Time Warp

Purpose

We will think more about time and the Sun and the shape of the Earth. It is important to realize that the Sun does not rise at the same moment in different places and that clocks around the world are set to their "local" time. The National Science Education Standards require that the motion of the Earth be linked to the changes on it, such as length of day. The vocabulary words which can be integrated in this Thread are time, clock, time zones, orbit, and international date line.

Teacher Background

It used to be common for each city to keep its own time according to the position of the Sun in the sky. Long train rides, particularly easterly and westerly trips, often required travelers to change their watches several times. What a pain. Eventually it was arranged that the globe would be simply divided into vertical chunks according to the country and local desires, keeping uniform time within each chunk. This is why the time zone map looks much different from the actual longitude map. We've included a convenient map here to help visualize what we're talking about.

> You will need: globes, clocks, overhead projectors, blue-tak, golf tees (younger grades can use their toothpick trees).
>
> You may want to spend some class periods on this subject, as the idea of time really can be extended to many other lessons you may want to do. The early grades especially learn how to read clocks and tell time, so you may want to slip this Thread somewhere into your other lessons after your class has had a chance to think more about time keeping. Other grades may want to build different types of clocks to think more about accuracy. At the end of this Thread is a page of supplementary clock-making activities. Materials collection can be very brief or extensive, especially if you use the extra clock activities.

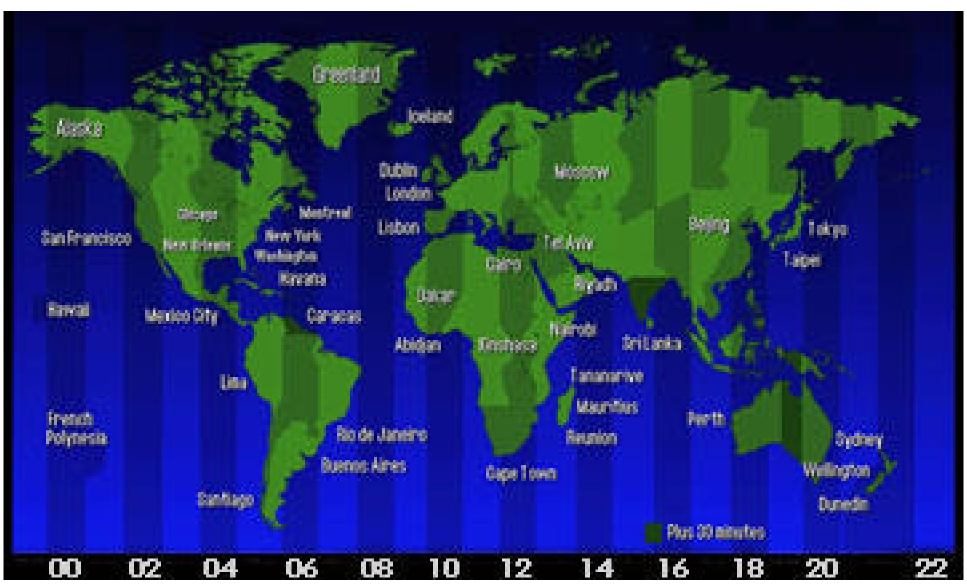
From a scientific point of view, of course, it would be far more logical to have divided the world up into 24 equal parts, one part for each hour of the day. With the circumference (distance around a sphere) of the world being about 24,000 miles, this would divide quite nicely into 1000 miles around the equator for every hour. So, if you knew the distance from here to Tokyo, you could find the local time there. Or could you? Which way would you measure from?

Thinking about the rising of the Sun is thinking about time. Which way does the world spin to make the Sun appear to rise in the east? The world must spin towards the east, so that we spin towards, past, and away from the Sun to make a day happen. This would mean that people further east of us will spin towards the Sun before we reach the same point, we being a little further back from them along the curve. So, to find out what time it is in Tokyo, you should think about that and the fact that the starting point (International Date Line) was decided to be somewhere in the Pacific Ocean.

So, is it later or earlier in Tokyo from where you are? If you are in Boston, it is later in the day for Tokyo because they have had more Sun time than you have. If you are in New Zealand, it is earlier in the day for Tokyo because they have had less Sun time than you have. On a globe, if you live more to the east, (to your right, so long as the North pole is “up”) than the place you want to know about, then you have had more day than they have. Just be careful about which side of the International Date Line you fall!

