THE SCIENCE OF *FALAK* ON VIRTUAL REALITY

Achmad Mulyadi
Institut Agama Islam Negeri Madura
mulyadidik71@gmail.com

Abstract

In the era of the industrial revolution 4.0, astronomers as well as modern society in general cannot turn away from the reality of virtual life. People get information, read and study any knowledge is very easy because everything is available in their hands. Faced with this condition, what about astronomy scholarship? Amid the assumption that astronomy and experts are very rare. So astronomers are demanded to be able to adapt and develop themselves with 'literacy' technology to be able to package the astronomy knowledge and present its content to the public easily and to construct it in digital form. Why does this virtual reality have to be faced and how to deal with it? Associated with efforts to answer the needs of the public about astronomical scholarship in virtual reality, various innovations and creativity of astronomers emerged in the form of digitizing material, books (books) and astronomical applications. This variety of innovations will increase the interest of millennial students to learn and master it. Through this paper,-some of the digitization pattern-, the author will study it with the content analysis method and describe it descriptively-interpretatively. From the results of studies, the author has led to a conclusion that; the first, found a number of patterns of celestial scientific digitalization; from the side of the content, the digital astronomical material consists of the calculation of qibla direction, prayer time, the beginning of the month and eclipse and the practice of its determination, from the media aspect, the astronomy knowledge is presented through social media, such as facebook, instagram, whatsApp and youtube; through website-based media, such as bimasislam.kemenag.go.id, and if.walisongo.ac.id., in the form of smartphone applications, such as digital falak, mizwandroid, qiblat, usholli and so on. While the design of the presentation is varied, in the form of text,

video, images and pdf. The second, each of these patterns has made a valuable contribution to the virtual learning of astronomy for millennial society in the current era of the industrial revolution 4.0.

Keywords: digitalization, book and celestial application, santri milineal

Abstrak

Di era revolusi industri 4.0, para ahli falak sebagaimana halnya para masyarakat modern pada umumnya tidak bisa berpaling dari realitas kehidupan virtual. Masyarakat mendapatkan informasi, membaca dan menelaah ilmu apapun sudah sangat mudah karena semuanya sudah tersedia di tangan mereka. Menghadapi kondisi ini, bagaimana dengan keilmuan falak? Di tengah asumsi bahwa keilmuan falak dan ahlinya sangat langka. Maka para ilmuan falak dituntut bisa beradaptasi dan mengembangkan diri dengan 'melek' teknologi untuk mampu mengemas keilmuan falak dan menyajikan kontennya kepada masyarakat secara mudah serta mengkontruksinya dalam bentuk digital. Mengapa realitas virtual ini harus dihadapi dan bagaimanakah menghadapinya? Terkait dengan upaya menjawab kebutuhan masyarakat tentang keilmuan falak pada realitas virtual, muncul beragam inovasi dan kreativitas para ahli falak dalam bentuk digitalisasi materi, buku (kitab) dan aplikasi falak. Ragam inovasi ini akan meningkatkan ketertarikan para santri milineal untuk belajar dan menguasainya. Melalui artikel ini, penulis akan mengkaji beberapa pola digitalisasi tersebut dengan metode konten analisis dan menguraikannya secara deskriptif-interpretatif. Dari hasil kajian yang penulis telah lakukan mengarah pada sebuah kesimpulan bahwa pertama ditemukan beberapa pola digitalisasi keilmuan falak. Dari sisi kontensnya, materi digital keilmuan falak tersebut berupa perhitungan arah kiblat, waktu solat, awal bulan dan gerhana serta praktik penentuannya. Dari aspek medianya, keilmuan falak tersebut tersajikan melalui media sosial, seperti Facebook, Instagram, WhatsApp dan Youtube; melalui media berbasis website, seperti bimasislam.kemenag.go.id, dan if.walisongo.ac.id., dalam bentuk aplikasi Smartphone, seperti aplikasi Digital Falak, Mizwandroid, Kiblat, Usholli dan lain sebagainya. Sedangkan desain penyajiannya beragam, yaitu berupa bentuk teks, video, gambar dan pdf. Kedua, masing-masing pola tersebut telah memberi kontribusi berharga untuk pembelajaran virtual keilmuan falak bagi masyarakat milineal di era revolusi industri 4.0 saat ini.

Keywords: digitalisasi, applikasi buku dan bola langit, santri milenial

A. Introduction

World is now entering the era of industrial revolution 4.0, that is the era that emphasize on the pattern of digital economy, artificial intelligence, big data, robotic, and so on or as known as the phenomenon of disruptive innovation. Facing those challenge, education teaching and strategy in the university as well as in general society are demanded to change the quality for the next generation, including producing lecturer and scientist. Then, how about activist of *falak* science? Now is the era of resurrection of *falak* science. *Falak* science is no longer called a rare science, because there many experts,

activist, observer and reviewer of *falak* science. However, in the other side *falak* scientists in Indonesia currently are still dominated by the generation of baby boomers and X generation that is digital immigrant. While college students, *santri* and the other productive circles currently are the milenial generation or as known as digital native.

