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FOREWORD

Educational activities on General Studies triggered by the ancient Chinese astronomy exhibition

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When I was working on creating new exhibits and educational activities, I like to borrow ideas from historical items. Many modern day equipments need computer processor to operate, however most of the scientific principles were hidden behind the "black box" that primary students would have difficulties to comprehend. On the contrary ancient instruments were designed on the basic. The Ancient Chinese Astronomy Exhibition provides very good examples.

Most of us know how to identify direction. Normally a compass is needed. But how about when we are lost in an unfamiliar place such as a wilderness with no instrument on hand? Although we can use the rising and setting position of the Sun to learn where is east and west, our ancestors knew long ago that this would not be accurate enough. The direction of sunrise is northeasterly in summer and southeasterly in winter. Some clever ancestors found that to determine direction with good accuracy, all they needed were just a rod, a rope and a marker. A set of outdoor experimental activities designed along this line would help the students to understand the movement of the Sun with respect to that of the Earth. They would further be able to learn how to measure the time of a day, the length of a year, and the time of the seasons etc.

Ancient stone carvings may also be used to teach not just history or arts but also science. A stone carving in the exhibition called "Xihe holding the Sun and Changxi holding the Moon" is a very good example. It illustrates an ancient Chinese legend that the Sun was one of the ten sons of Xihe and the Moon was one of the twelve daughters of Changxi. The Sun was depicted as a circular disk with a crow inside and the Moon was another disk with a toad. An activity will lead the students to understand that our ancestors had witnessed the sunspots that they had taken as the crow. For the toad on the Moon, we now know that it is composed of regions of low lunar area known as the "seas" or "oceans".

Instruments on time measurement in ancient China can also be served to illustrate the science behind. It had been known that a dripping bag of water could be used to show time. It was later developed into a clepsydra. However a clepsydra with a single vessel suffers a drawback: the same time intervals between starting and ending time to be marked on a floating calibration rod would not be of the same length. Ancient Chinese had spent lots of effort to improve the timing devices resulting in multi-stage clepsydras and other instruments. Understanding the details is again another interesting scientific investigation for students.

Attached with this article are four examples to demonstrate the ideas mentioned. Additional information related with ancient Chinese astronomy can be found in the web pages of the Hong Kong Science Museum and the Hong Kong Space Museum.

Hong Kong Science Museum

Ancient Chinese Astronomy Exhibition

Activity Guide for Teachers

Activity 1 - Chinese Legends of the Sun and the Moon

Curriculum: General Studies of Primary School Year 1

Topics: Stars, Moon and sun - Objects in the Sky

Duration: one 35-minute session

Aims: To introduce the Chinese legends of the Sun and the Moon

After the activity, the students should be able to

- say something on ancient legends about the Sun and the Moon (especially the well-known Chinese legends 'Ten Suns shot by Yi' and 'Flight of Chang'e to the Moon')
- share their views on the difference between legends and facts

Basic Concpets:

Ancient Chinese legend in 'Classics of mountains and Seas' said : "There are ten suns living in Fusong. One sun comes and one sun is out. They are all carried by a crow." It means that there are ten suns in the sky and they take turns to come out and they are all carried by a black crow.

Ancient Chinese legend in Huainanzi (The book of Huainan; Compendium of Natural Philosophy) said: " At the time of Emperor Rao, ten suns appeared in the sky. The burnt farm yields, killing grass and trees and the people as a result did not have anything to eat..... Rao deployed Yi ..... Yi shot down the suns ..... the people were all happy." The legend described that ten suns once appeared together and Yi shot down nine of them and only one left in the sky until nowadays.

Ancient Chinese legend said "Chang'e, the wife of Yi, stole the longevity pill. She took in the pill and flight to the Moon ..... Chang'e stayed in the Moon which was what we saw as the toad on the Moon'. The legend explains Chang'e's flight to the Moon and the story of the 'Toad' on the Moon.

There is no evidence to prove that ten suns once existed. But there is possibility that the ice crystals in the cloud may refract sunlight and produce multiple images of the Sun.

We now know that there is no living thing on the Moon. The mare basins on the Moon are relatively dark regions which looked like a 'toad' from the ancient people's imagination.