However, this 24 hour/1000 mile system is all well and good only for a uniformly populated world and from a scientific point of view. Time zones proper come from the desire of governments to limit the confusion which would result from too much watch changing among the ever mobile populations of their countries For example, although the contiguous United States spans one-fourth of the circumference of the world, it only has four time zones when it really might have had six.

This map was taken from: http://www.telkom.co.za/time_zone_map.htm



Developmental Issues

It will be very hard to talk about time zones, since math and abstract perspectives need to be utilized to really understand the time zones. Therefore, what we will do for this age group is use the globe to see the Sun shadows through the day. We will try to link these with time.

The big understanding for this group is: "If people live pretty close to you, then it's dark for them when it's dark for you. If they live far away, it could be dark outside when it is light for you and vice versa."

Inquiry Introduction

With the globe set-up from the last Investigation, *Latitudes and Attitudes*, let's direct our questioning to a different idea. Which tee on the globe gets to make a shadow first? What does that mean about which people get to see the Sun first? Are they the same? Then how long do we have to wait for morning to come? Could we actually have a friend who wakes up half a day earlier than we do because she has morning half a day before us?

Inquiry Investigation

Play with the globe, turning it in front of the light. Have the students place the golf tees where morning would arrive first. Trick them by turning the globe and then having them try again. There has to be some place on the globe where we start, some place where we all measure morning from. Point out the International Date Line on the globe, and have them try this all again.

Where is our home? Where are family members or friends? Where is it night? Where is it day? What is a time of day which is daytime, 10 p.m.? Maybe more like 9 AM. If we are having morning at 9 a.m., should everyone in the world call it 9 AM? Maybe they should call their morning time 9 a.m.

What does that mean about time? Is there anything that is always keeping time going, without a battery or electricity? Something we could watch and know roughly the time? Can we all have the same clock? Or do we need to change it depending on where we live? Wouldn't that be a bother? In what ways do we rely upon time for things we do everyday? How could we all tell time without the clock or the Sun?

Second Grade through Fourth Grade

Developmental Issues

This age group is becoming familiar with the idea of time and future, and can also use numbers to think about things. They are also capable of thinking about others' points of view. Therefore, we will use the globes and talk about time as it relates to a spinning Earth. This age group would enjoy making the sand or water clocks.

Inquiry Introduction

How many hours are there in a day? Why? What is an hour? Who decided about that? Or about minutes or seconds? Why sixty seconds in a minute? Why not 50 or 100? That would be much easier to understand and think about. What is happening in those 24 hours? What is moving and can we watch it happen? Do you recall the Sun's movement across the sky? The Sun appears to move once around the Earth in those 24 hours.

Inquiry Investigation

Reconstruct or grab the globe with the golf tees on it. We learned about the Sun height here in relation to where you live on the curved world. What about the sunrise? Shine the overhead lamp on the globe again. Spin the globe and ask the students which tee is getting the Sun first? Who is having dinner or sleeping when this tee is having lunch? What happens if you call a friend at 9 a.m. and she lives far around the world? Is it 9 a.m. for her? What is her time? Why? Would it be hard to have everyone using one clock? We could never talk about morning being 9 a.m. because it isn't morning for your friend over there, is it? What might we do to straighten this out? What could we think about that has to do with clocks which could help us here?

Thinking some more about time, it seems that the Sun really tells us much about time in our lives. We rely on it to govern how long a day is, right? What is a day? It is the time it takes for the Sun to appear to go all around the world, or in other words, the time it takes the world to spin once. But those hour things are man-made. Could we use a day to think more about longer lengths of time?

What other periods of time are there that do not rely so heavily on made-up time frames like hours? Suggest that they think about going around in a circle around the Sun. How many days does that take? Does the length of time the Earth takes to spin us past the Sun rely upon someone else's definition of something? Since a day is usually measured by these things called hours, while a year is measured by definite cycles called days, could 365 days be a good unit of time measurement? If a day is an Earth-turn time, a year is an Earth-orbit time. Play more with globes and this new idea. Students ready to play with some math ideas here could manipulate the globe and try to divide it up in easy ways. Or check out the math activities in the next level of this Thread.

