge) are the same thought processes used by scientists to determine the ages of planets, stars, galaxies, and the age of the universe itself.

Overview:

How old are the objects around us and how do we know? What is our place in time? How can a timeline be used as a model to understand age and change? How is my thinking both the same and different from what a scientist would think to answer these questions? What is the evidence for change in the universe over time?

In this activity, students either collect or are provided with a selection of objects and pictures of objects of different ages. They then group them and place them on a cosmic timeline to explore the concepts of time, change, and their place in time within their world and universe.

What You Need:

For the class:

- ❑ Master set of "Time Category" labels, possibly with absolute age ranges written on them
- ❑ Master set of Pictures, see end of write-up
- ❑ Additional, one of a kind objects such as meteorites, fossils, antiques

For each group of students:

- ❑ "Time Category" labels
- ❑ Pictures, see end of write-up
- ❑ Objects, collected/provided by students if time allows, or pre-selected groups of objects can be provided to students by the teacher. Possible objects include:
  - ➢ Natural objects; Rocks, leaves, wood,
  - ➢ Personal/Manufactured objects; fabric, stamps, comb, pencil, pictures of family
  - ➢ Items that already have dates; coins, newspapers, magazines, books. Having items with ages help students when they are challenged to think about absolute versus relative age.

Getting Ready

If students have time to prepare for the activity before hand, they can be encouraged to collect their own objects and pictures. This can include pictures of things they've seen on vacations, photos they may have taken through telescopes, as well as drawings or paintings. When dealing with pictures, the age in question is that of the object in the picture, not the age of the picture itself (which could range from 2 seconds ago to several decades). A selection of objects may include a globe of the Earth for example. One student may think about the age of the object as dating from when the globe was made, and another may think about the age of the Earth itself. Both are correct, but be certain you know what idea they have in mind. Such items can also be used to represent both ages for older students, who won't get confused with that concept.

Procedure:

Part 1. Discussion

- Facilitate a class discussion around time and age, and how they know. Ask specific questions and list their ideas; How do you know how old something is? Who is the oldest person in the room? The youngest? What do you think the oldest thing in the room is? What is the oldest thing you can think of in the whole universe? What is 'relative age'? How does that differ from 'absolute age'?
- This discussion is designed to get students thinking about the full range of ages of objects, the kinds of indicators and evidence that are available, how they use those to estimate age, and how objects in the universe change over time. It also begins the process of allowing them to place themselves in the larger picture by grounding the activity in the familiar environment around them.

Part 2. Pictures in Small Groups

- Distribute a set of pictures and Time Category labels to each group.
- If time permits, have students collect or draw additional objects to add to their selections.
- Have students place all their objects and pictures into one of the Time Categories. Encourage discussion. Let them know it is fine to have things in the "I Don't Know" category. Also try pointing out or adding things to their collection that have actual dates on them, like coins and magazines. Then help them try to assign categories to other objects relative to these.
- Possible questions include, "How did you know how old this was?" "Is there any evidence for the age of this object? (i.e. a date stamped on it, maybe it is weathered or worn, etc.)" "What other clues to age are available?" Do they equate shiny things with young things? Does grouping objects into shiny versus worn/rusted/tarnished help suggest a difference in age? Why?

Part 3. Building the Master Timeline

- After the time allotted to small group sorting and discussion, get the students into one big group. Have a set of Time Category labels on a separate table or other area. This will be the 'Master' Time Categories to which each of the small groups will contribute.

- Have each group bring an object or selection of objects from their categories up to the Master Timeline and place them there. Have them explain why they chose that category. Go around the groups until a good selection of objects and pictures have been placed. Encourage students to use objects from their "I Don't Know" category, discussion with the rest of the class may allow these objects to be placed.
- At this point add any one of a kind objects such as meteorites, fossils, etc. Ask the group where they should be placed and why.
- When every small group has placed their items into the 'final' Time Categories, ask them if any of the items need to be moved. Some students, after seeing what else is in the timeline, might revise their idea of the relative age of the object. Shuffle items around until the group is generally content with the order.
- If time permits, allow students to consider relative ages first, and then see if they can define absolute ages for each category. This may help them re-categorize problem objects. Otherwise, start with ages on the categories. Have students order the objects, or some of the objects in each age category from youngest to oldest. Use objects that have actual dates, like coins, magazines, etc., to start them on their way. If they can't give an absolute age for an object, can they give an age range, say from 100 to 1000 years old?

Part 4. Final Discussion

- Draw students back to the main goals of the activity by leading them in a final discussion. Revisit the idea of a timeline as a model. What new ideas do they have about the ages of objects and how things change with time? Emphasize that in many cases, things change in predictable ways, and at predictable rates as they get older. These allow us to estimate the ages of objects, like the age of a person based on our knowledge of human biology. Point out that scientists use these same ideas and knowledge of predictable change with time to estimate how old planets, stars, and galaxies are. The thought processes they use to estimate the age of a person is much the same as that of a scientist. Even to that of a scientist estimating the age of our own universe.

Discussion Notes:

Specific Questions:

Why did you place this object in this category?
Say you found this object (something you are pointing to, something you hand them), where would you put it and how would you know?
How did you guess the age of this object?
You say it looked old (young)? Why do you say that?
What is the very oldest (youngest) thing in the piles? What, given the whole universe to choose from, would be older (younger) than this? (Responses can be listed, and then you can bring out specialty items that are older, younger, or point to other objects, to get them thinking.)
You say it looked similar to other things already in that category or pile? How does it look similar? Why do you think that similarity has something to do with its age?
Is the object worn/shiny/rusted/tarnished/faded/used/smooth/rough etc.? Does that suggest anything about its age?

Timelines as a Model:

Discuss the idea of timelines as a scientific model with the students. Where and in what situations would the relative or absolute timeline they created be a useful model? Every type of method that is used to estimate age is in itself a model for how we 'expect' that change to take place. What are some of the uses and limitations of these models? Where do they give you a good estimate for the age of an object, and where do they lead you astray? (For example, something rusty might be called "old" and a shiny version of that object "young" because students know some metal objects rust with time. But for that model to work, both objects must be subjected to the same conditions. If a shiny metal object was kept in an airtight package for 100 years, it might look brand new. The same object exposed for just a few weeks outside might be completely rusted.)

Change as a Process with Predictable Rates and Timing:

A critical component to this activity is helping students understand that they way they estimate age for common objects is the same as the way a scientist estimates age for astronomical objects. In both cases we look for signs of possible change (measurements, observation, evidence) and then use our understanding of change with time (records, timelines, techniques) for that class of objects to estimate its age. For example, we can determine relative ages of objects by looking at:

Style, Fashion, Form – hairstyles, architecture, tools, pottery shards, music CDs, specific styles can be tied to specific decades or centuries.
Weathering - getting worn/used, faded/bright, exposure to the elements
Cycles and Growth - leaves change size and color, children grow into adults, stars are born and die
Positions and Layering - superposition, what's on top is generally younger than what is on the bottom, rock layers, lava flows; position changes, for example sand dunes can come suddenly to cover over rocky surfaces. The idea of position might also include knowing that a rock has to be older than a building, if the building is made of that rock.

While students may not understand the specifics of a scientific technique for determining age, like radiometric dating, they can understand that it is not just the shape and form of something that can change with time, but also chemistry and composition. Molding cake and a rusting nail, are some general examples of how the chemistry of something can change as time goes by. If you know how fast something rusts, or how fast a cake will mold, you can get a better estimate of its age.

Totally New

Pretty young

Somewhat Young

Medium Age

Somewhat Old

Very Old

Really Ancient

I Don’t Know