Preparation for Activity:

1	Picture of 'Xihe Changxi Stone Carving'. They are artifacts of the Ancient Chinese Astronomy Exhibition.
2	Picture of the Sun with sun spots
3	Picture of the full Moon

Activity:

1	Let students have a look of the artifacts or pictures of 'Xihe Changxi Stone Carving'
2	Explain to students that the carving was made in Han Dynasty which is dated about 2,000 years ago.
3	Ask students to guess which circle carved on the stone represents the Sun and which one represents the Moon
4	Explain to students that ancient Chinese thought that the Sun moved across the sky by riding on the back of the crow.
5	Explain that the crow as seen by the ancient people might be sun spots
6	Tell that in the Chinese legends there was a 'Toad' living on the Moon.
7	Show the picture of the Moon to the students and explain that the 'Toad' is merely a dark region (Mare basin) on the surface of the Moon.
8	Explain that the knowledge of astronomy in ancient times was not as good as today, so ancient people could only depict what they saw by way of legends.
9	Explain the relation between Flight of Chang'e to the Moon and Chinese Mid-Autumn Festival.
10	Ask students to find out the legends of the Sun and the Moon originated from various cultures.

Follow-up activity:

1	Compare the legends of the Sun and the Moon that students have found and display them on the notice board.

Hong Kong Science Museum

Ancient Chinese Astronomy Exhibition

Activity Guide for Teachers

Activity 2 - The North and the Noon

Curriculum : General Studies of Primary School Year 1/Year 6

Topics : Stars, Moon and sun - Objects in the Sky / Astronomical Phenomena

Duration : one hour activity session (The activity shall be conducted around noon time)

Aims: To introduce the use of the shadow of the Sun to determine directions

After the activity, the students should be able to

- differentiate the directions of East, South, West and North
- know that the shadow of the Sun changes in time
- know how the ancient Chinese use the shadow of the Sun to determine directions

Basic Concpets:

1	If students do not have an idea of left and right or front and back, supplementary activities are needed to introduce these ideas.
2	The Sun rises from the east and sets in the west. This is the first step to know about direction.
3	If the east is in the left and west in the right, then the front is south and the back is north. (* note that the directions of south and north in Chinese mahjong games are different from this concept. Teachers might have to point out this misconception.)
4	The directions the sun rises and sun sets are not always exactly due east and due west. By measuring the positions of the shadow of the Sun at various times and drawing lines and circle, we can accurately find the direction of east, west, south and the north. Ancient Chinese used this method to determine directions with high precision.

5	Other than using east, west, south and the north to indicate direction, the ancient Chinese employed the twelve Terrestrial Branches too. That is Zi, Chou,Yin, Mao etc. Zi represents north, Mao represents east, Wu represents south and You represents west. Due Wu, meaning due south, is equivalent to the time when the Sun is at the due south position.

Preparation for Activity:

1	This session has to be done outdoors during the noontime
2	Find a flagpost which can be reached by sunlight at noontime (or find a straight pole and make it stand perpendicular to the ground).
3	A long piece of rope.
4	A piece of white chalk

Activity:

1	About the time shortly before 12 a.m., aske the students to watch the shadow of the flagpost. Take the standing point of the flagpost as the centre(A) and use the rope and chalk to draw a circle whose diameter is a slightly shorter than the shadow of the flagpost.
2	Ask students to notice changes in length and direction of the shadow of the flagpost under the Sun. When the shadow of the flagpost's tip intersects with the circle drawn, tell the student to mark down the point (B) and record the time by using the chalk.
3	Ask student to continue to watch changes of the shadow of the flagpost and use the chalk to mark down every 5 minutes the position of the tip of the flagpost.
4	Continue with the observation until the shadow leaves the big circle and similarly mark down the point of intersection(C) with the circle and record the time.(note: the whole process might take more than an hour).
5	Use the rope and the chalk to draw a straight line (D) passing through (B) and (C) and indicate that this straight line is running east to west. Position of (C) is east and position (B) west.
6	With the help of the rope divide the straight line (D) into two halves and mark in the middle position (E).