Developmental Issues

Let's use some simple subtraction and division to think about dividing the world up into time zones. It would be good to approach this subject from that angle, because geometry plays such an important role in thinking about our world — the more we use it, the better we will feel about using it more!

Inquiry Introduction

Where does the Sun rise for the different towns around the world? What about for those cities we have chosen to think about. Why doesn't it say that the Sun rises at 5 p.m. for them? Can the Sun possibly rise for them at the very same moment it does for us? What is time, then? Who determines the time for a certain place?

Ask the students how they think they might solve this problem. Could we find a way so that everyone could have a time and it would be right? Would it be useful for *everyone* in the world to say it was noon when the Sun was only overhead at *one* place on the Earth? About a century ago, this problem was addressed at an international meeting and twenty-four standard time zones were adopted. Why were there 24 time zones made? Hopefully, students will link these 24 zones with the 24 hours that make up one day.

Inquiry Investigation

Can we divide the globe into 24 zones? How do you see 24 zones, and in which way should the globe be divided so that the pieces are related to the Sun's movement? Ask them whether or not this makes sense given our understanding of time. If all the clocks in a given time zone are set to the same time, by how much do adjacent time zones differ? This is good practice for learning to use numbers in a practical fashion. What time is it two time zones away to the west of us? This is a trickier question. With the globe and light source, can the students prove their answers? Can everyone see that the world to the west is having sunrise later and therefore their clocks are behind those in the world to the east? Do they now find a different answer for which 24 pieces they would divide the globe into? Each time zone is centered about a line of longitude, or meridian.

How far across the sky does the Sun appear to go during daylight time? They will say all the way across, or halfway around the Earth. Ask them what that amount could be called instead of "all of the way" or "halfway". How many fists do we need to cover the arc of the sky? Does anyone recall how many degrees a fist covers? It is roughly 10°. How many degrees are in a circle? How many degrees are in half of a circle, then? They will find that it takes around 18 fists or so to measure from one horizon up and over to the other. How many more fists would you need to cover the sky seen by people on the other side of the Earth? Find out from them if they think they could use math to find that answer easier than trying to measure it.

Since it takes twenty-four hours for the Earth to spin (or for the Sun to pass over all of the Earth), how many fists can the Sun travel through in only one hour? Remind the students that in 24 hours, the Sun has to travel through 36 fists. So the real mystery is solved by a little math. How many fists do we need to measure one hour? The math is of course 36 fists ÷ 24 fists which is 3÷2, 1.5 fists, or one and one half fists. How many degrees are in one fist? So, how many degrees does the Sun seem to travel in one hour across the sky? 15 °. Going backwards, saying if the Sun can travel 15° in one hour, how many degrees can the Sun travel in 24 hours? 360° of course, since 15° in one hour times 24 hours = 360°. That is how many degrees there are in a circle.

So, then ask your students this: If the globe is divided up into 24 time zones, how many degrees wide is each time zone? They should then conclude that the time width of each time zone is one hour, so the number of degrees in this zone is 15 in longitude.

The establishment of standard time zones is intimately linked with the establishment of the standard grid of latitude and longitude. Ask students: if it is 7 P.M. in Boston, where is it midnight? Midnight is 12 o'clock. 12 minus 7 is 5. Whoever is having midnight is five time zones away. They will hopefully count ahead to the east on the globe 5 slots to rest on England. Ask them what day it is at that point. Do they think that they would be time traveling if they flew westward to this point?

Using a globe, have the students locate the United States. There are four time zones in North America: Eastern, Central, Mountain and Pacific. Can they discern how many degrees there must be across the country's mainland from the number of time zones across it? Think if there are 24 hours in a day, there should be 24 time zones. 24 goes into 360 degrees 15 times. So, each time zone should be approximately 15 degrees across, making the United States 15 degrees times 4 across the globe, or 60 degrees. Check this with the latitude measures on the globe. You will have to account for fractions. What do we notice about how regular or irregular the real time zones are? Why might this be so? Think about politics and the shapes of states.

Students should already understand that different locations on the globe experience day and night at different times. Even so, the whole notion of time zones may seem a bit mysterious at first glance. Can we find the local times for our relatives around the country right now? What about for areas in the news? Which city on the Earth will yell, "Happy new year!" first? Can students begin to think of locations in terms of both time zones and longitude lines?