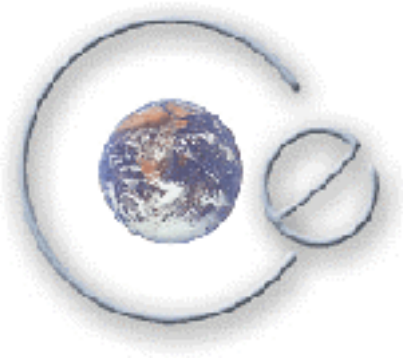


Cosmos Education

Under African Skies Curriculum, 2004

Week 2

Major Themes: Water-Health-Environment

Duration: Two, three hour sessions of educational material to be used in secondary school (high school) classrooms.

Format: Designed for hands-on activities in small groups of 10-25 students. Maximum total size should be 100 students so that the Cosmos team can provide 2 team members per group of ~20 students.

Week 2: Curriculum Sequence

Introduction: Cradle to Cradle

[Estimated Time: 10 minutes]

Introduce Cosmos Education, describe what we do and who we are – introduce team members again.

Why are we here?

By engaging, empowering, and inspiring you the youth we hope to drive the development of Africa from *within*.

Right now the world, our Home, is changing rapidly.
Who can give me an example of how things are different now than they were five years ago?
Africa is changing quickly. But how are those changes being made and who is deciding what those changes should be? Unfortunately, not enough of the changes are being controlled wisely.

Learning from the Past: Mistakes of Industrialization vs. Waste equals food

In the past, many companies have designed products only for one incarnation. The Car/Cellphone/Running shoes you use become a burden on the Earth after you are finished with them. They can be recyclyed but they were not designed for this and so it is inefficient. Nature designs for reuse – the leaves that fall from the tree become food for new trees. The cow gives birth to new cattle before she dies.
If we think carefully, we may be able to design our technology in the same way so that the exhaust gasses from a power station are used to grow wood which can in turn be burnt again, or the obsolete cell phone can be disassembled and used to manufacture new cell phones. The biosphere based on efficiency and reuse would be joined by a technosphere based on optimization and effectiveness.

Someone once said, *"Even a fool learns from his own mistakes; the wise person learns from the mistakes of others."*

By looking to industrialized nations, developing countries can discriminate between wise and dangerous paths. Here in Zambia, many people are going straight from no phone to cell phone. This avoids the environmental and financial cost of installing phone lines.

The students should think about the cycles we see in nature and how we can copy these ideas to close the life cycle of technical products

Reminder: Our Three Rules

1) Slow Down, 2) Ask Questions, 3) Have fun

Break in to groups.

Round Earth

Time: 15-20 min

Objective: To introduce a practical and surprising use for geometry
To Inspire the students by teaching them about a great African thinker.

Equipment: Bucket (~ 10 litres)
String
Scissors
Drinking Straw
Adhesive Tape (masking tape works well)
2x tacks (= drawing pins/thumbtacks)

Instructions:
Cut the straw into 4 segments.
Thread a length of string through the sections of straw and tie into a loop which fits snuggly around the bucket near the middle.
Using the tape, fix the sections of straw to the outside of the bucket so that the string is relatively taut. The sections should each be a quarter of the way round the bucket.
Near the end of one segment of straw, attach the first tack to the bucket so that it is sticking through the tape away from the bucket. If you are not using masking tape, you will need to push the pin through a small piece of white paper before putting it through the tape. This is so that a shadow will be visible.

Push the second tack through the string and stick it in place by folding tape from under the tack and over the string. Again, if not using masking tape, attach a piece of paper under the tape so that this tack can also cast a shadow.

Diagram:
To Follow.

Talk:
Okay, we're going to start with an exercise in geometry. We're going to try to measure the circumference of this bucket by just using two tacks. Does anyone think they can do this? Does anyone have any ideas?

Pick two volunteers and hand them two tacks. Let them play with the bucket but make sure they do not mess with the straws, tape, and string on the bucket. Have them use the bottom of the bucket.