7	Use a straight line to link up centre (A) and position (E) and explain to students that this line is the meridian - the line running from south to north. When standing at position (E), if the left is east, the right is west, then the front is south and the back is north.
8	This explains the origin of the term meridian in Chinese (it means the line of Zi-Wu). In ancient China, the Zi represents north and the Wu represents south.
9	Ask students to tell you about what time the shadow of the flagpost passes the meridian? And can they identify this position (say F)?
10	Explain that this is the way ancient people in China measure the north and south and the position of the meridian which is crucial in the placement of the gnomon.
11	Ask students to use other replacement (e.g. long stick) to repeat the experiment and discuss the pros and cons
Further Note	The higher the pole, the shadow of the tip of the pole becomes obscurer. Guo Shoujing of the Yuan Dynasty of China designed a device called 'Jingfu' (the shadow definer) to solve this problem. In a cloudy day, it may not be possible to record a full set of shadow positions at different times in a day. Guo Shoujing invented a 'Direction-Determining Table' (a square plane with 20 circles of various sizes) to do the measurement. With older kids, you can discuss why noon (that is when the shadow passes the meridian) is not exactly at 12:00 noon. You may also explain why we have to designate time zones. Students should not keep starring at the shadow of the Sun for a long time because sunlight reflecting from the ground may become too intense after continuous watching

Hong Kong Science Museum

Ancient Chinese Astronomy Exhibition

Activity Guide for Teachers

Activity 3 - The Winter Solstice

Curriculum : General Studies of Primary School Year 6

Topics : Astronomical Phenomena - Movement of the Earth

Duration : one 35-minute sessionactivity session (Students are required to record data in different days)

Aims: To introduce to students how the shadow of the Sun changes in a year and the concept of 24 fortnightly periods ('Jieqi') in Chinese calendar

After the activity, the students should be able to

- know that the positions of the shadow of the Sun at noontime varies day by day
- understand the function of the gnomon
- notice the characteristics of the shadows of the Sun at noon time on Summer and Winter Solstices
- know that the Chinese divides up a year into twenty-four fortnightly periods ('Jieqi')
- recognize some of the festivals in China or other places in the world related to 'Jieqi'
- understand that measuring the periodical change of the shadow at noontime we can determine the length of a year

Basic Concpets:

1	In places north of the Tropic of Cancer, the shadow of the Sun at noontime will be shortest on Summer Solstice and longest on Winter Solstice. (But for places south of it and north of the Equator like Hong Kong, the shadow is shortest not on Summer Solstice but in certain days between the Spring Equinox and Autumn Equinox (there are two days). But the day of longest shadow at noontime is still on Winter Solstice.
2	The Chinese divides a year into 24 'Jieqi'. In addition to Summer Solstice and Winter Solstice, two more important 'Jieqi' are Spring Equinox and Autumnal Equinox which fall between the Summer Solstice and Winter Solstice. The 24 Jieqi start with the Beginning of Spring, then respectively are Rains, the Awakening of Insects, Spring Equinox, Clear and Bright, Grain Rain, the Beginning of Summer, Lesser Fullness, Grain in Ear, Summer Solstice, Lesser Heat, Great Heat, the Beginning of Autumn, End of Heat, White Dew, Autumn Equinox, Cold Dews, Descent of Hoar Frost, the Beginning of Winter, Lesser Snow, Great Snow, Winter Solstice, Lesser Cold and Great Cold.
3	The first calendar in China 'Huangdi Calendar' already set down that a year has 365 and a quarter days.
4	Ching Ming festival is linked to the Jieqi - Clear and Bright. Traditionally people worship their ancestors in Ching Ming Festival. Winter Solstice though not a traditional festival, the Chinese people treat it more important than the Chinese New Year. And most families celebrate on that day. In many places, Winter and Summer Solstices are important days for celebration. For example in Britain, celebration activities are organized at the Stonehenge on these two days every year.

Preparation for Activity:

1	This activity shall be conducted a few days before the Winter Solstice or Summer Solstice in outdoors.
2	Complete the Activity 'North and the Noon' first.
3	Find a flagpost in an open ground at noontime (or erect a vertical pole on the ground).
4	A long piece of rope and a piece of chalk

Activity:

