

Gaining Holistic Insight to Inthakin Festival via Stellarium Sky-mapping

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Abstract: The Stellarium, a planetarium software to visualize the ancient sky, is the most helpful software used in the *Loy Krathong* Module teaching in SCiUS CMU at Chiang Mai University Demonstration School. This module emphasizes astronomical content related to the festivals and beliefs in *Lanna*. Based on this tradition that the ancient *Lanna* astronomers had been using the star to determine the season. This paper demonstrated how the Stellarium software could be used as a learning tool for students to enquire, as a case study on which star is related to the *Inthakin* Festival in Chiangmai, Thailand. By visualizing the ancient sky, it enhanced student's imagination of how ancient *Lanna* astronomers used the star to determine the rainy season related to this festival in three different periods. The software revealed that the star was the Pleiades. Furthermore, it astronomically simulated how the ancient astronomers viewed the sky, and how the star could determine the year to which one extra lunar month must be added to synchronize the Lunar year with seasons.

Keywords: Stellarium, virtual archaeoastronomy, *Inthakin* Festival, *Lanna*, Pleiades

1. Introduction

Nowadays, holistic learning and teaching, such as the concept of problem-based learning through scientific processes and collaboration, is an effecting concept for education, which is still less well done by educational institutions. In addition to science, there are social sciences in a wide range of disciplines such as anthropology, archaeology, geography, history, philosophy, political science, religion, agriculture. This concept is embedded in the curriculum for The Science Classrooms in University-Affiliated in School Project under supervision of Chiang Mai University (SCiUS CMU) at Chiang Mai University Demonstration School in the *Loy Krathong* Module emphasizes in astronomic content related to the festivals and beliefs in *Lanna* (presently northern Thailand) such as *Songkran* Festival, *Inthakin* Festival, and *Loy Krathong* Festival. One of the activities of this project was a site survey at Chedi Luang Temple, Chiang Mai province, where Inthakin, the Chiangmai city pillar, is located that involving worship and tradition as *Sai Khun Dok Inthakin Festival*.

The festival begins on the 12th of the waning moon day of the 8th *Lanna* lunar month and runs over seven days and ends on the 4th of the waxing moon day of the 9th month (around May). This ancient festival indicates the starting of the rice farming and rainy season, officially starts in mid-May until mid-October due to the Southwest monsoon, resulting in heavy rain all over the country. This festival is also related to the history of the founding Chiang Mai city, rooted in the ancestor wisdom on seasonal examination, with the strong believes that rain according to the season will provide the city prosperity and peace. Therefore, this tradition is significant to Chiang Mai and worth preserving and passing on to the younger generation to study and cherish this local wisdom forever.

After study a related topic, students have learned that in ancient times, a year length was based on a sidereal year which is an annual seasonal determines by positions of the Sun in a complete revolution with respect to a specific star uses either the opposite reference star or the opposite full moon. Ancient reference stars normally used are Spica, the Pleiades, Regulus, Aldebaran, and Antares, especially Spica which has been important for calendric reckoning since Hipparchus observed and recorded the position of Spica with respect to the Equinoxes (Saha & Lahiri, 1992). Ancient people of various ethnicities used stars, the Sun, and the Moon to determine the date, time, and agricultural

calendar. For example, Egyptians in the middle of the third millennium BCE might use the circumpolar star Kochab (β Ursae Minoris) and Mizar (ζ Ursae Majoris) to align the Great Pyramid at Giza to true north-south (Penrose, 1901). The ancient Chinese had to watch stars in the night to determine the proper time for planting crops. During the primitive period, the year length was indicated by the sidereal point of reference. The fixing of the solar annual date and the rectifying of the lunar year was suggested adding the intercalary month (Chu, 1947).

Then, students have searched for evidence about astronomy in *Lanna*. There are several records on using asterism to determine seasons found in northern Thailand. Kampengphet Astronomy Club found the Lower Northern Thais used two important reference stars namely Ursa Major (*Lanna* called an elephant star) and the Pleiades (*Lanna* called a fan star). If they saw the Ursa Major pointed its trunk of the elephant straight up, means, it's time to wake up to do farming; or using the Ursa Major to defy the 3rd Lunar month to stop rice threshing. Ancient books by many venerable *Lanna* monks, such as *Pathamamullaloka*, version of the *Abhijaiyakhaipi* (InJan, 2018), *Arunawadi Sutra* (National Library, 1990), and the *Lanna Triphumi Scripture* (Fine Arts Department, 1990), documented the use of asterism for seasonal determination, directions when lost in the forest, *Lanna* astrology and Buddhist cosmology, illustrated their expertise in using stars to establish a calendar. These raised a question in the classroom on which star is related to the *Inthakin* Festival and how such a star can indicate the leap-month year.