Applaud the students for their ideas and then tell them that we're going to make the measurement using on more thing. We're going to use the Sun!
In particular, we are going to use the shadows cast by the two thumbtacks.

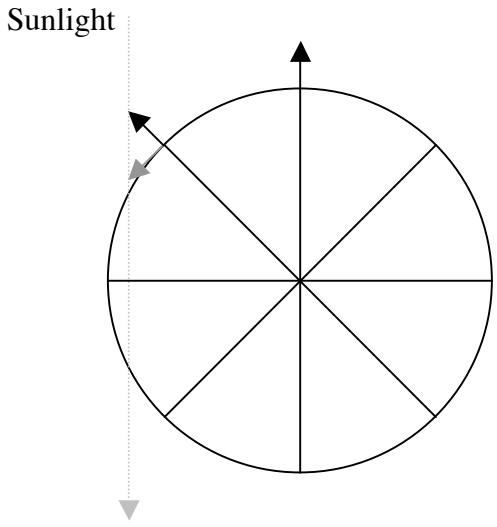
Show the tacks on the string on the bucket and explain that you have made this arrangement so it is easy to move the tacks around the surface of the bucket. Ask one student to hold the bucket and adjust the position of the bucket until the first tack casts no shadow. This can be achieved by holding the mouth of the bucket up against the chest and moving until the tack points directly at the sun.

Once the first tack is no longer casting a shadow, have the second student slide the tack on the string until the length of the shadow is equal to the height of the tack. Ask them to do this as carefully as they can and once the student is satisfied with the position of the tack, have a few other students check to see if they agree. Once they are all satisfied, hand a student a short piece of string and ask him/her to measure the distance between the two tacks.

Ask the students what fraction of the circle they estimate to be covered by the section between the two tacks. Is it half the distance around the bucket? Two thirds? One quarter? One eighth? One tenth? If they have adjusted the tacks correctly, the distance should be about 1/8 of the total distance around the bucket (the angle is about 45 degrees).

So if that distance is 1/8 then 8 times the length of the string should equal the total circumference. Ask students if they agree and make sure they understand what you are saying. This is a very important conceptual part of the demonstration and you don't want to lose anybody.

Once they agree, have the student with the small string measure out 8 lengths of his string onto a larger piece of string. The total measured on the larger string should be approximately equal to the circumference of the bucket. Show this by wrapping the string around the bucket.



Make sure the students understand what has just been done before revealing the next section.

Okay, now I have a completely different question for you. How do we know the Earth is round? Who was the first person to make this discovery?

Let me tell you something – the person who first deduced that the Earth was round was an African! Yes! He lived long ago – more than 2200 years ago. His name was Aristhothenes and he lived during the 3rd century B.C. in the magnificent city of Alexandria, Egypt.

Can you say Aristhothenes?

At that time, Alexandria was the intellectual focal point for the world. One of the reasons it was the focal point was because of its amazing library. Aristhothenes was the chief librarian an he read and read and read. Not only did he deduce that Earth was round, he was also the first person to come up with an accurate measurement of the circumference of the Earth.

One of the things he read was that a man to the North of Alexandria, in the city of Siene, reported that on a certain day at noon, the tall objects around – such as poles in the ground – do not cast a shadow. Aristhothenes was confused because he knew that on that same day at noon in Alexandria, tall objects do cast shadows.

Aristhothenes was confused because if the Earth was flat then there should be no difference in the shadow cast by the two objects. But here, according to this man's description of the shadows, was proof that there was a difference in the shadows of the two objects. He thought about this for quite some time and he realized that the only way for these observations to make sense was if the object were located on a curved surface. Only then would the shadows be different.

Show the demonstration with the sheet, show it flat first and then bend it.

Aristhothenes then paid a man to pace out the distance between Alexandria and Siene. The distance was 800 kilometers. He also determined that the angle between the two objects in the different cities must have been about 7 degrees in order to give the observed shadow shapes. Demonstrate this by holding two sticks to the ground and varying the angle of one so the shadow changes. This is also very similar to what they did with the bucket.