1	Discuss with students on the concept of directions, the meridian and noon. (Refer to the activity "North and the Noon").
2	Ask students whether they could see the position (F) that was defined in the previous activity?
3	Ask students to notice the changes in the position of flagpost shadow before noon.
4	When the shadow passes the meridian, ask students to mark down the point (G)
5	Ask students whether position (F) is the same as position (G)?
6	Explain that the length of the shadow at noon varies everyday.
7	Point out the changes in the length of the shadow at noon will repeat every year.
8	Explain that the simplest astronomical instrument in ancient China was designed for measuring the changes in the shadow of the Sun in a year.
9	Tell that the ancient Chinese astronomical instrument for measuring shadow of the Sun(the gnomon) had a vertical pole ('biao') and a horizontal plane on the ground to measure the length of the shadow
10	Explain that the day when flagpost's shadow reaching the most southern position is Summer Solstice and the day the shadow reaching the most northern position is Winter Solstice.
11	Explain that the Chinese divides a year into 24 Jeiqi. Summer Solstice and Winter Solstice are two of them.
12	Ask students whether they have any celebration activities on the days of Winter Solstice and Summer Solstice.
13	Ask students to continue to observe the length of the shadow in the next couple of weeks to see if the days of Summer Solstice and Winter Solstice can be determined by just observing the changes in the length of the shadow.
14	See if students can find the exact day of Summer Solstice or Winter Solstice.
15	Explain to students that for a long time in history, the ancient people did not really know the causes of Jieqi.

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Activity Guide for Teachers

Activity 4 - Time Measurement

Curriculum : General Studies of Primary School Year 1 / Year 6

Topics : Stars, Moon and sun - Objects in the Sky / Astronomical Phenomena - Motion of the Earth and the Sun

Duration : one 35-minute activity session

Aims: To introduce to students how to measure time by a clepsydra

After the activity, the students should be able to

- know how to make a simple clepsydra
- know the correlation between clepsydra and time
- know of some methods to improve the precision of time measurement using a clepsydra

Background:

1	Long time ago, people discovered that a dripping bag could be used to measure time and that led to the invention of clepsydra.
2	Early clepsydra has only one bottle which can only measure the time for draining out all the water.
3	Later on they added a sinking ruler (later they also introduced a collecting bottle with a floating ruler in it). They put marks on the ruler to measure shorter period of time.
4	The higher the water level, the faster the water leaks out because of the effect of water pressure. As such the mark on the ruler would not be evenly spaced.
5	Later on, multi-stage clepsydra was employed. In the first stage more water was used in order to keep the water level in the last stage constant throughout. This device maintain constant flow rate to fill water into the collector bottle.
6	Other than clepsydra, hour glass and burning incense were also used to measure time.

Preparation for Activity:

1	A one-litre plastic bottle with a small hole drilled at the bottom of it.
2	Take another one-litre plastic bottle for collecting water.
3	Use a basin to collect the overflow water.
4	A plastic ruler with a piece of foam attached to its bottom to enable it to float in water.
5	A watch with second hand or a stopwatch.
6	A 2-liter plastic bottle with a hole drilled at the bottom.

Activity:

1	Close the hole with your finger and fill up the one-litre bottle. Release your finger and ask students to measure the time for all the water to drain away.
2	Explain that this device is equivalent to the early clepsydra - the time unit is how long for all the water to come out.
3	Explain that a bottle can be placed under the clepsydra to collect the water coming out.
4	Ask students to think about how to use this clepsydra to measure double of the time interval or how to measure half of the time interval?
5	Put a floating ruler in the collection bottle and let students to experiment if the half-time interval can be correctly measured.
6	Explain that using a single clepsydra to measure time has a drawback that the time interval is uneven.
7	Discuss with students why interval is uneven and what method can be used to make the interval more even.
8	Ask students to make a two-stage clepsydra and try to test with the different designs (e.g. volume of the first stage is the same as the second stage, or volume of the first stage is smaller than the second one).
9	Discuss with students which design is better.
10	Put a floating ruler in the collection bottle again. And compare the measurements in two equal time interval
11	Explain that more accurate timing device was used in ancient China and multi-stage clepsydras had been employed
12	Ask students to find out what other methods were used in the past for measuring time.
13	See if the timing methods found by students are workable or not.

Relevant Websites

http://www.lcsd.gov.hk/CE/Museum/Science/temp-exh/acae/acae.htm

http://www.lcsd.gov.hk/CE/Museum/Science/aca/index.htm

http://www.lcsd.gov.hk/CE/Museum/Space/FAQ/c_index.htm

http://www.lcsd.gov.hk/CE/Museum/Space/Education/c_index.htm