The Stellarium software, an open-source planetarium for personal computers, was the essential tool to help the student simulating the study of the ancient night sky view on the astronomical phenomenon of the related stars. It shows a realistic sky in 3D, just like what you see with the naked eye, binoculars, or a telescope. It is also opened to interested parties to join the team for further development. It is under the copyright of GNU General Public License (GUN GPL). This paper demonstrated how the Stellarium software can be used as a learning tool for students, as a case study about astronomy related to the *Inthakin* Festival, with the objective to find out on which star that the ancient used to mark the timing for this festival. The cosmical, acronychal, and heliacal rising and setting of the stars in particular relation to the Sun, namely at or close to sunrise and sunset, used in ancient times (Komonjinda et al, 2020) were also investigated on the new moon day. Furthermore, we performed an astronomical simulation on how the ancients observed the sky view and how the position of a star can be indicated a leap-month year.

2. Materials and Methods

The Stellarium software was applicable to simulate the study of ancient astronomers on the 15th day of the waning moon of the 8th *Lanna* lunar month (or new moon day of the 8th month: *NMD8*) from those three different periods of *Lanna* Kingdom, as follows:

1. *Mangrai Period*: from 1296 to 1298. The *NMD8*-dates were sought out by referring to the founding date of Chiangmai on the Wat Chiang Man inscription, which was equivalent to 19 (12, for Julian) April 1296 (Saelee et al., 2021b). The year 1296 and 1298 were regular years, and the year 1297 was a leap-month year as used in the Burmese Calendar (Saelee et al., 2021a).
2. *Chet Thon Period*: from 1825 to 1827. The year types and *NMD8*-dates were found by using the evidence from the date mentioning in the *Chronicle of Chiangmai* about the worship of Chiangmai city during the *Chet Thon* Dynasty (Wichienkaeo & Wyatt, 1995, p.209), and found that the year 1825 and 1827 were regular years, and 1826 was a leap-month year.
3. *Present Period*: from 2019 to 2021, the year 2019 was a regular year, the year 2020 was a leap-day year, and the year 2021 was a leap-month year according to the Thai Civil Lunar Calendar.

The case study was proceeded as follows:

1. To identify a marked star indicating the rainy season from past and present-day on the new moon day during the *Inthakin* Festival. We used Stellarium, set location at Chiangmai, Thailand ($18^{\circ}47'27.60''\text{N}$, $98^{\circ}58'41.53''\text{E}$), adjusted the required date on the *NMD8* of the selected years and time at 24:00, and collected the star map images by choosing a proper background, i.e., keep the ecliptic line in a circle.
2. To simulate ancient *Lanna* sky view to learn how the position of a star can indicate a leap-month year, and to visualize the acronychal, cosmical, and heliacal rising/setting of stars with respect to the Sun at dawn and dusk. We adjusted the time in Stellarium for the Sun rising/setting, then obtained the east/west sky view.

3. Results and Discussion

3.1 The Sun Position on the New Moon Day during the Inthakin Festival

From the Stellarium, it was found that the Sun was in conjunction with the Moon (New Moon) each year in a different position but located near the Pleiades. To find out the related star, we illustrated the astronomical view by the star maps as shown in *Figure 1*.