The main challenge for *falak* science activist in the era of industrial revolution 4.0 is to move from the exclusive to inclusive, vertical to horizontal, individual to social, from traditional to digital by innovating to develope and to integrate the *falak* science on information technology (rampant use of social media) that currently become more brilliant.

Movement and change on this era of industrial revolution 4.0 looks so massive, because of that, if *falak* science just put forward the historical romanticism about the past achievements, so this science will develope very slowly, or even left by the milenial society and also left because run over progress of science and technology. To analyze and move this *falak* science to the way more massive, popular, effective and optimal, then make progress in science and technology as the media or learning tools and the development become very urgent and a necessity and also as the main duty of the experts and activists of *falak* science in the present and the future.

B. Histories of Classic *Falak* Science

The study of *falak* science in Indonesia, historically, periodized by three periods, that are (1) strating periode with the characteristic the basic of geocentric calculation, (2) middle periode with the characteristic there are many heliocentric calculation system and the use of *haqiqi time*, and (3) contemporer periode with the characteristic a marriage between *falak* science with modern astronomy science.

Starting periode, the study of *falak* science are found the implementation on *pesantren*. This matter can not be separated from long history before the entry of Islam in Nusantara. As understandable that before the presence of Islam in Nusantara, calendar system already known by society of Nusantara, that is calendar of Saka that is imported from India together with the entry of Hind religion. This system of Saka calendar was pioneered since 78 CE, exactly on March 14th 78 CE, that is one year after the

coronation of Prabu Syaliwahono (Aji Soko). Calculation in this calendar system are based on circulation of the sun surround the earth (solar system). On 1633 CE, coincide on 1043 H or 1555 Saka, Saka calendar system and *Hijriyah* (Islam) were integrated by Sri Sultan Muhammad or as known as Sultan Agung Anyokrokusumo that reign on The Kingdom of Mataram Islam. The form of integration is the number of the year continuing the number of the Saka year, but the system is replaced by using the Islamic or *Hijriyah* system of Sultan Agung's version, which is a calculation based on the circulation of the moon around the earth (lunar system).

This calendar system is then called the Islamic Javanese Calendar or Javanese Calendar. However, after the arrival of the Dutch colonialists in the 16th century, the calendar system was replaced by the Gregorian calendar system which was used for government administration and the official calendar. In addition, the ideas or theories of Ulugh Beik or Ulug Beg (d. 1449 AD) from Samarkan Uzbekistan, were also very influential in the study of astronomy in the archipelago, especially through Zeij Sulthani's table based on geocentric calculations. Although at the next stage this geocentric theory was annulled by Nicolas Copernicus' Heliocentric theory (1473-1543 AD), Ulugh Beik's influence with his Geocentric theory is still widely followed by Nusantara scholars today. The Ulugh Beik table itself entered the archipelago at the end of the 19th century AD by Sheikh Abdurrahman ibn Ahmad al-Misra who in 1314 H / 1896 AD came to Betawi. He taught the Ulugh Table to scholars, such as Ahmad Dahlan as-Simarani or at-Tarmasi (d. 1329H / 1911M) from Pesantren Termas Pacitan and Habib Usman ibn Abdillah ibn 'Aqil ibn Yahya from Betawi known as Mufti Betawi. Then Ahmad Dahlan as-Simarani or at-Tarmasi taught it in the Termas (Pacitan) area by compiling the book Tazkirah al-Ikhwan fi Ba'di Tawarikh A'mal al-Falakiyyah bi Semarang which was finished written in 1321 H / 1903M. Meanwhile, Habib Usman ibn Abdillah ibn 'Aqil ibn Yahya continued to teach at Betawi. He wrote the book Iqazu an-Niyam fi Ma Yata'allaq bi Ahillah wa as-Siyam (printed in 1321H / 1903M). Habib Usman has a student named Muhammad Manshur bin Abdul Hamid bin Muhammad Damiri bin Muhammad Habib bin Abdul Muhit bin Tumenggung Tjakra Jaya Betawi who wrote the book Sulam an-Nayyirain (first

printed in 1344H / 1925 AD). The book is still popular among salaf pesantren to this day.