So how many degrees are there in a circle? 360, yes! So how many times does 7 divide into 360? About 50 times. Now, here is a very important step: we multiply 50 times 800 kilometers and from that we get an estimate for the circumference of the Earth.

Aristhothenes measured it to be about 40,000 km. This is correct to within a few percent. Not bad for 2200 years ago!

(If the students ask, it is actually 40,075.16 kilometers around the earth at the equator but they don't need to remember this.)

Okay, does everyone understand? Quite impressive eh? An African librarian 2200 years ago was the first to measured the distance around the Earth. Now its time to discuss what you want to do with your life!

Career Statements: Vision for What Ahead

[Estimated Time: 40 minutes]

Have the students hand you their career statements. Make sure the name, date, and school are written at the top. Sit in a circle and select one from the pile and ask that student to read his or her copy of their statement (remember that the students were supposed to write two copies.

After the student has finished reading ask him/her if there is anything more they would like to add.

What subjects to study?
What schools to go to?
How to afford school?
Who to talk to in order to find out more?
After school – where do you want to work?
What do you hope to achieve with this career? How will your career make a difference in the world 10-20 years from now?
What makes you want to pursue this career?

Work through a few more case studies from the pile of career statements.

DNA Dance

[Estimated Time: 20 minutes]

Okay, time for an activity. Everyone stand up. Last week we discussed cells, bacteria, and viruses. This week we are going to go a bit further into how cells and viruses work.

Where in a cell are all the instructions for the cell stored? [They may say nucleus, which is correct, but then say, where in the nucleus.] The information and instructions are stored in the DNA.

What is DNA? DNA stands for deoxyribonucleic acid. Can everyone say that: DEOXY-RIBO-NUCLEIC-ACID. Have them repeat this until the are saying it correctly.

Notice the middle bit, “nucleic” means it is found in the nucleus.

Okay, it’s a long word so we just call it DNA. DNA is a large molecule made of smaller molecules. And what are those smaller molecules made of? Yes, atoms!

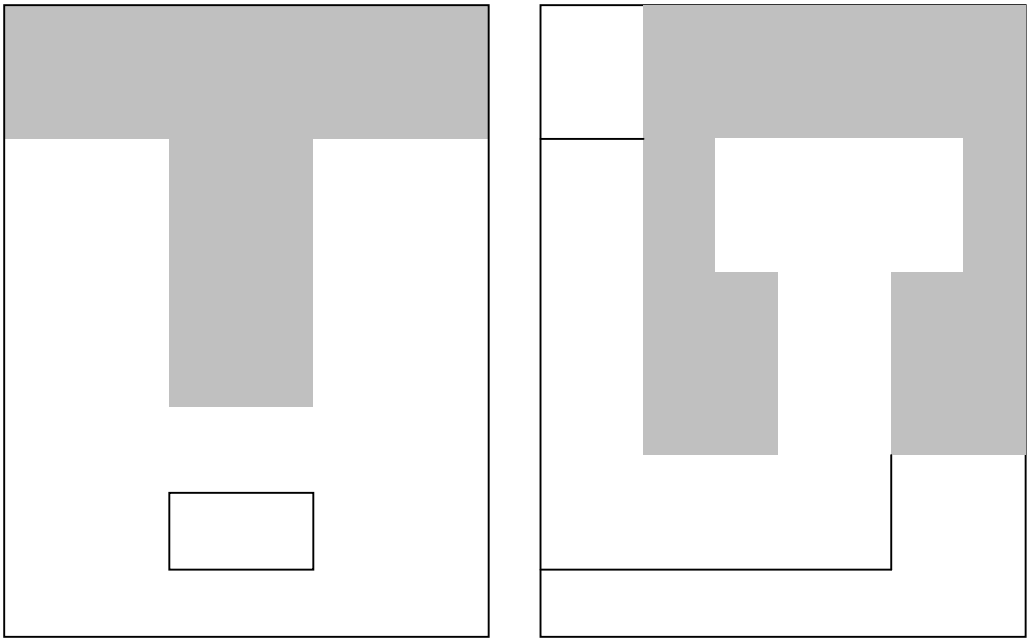
Lets discuss the structure of DNA: The students may have some ideas.