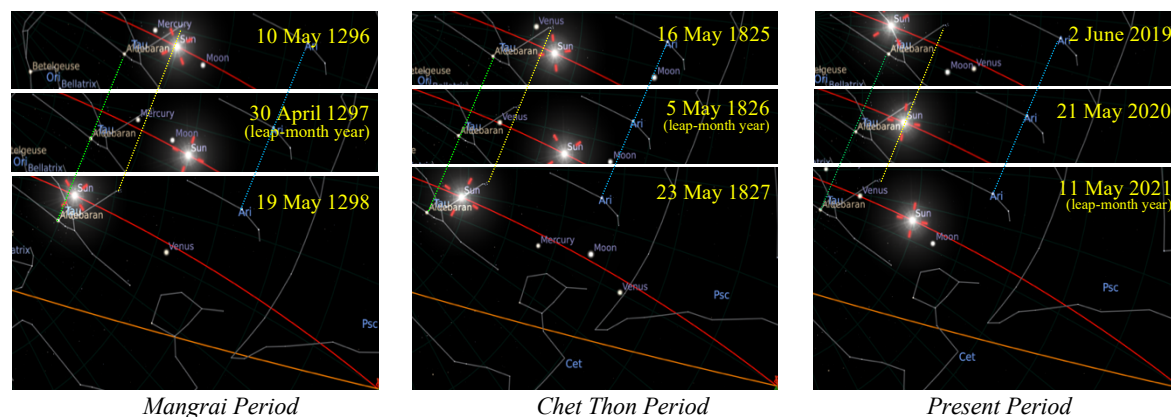


Figure 1. Star chart on the NMD8. In each period, three successive years were presented with the dot lines perpendicular to the ecliptic (red line) on which Aldebaran (green line), the Pleiades (yellow line) and Hamal (blue line) were fixed to indicate the Sun's position.

All the star charts of the three different periods indicated that the marked star on the NMD8 was in Taurus, i.e., the Pleiades and Aldebaran. On that day, the position of the Sun and the Moon varied between Hamal (α Arietis) and Aldebaran but mostly closed to the Pleiades.

The patterns of the Sun's position for *Mangrai Period* and *Chet Thon Period* were similar, unlike *Present Period*. Because the leap-month year was in the second year (AD 1297 and 1826) of both formal periods, but the later period was in the last year (AD 2021). Hence, the differences came from the different year types. It implies that if choosing the period of 2020, 2021, and 2022, the pattern of the last period might be the same as the early ones.

The star maps of the year 1297, 1826, and 2021 showed the relationship between the Sun positions with Aries (close to Hamal) and the leap-month year. As consequence, the Stellarium helps the students to understand how the ancient *Lanna* knew the NMD8 came too soon. It was a signal to add one more lunar month in these years to sync the lunar year with the season.

3.2 The Sun Rising/Setting on the New Moon Day during the Inthakin Festival

The sky view visualized by the Stellarium was used to give insight into how the ancient *Lanna* had observed. For instance, considering dawn, the stars could only be visible when it is dark enough before the effect of the sunlight. However, the visibility conditions vary according to place, the brightness of stars, atmosphere, air condition, season, etc. Therefore, *Figure 2* represents how the sunlight affected visible stars when the Sun was below the horizon at dawn before rising in 10-minute intervals for each picture.

From the observer's point of view, when looking to the horizon while the Sun is rising or setting. The sky views when the Sun was rising were presented only *Present Period*, for example, in *Figure 3*.

From *Figure 3: Left*, looking at the eastern horizon when sunrise, on the NMD8 in the Year 2019, Hamal was in the high position as it had risen for almost two hours, then the Pleiades rose approximately one hour before the Sun rising. For the years 2020 and 2021, the *Lanna* astronomers might have seen Hamal had already risen but not the Pleiades as it rose concurrently with the Sun. While looking in the west when sunrise as displayed in *Figure 3: Right*, the Year 2019, Corona Borealis was setting, so-called "cosmical setting." For the Year 2020, cosmical setting of both Corona Borealis and Antares appeared, but not Arcturus (as it set before sunrise). For the Year 2021, the *Lanna* people

might have seen cosmical setting of Libra, Arcturus, then Antares, and then Corona Borealis. Furthermore, there were also observed the stars rising/settling concurrent with sunrise/sunset.