In other areas, such as Sumatra, the study of astronomy is also developing, which is taught by scholars, such as Shaykh Thahir Djalaluddin through his work Pati Kisaran Pada Detaining Five Time (published in 1357 H / 1938 AD), and Natijah al-Ummi The Almanac: Muslim and Christian Calendar and Direction of Qiblat according to Shafie Sect (printed in 1951) and Djamil Djambek with his works Almanak Djamiliyah and Diya'al Niri fi ma Yata'allaq bi al-Kawakib.15 Another Falak figure is Syekh Ahmad Khatib al- Minangkabawi, Ahmad Rifa'i, and KH Sholeh Darat. The next period was marked by the emergence of Matla 'al-Sa'id fi Hisab al-Kawakib' ala Rasd al-Jadid and al-Manahij al-Hamidiyyah by Husen Zaid al-Mishra and al-Manahij al-Hamidiyah by 'Abd al-Hamid Mursi. Gais al-Falaki asy-Shafi'i. Those two books were brought by those who performed the pilgrimage and studied in the holy land. According to M. Taufik, many books on the science of astronomy written by the archipelago falak scholars in this second period are many of which are extracts from the two books. Among the books written by Indonesian scholars are the book al-Khulasah al-Wafiyah by Zubair Umar al-Jailani (printed for the first time in 1354 H / 1935 AD), the book Science of Falak and Hisab and the book Hisab Urfi and Hakiki by KRT. Wardan Diponingrat (printed in 1957), the book al-Qawa'id al-Falakiyyah by Abd al-Fatah as-Sayyid at-Tufi al-Falaki, and the book Badi'ah al-Misal by Mauhammad Ma'shum Jombang (w 1351 AH / 1933 M) .17 In addition to the book al-Matla 'as-Sa'id fi Hisbah al-Kawakib' ala Rasd al-Jadid and al-Manahij al-Hamidiyyah which are used as references, the studies of astronomy in Indonesia in general and pesantren in particular also refers to the book Almanac Menara Kudus by Turaikhan Adjhuri, Nur al-Anwar by Noor Ahmad SS Jepara (printed in 1986), al-Maksuf by Ahmad Soleh Mahmud Jauhari Cirebon, and Ittifaq Zat al-Bain by Muhammad Zuber Abdul Abdul Karim Gresik

The next period was the modern (contemporary) period, which was marked by a combination of Spatial Science and Astronomy. This discussion on the history of the development of modern Indonesian astronomy cannot be separated from the role of Saadoe'ddin Djambek. He was an astronomer from Bukittinggi who was born on March 24, 1911 M / 1330 H, and died on November 22, 1977 M / 11 Zulhijjah 1397 H, in

Jakarta. He was the son of the great scholar Sheikh Muhammad Djamil Djambek (1860-1947 M / 1277-1367 H) from Minangkabau. He developed Saadoe'ddin Djambek's expertise in the field of Exact Science and Phallology through the tasks he carried out in several places. In 1955-1956 M / 1375-1376 H, he became associate professor in the exact science subject at the PTPG (Teacher Education College) in Batusangkar, West Sumatra. He also gave a lecture on Falak Science at the Syari'ah Faculty of IAIN Sunan Kalijaga Yogyakarta (1959-1961 M./1379-1381 H.). As an expert in astronomy, Saadoe'ddin Djambek wrote extensively on the science of reckoning. Among his works are: (1) Time and Schedule of Popular Descriptions of the Travel of the Earth, Moon and Sun, the Djamiliyah Almanac, (3) Comparison of Tarich, (4) Guidelines for Prayer Times for All Time, (5) Prayer and Fasting in the Polar Regions , and (6) Reciting the Beginning of the Month of Qamariyah. This last work is the characteristic of Sa'adoeddin Djambek's thought in hisab at the beginning of the month of Qamariyah. It was he who laid the basis for calculating the beginning of the month of Qamariyah using hisab which is based on astronomy. One more contribution of Sa'adoeddin Djambek is in determining the geographic coordinates of the Ka'bah. While performing the pilgrimage, he took measurements of the geographical coordinates of the Ka'bah. He stated that the geographical coordinates of the Ka'bah are latitude (Φ) 21 ° 25 'N and longitude (λ) 39 ° 50' East. Sa'adoeddin Djambek's scholarship was continued by his students, such as Abdul Rachim who wrote works, among others; Falak Science (printed in 1983), Calculation of the Beginning of the Moon and the Solar Eclipse of the Newcomb system, and A. Mustadjib.

In addition to some of the scientists above, another scholar who took part in developing astronomy during this period was Taufik. In 1998, Taufik and his son compiled Win Hisab version 2.0, whose license right currently lies with the Hisab and Rukyat bodies of the Indonesian Ministry of Religion. Win Hisab is also known as the Ephemeris System which is widely used in the Ministry of Religion of the Republic of Indonesia and Islamic mass organizations. Since the birth of the Win Hisab software program version 2.0, written by Taufik and his son, then other software from astronomers has emerged, such as Mawaqit by ICMI Korwil Holland (1993), which Kholik refined into Mawaqitt version 2002; the Najmi falakiyah program by Nuril Fuad

(1995); Astinfo program by the Department of Astronomy ITB (1996), and the Badiah al-Mitsal program (2000), and Ahillah, for example, Pengetan and Tsaqib by Muhyiddin Khazin (2004).