DNA exists as a double helix. A helix means a shape like a spring. The two strands of DNA wrap around eachother in a twisty way. Imagine taking a zipper from some trousers , holding the two ends and twisting them in opposite directions.

The teeth on the zipper can represent some of the molecules in DNA. These are the bases: Guanine, Cytosine, Adenine, Thymine. (No need to remember these!)
Because these are long words, they are commonly represented by their initials: G,C,A,T.

The bases act like the teeth of the zipper, but in a special way. Each base will only join to one other base:
C joins to G only.
A joins to T only.

These can be represented by some pieces of card cut out as follows:

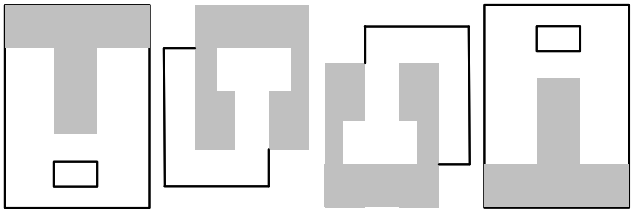


To replicate the DNA, imagine the moving part of the zipper undoing the two portions. As it goes along, individual bases are attached to each strand of the DNA. Because each base only ever attaches to one partner, we end up with two strands of DNA each the same as the first.

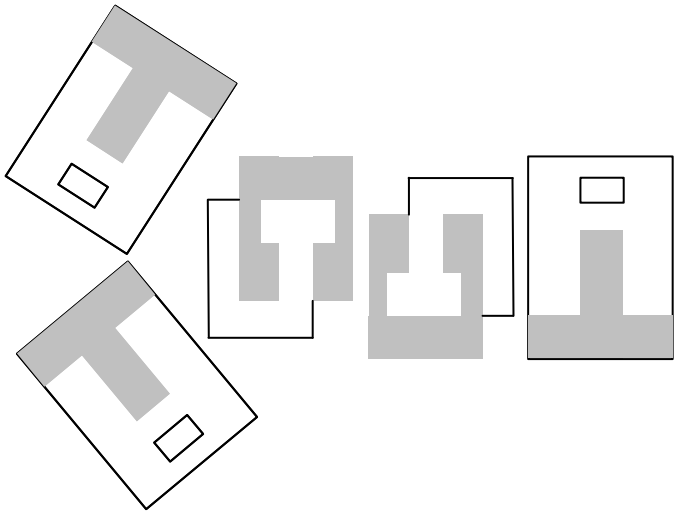
We’ll play a game to help understand this idea.

Ensure that you have eight base pairs. Select four students and give them each a different base. Ask them to stand side by side with the base held out in the left hand, and their right arm linked through the left arm of their neighbour.

Now select another four students and give them each a different base. Ask them to stand opposite their complementary base. They can do this by seeing if their base fits into the base opposite them. Ask everyone to look at the structure. Point out that the 'A's only join with 'T's and the 'G's with 'C's. They should now imagine about a million more students joining each chain to form a DNA molecule.

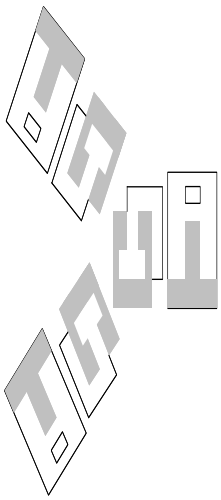


Now, to replicate this DNA. Give out the rest of the bases to eight more students. Move along the line, and separate the first base pair. Ask them to step back a bit. (Don't break the linked arms, though).