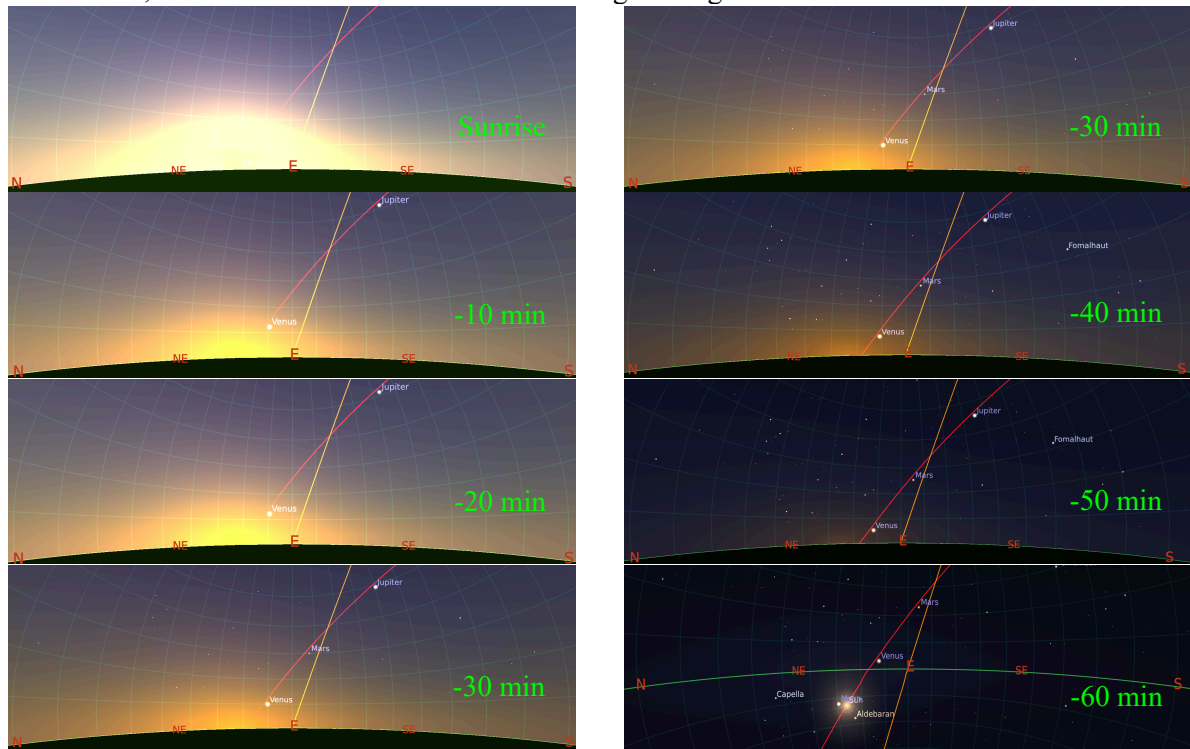


Figure 2. Sky map views in the east horizon visual visible starts during dawn, up to 1 hour before sunrise (bottom right) until the Sun appears on the horizon (top left)

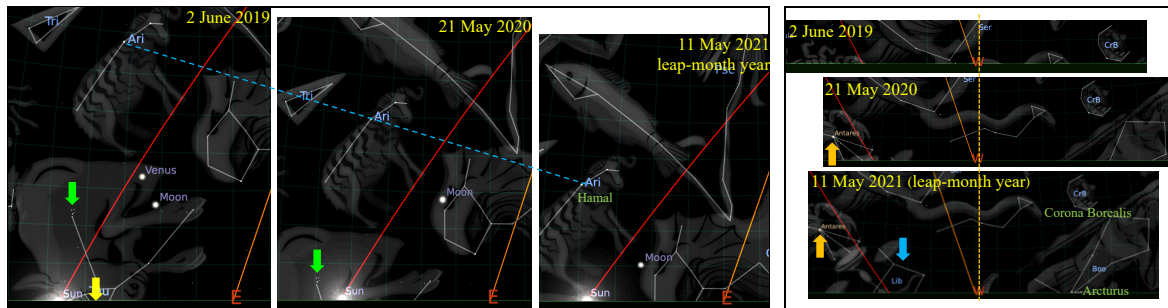


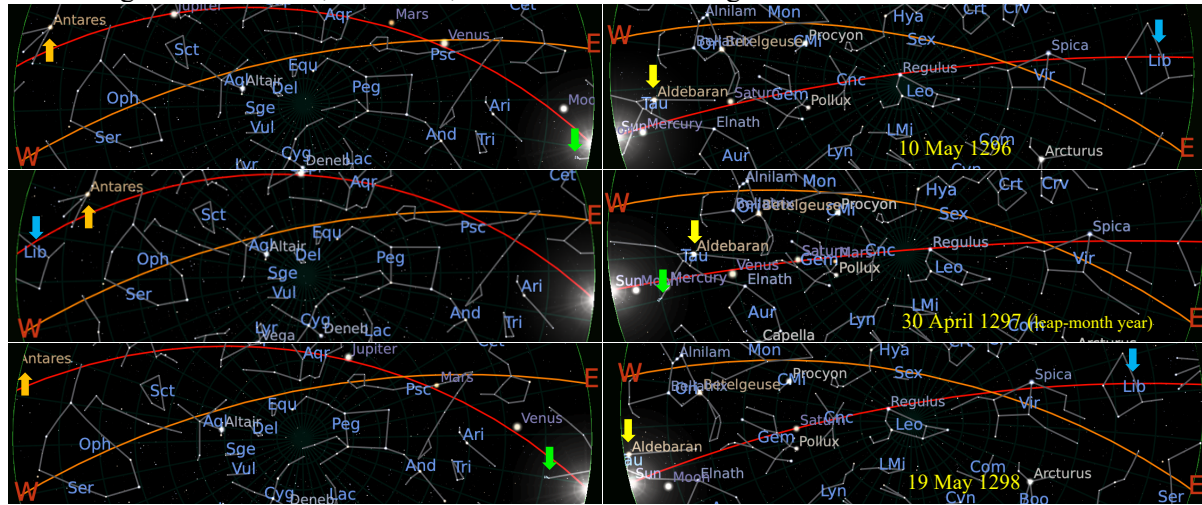
Figure 3. Left: eastern sky view and Right: western sky view when sunrise on the NMD8. The heliacal rising of the Pleiades (green arrow), and the cosmical setting of Libra (cyan arrow) had occurred when sunrise, while the heliacal setting of Aldebaran (yellow arrow) and the achronycal rising of Antares (orange arrow), appears when sunset. The ecliptic (red line) and the equator (orange line) are presented.

For an informative study, Figure 4 shows how ancient *Lanna* astronomers had viewed the sky with neglected atmospheric and sunlight distortion. For *Mangrai Period*, in the first two years (1296 and 1297) of the founding of Chiangmai, the Pleiades could not see at dawn, but it was visible at dusk after sunset, as a so-called "heliacal setting." On the other hand, a cosmical setting of Libra and Antares could be visible at dawn but not at dusk. However, in 1298 the Pleiades had risen before sunrise, so-called "heliacal rising."

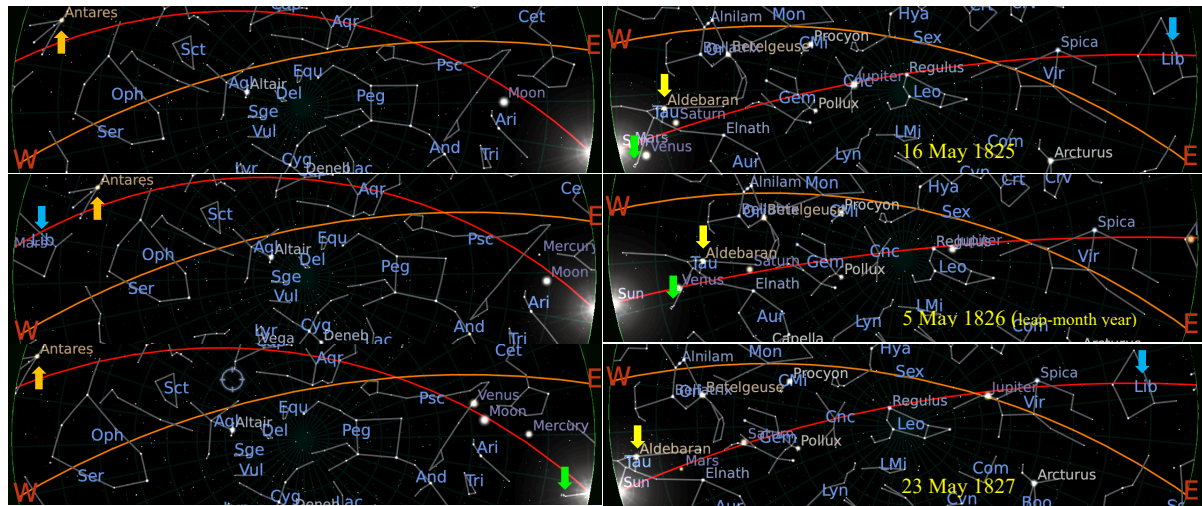
In *Chet Thon Period*, the cosmical setting of Antares could be observable in the west at dawn and a heliacal rising of Hamal in the east. The Pleiades could be visible after sunset whereas the heliacal setting of Libra, and Spica could be visible in the east after the sunset, so-called "acronical rising."