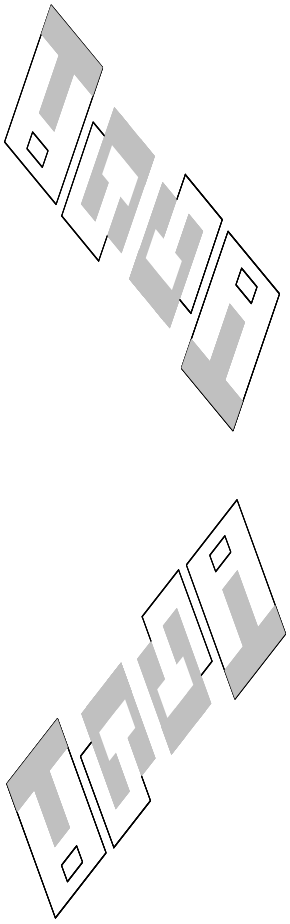
Help the "free" bases to work out which of them can now connect opposite the separated bases at the end of the chain.

Now separate the next base pair and add their complementary bases, connecting arms between the new person and the person paired up previously.



And continue until each original pair has been broken and joined to a new partner.

You should now have two strands of DNA the same as the first.



In normal cell division, the cell would now split taking one copy of the DNA into each new cell.

Virus DNA replicates in exactly the same way except that it will do it over and over again until the cell splits open.

Viruses and Arresting Exp Growth

10 min

We spoke last week about exponential growth. Remember that in the handshaking game, the number of infected people almost doubled every time until most people were infected.

We also discussed how human population increases exponentially if parents have more than two children per family and the problems this can cause.

How can we stop exponential growth?
[discussion]

Behavioral changes can stop the exponential growth of population if we stop having so many children. It can also slow the spread of diseases.

How could we change our behaviour to reduce the number of people who become infected with sexually transmitted diseases?

[Gather ideas but don't just go to Abstain, Be Faithful, Condomize – let them come to the ideas]

Now introduce a second hand shaking game. It is played the same as in week one excepting that now it may not be the volunteer who is infected, but could be one of them; and it is now "Disease X" instead of HIV:

1) Players may decide whether to shake hands and with whom. It needn't be a different person each time.
2) If a player decides never to shake hands they will receive two candies at the end of the game.
3) For each round in which a player shakes hands, they will receive one candy at the end of the game (Maximum 5 candies) Unless:
4) If a player contracts "Disease X" they will receive no candy

Play and at the end announce that it was the volunteer who was infected with "Disease X" at the beginning.
Give two candies to anyone who did not shake hands at all.
Go through the rounds of hand shaking and at the end, give the appropriate number of candies to any student not infected.

HIV Discussion

[Estimate Time: 30 minutes]

Have the students sit in a circle. Ask them about HIV/AIDS and make sure they participate in the discussion. Tell them that they can ask any questions they like. Make sure that you specifically ask any quite students if they have and thoughts, ideas, questions or comment.

If you like, use some of the HIV/AIDS brochures from UNICEF to guide you in your discussion.

Once you have finished, return to the large group gathering place.

Towers of Hanoi Challenge

Once the group has gathered together we will get 3-6 volunteers to have a showdown competition with the Tower of Hanoi Game. Using 5 discs they will compete to see who finishes first.

Cosmos Clubs

[Estimated Time: 20 minutes]

Discuss the establishment of a Cosmos Club with the students. Have the teachers recommend three students to help organize a basic club with a list of names. Describe to the students some of the activities we think might be fun for the club to initiate (e.g. Green-up day, compost piles, visiting orphanages and youth centers, etc.).

Have two CE Zambia team members appointed to that school. They will commit to keeping in contact with the teachers and the Cosmos Club of that school.

Thanks and Goodbye!

Thank the students and teachers for their fantastic enthusiasm and participation. Restate the Earth as Home themes, the Cradle to Cradle themes, Development from Within, Youth are the Future, Education is the Key!