In *Present Period*, a heliacal rising of the Pleiades could be seen at dawn only in the year 2019 but not in the year 2020 (too close to the Sun) and 2021 (it rose after sunrise; see Figure 3: Left). However, it was visible after sunset at dusk as a heliacal setting, while an acronical rising of Libra and Antares could also be visible in the east, but it took further time from 2019 to 2021.

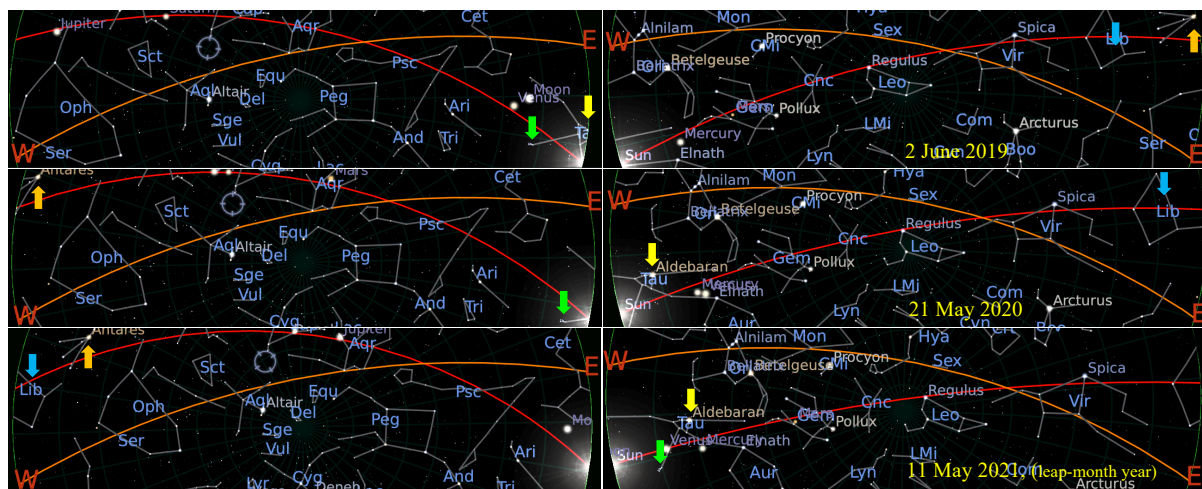
The sky map in *Figure 4* showed only the sequence for each star rising/setting, though the rising and setting time of the Sun, the Moon, and the stars could be gained from the Stellarium.



a) Mangrai Period



b) Chet Thon Period



c) Present Period

Figure 4. Sky view when sunrise (left) and sunset (right) on the NMD8 in the year indicated.

The Stellarium can illustrate that naked eye observation could do before sunrise and after sunset. Stars may not be visible at the start of the rising or setting, so observers must wait a while until the sky is dark enough, and a brighter star will see the first followed by the lesser ones. Therefore, this

software is a helpful tool that could apply to view astronomical phenomena in other festivals such as *Songkran* Festival and *Loy Krathong* Festival in further study.

4. Concluding Remarks

The Stellarium sky-mapping is a helpful tool for our study at SCiUS CMU. For the question of this study about using stars to indicate season by *Lanna*, via study asterism visible during the *Inthakhin* Festival from three time periods, we can completely understand and can conclude that:

1. The asterism associated with the new moon day during the *Inthakhin* Festival each year is Taurus. It is found that during the festival related to the star while the Sun is rising, especially a heliacal rising of the Pleiades, and that can be observed since the founding of Chiangmai until now.
2. The relationship between the Sun position and the stars could indicate a leap-month year, by which if the Sun in the *NMD8* is not closer to the Pleiades, but it was still in Aries instead and noticed a heliacal setting of the Pleiades. This informs that the *NMD8* arrives too soon then, the lunar month needs to be added so the Sun would locate back to near the Pleiades as in the previous year, resulting that the calendar will keep synchronizing with the seasons.

However, without the sky maps from Stellarium, it would be impossible to conduct the SCiUS CMU's *Loy Krathong* Module and understand how the ancient used stars to clarify the season to the younger generation with just starting the first Astronomy course.

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