Among the books on falak works by pesantren kiai are: Faidl al-Karim, Bughyat al-Rafiq, Anfa 'al Wasilah, Tsamarat al-Fikar, Irsyadul Murid, Taqyidat al-Jaliyah work, KH. Ahmad Ghozali bin Muhammad bin Fathullah (Born 7-1-1962), Lan Bulan Islamic Boarding School, Baturasang Village, Kec. Tambelang Kab. Sampang, East Java. His teacher is KH. Nasir Syuja'i Sampang, K. Abdun Nashir Kyai Yahya Gresik, Kyai Musthofa, KH. Muhyiddin Khazin Yogyakarta, KH. Noor Ahmad Jepara, and Muhammad Odeh from Jordan. The category of this book is haqiqi taqribi. Kitab Badi'ah al-Misal by Muhammad Ma'sum Pesantren Seblak Jombang. Tazkirah al-Ikhwan fi Ba'di Tawarikh A'mal al-Falakiyyah bi Semarang (1321 H / 1903M) by Kiai Ahmad Dahlan as-Simarani or at-Tarmasi Pesantren Termas, Pacitan. Iqaz an-Niyam fi Ma Yata'allaq bi Ahillah wa as-Siyam (1321H / 1903M) by Habib Usman ibn Abdillah ibn 'Aqil ibn Yahya Betawi, Jakarta. Sulam an-Nayyirain (1344H / 1925M) by Muhammad Manshur bin Abdul Hamid bin Muhammad Damiri bin Muhammad Habib bin Abdul Muhit bin Tumenggung Tjakra Jaya from Betawi, Jakarta. Mathla 'as-Sa'id fi Hisab al-Kawakib' ala Rashd al-Jadid and al-Manahij al-Hamidiyah by Husen Zaid al-Mishra. Al-Manahij al-Hamidiyah by Abd al-Hamid Mursy Ghais al-Falaki asy-Syafi'i. Al-Khulashah al-Wafiyah by Zubair Umar al-Jailani, Salatiga. Al-Qawa'id al-Falakiyah by Abd al-Fatah as-Sayyid ath-Thufi al-Falaki. Badi'ah al-Mitsal by Mauhammad Ma'shum (d. 1351H / 1933M). Jombang. Almanac Menara Kudus by Kiai Turaikhan Adjhuri Kudus. Nur al-Anwar (1986) by Kiai Noor Ahmad SS Kriyan Jepara, Al-Maksuf by Kiai Ahmad Soleh Mahmud Jauhari, Cirebon. Ittifaq Dzat al-Bain by Muhammad Zuber Abdul Abdul Karim, Gresik.

C. Falak Science on Factual Reality

1. Study of Falak Scientific Books in Pesantren

The existing and popular falak books in Islamic boarding schools do not have the same level of accuracy. Broadly speaking, the falak books written by Pesantren scholars can be divided into two categories: first, reckoning ‘urfi and second, reckoning haqiqi. Hisab ‘urfi is a reckoning system based on the average

time the moon travels around the earth so that the calculation results are less precise. While haqiqi reckoning is a system of reckoning based on actual time, remembering that each month is not always the same. The results of the calculation of this haqiqi reckoning system are more accurate and precise than the reckoning 'urfi. Hisab haqiqi itself consists of four categories, namely haqiqi taqribi, haqiqi tahqiqi, haqiqi tadqiqi, and haqiqi 'asri. Of the various categories of the haqiqi reckoning system, the accuracy rate of reckoning taqribi is the lowest, followed by a more accurate system, namely - in order: haqiqi tahqiqi, haqiqi tadqiqi, and haqiqi asri (contemporary reckoning).

Hisab haqiqi taqribi is a reckoning system that already uses astronomical and mathematical rules, but still uses simple formulas so that the results are less accurate. Among the books on the science of falak which are included in the reckoning haqiqi taqribi category are 'Iqaz Niyam, Sulam an-Nayirain, Fath ar-Rauf al-Mannan, al-Qawa'id al-Falakiyyah, and Risalah al-Qamarain. The haqiqi tahqiqi reckoning system is a computation system that uses a calculation method based on modern astronomical theories and the science of measuring spherical triangles and based on new observations, so that the results are more accurate. Among the books of the haqiqi tahqiqi reckoning system are al-Khlulasah al-Wafiyyah by Zubair 'Umar al-Jailani Salatiga, Almanac Menara Kudus by Turaikhan Adjhuri, al-Falakiyyah and Nur al-Anwar by Noor Ahmad SS Kriyan Jepara, al-Maksuf by Ahmad Soleh Mahmud Jauhari Cirebon, Ittifaq Zat al-Bain by Muhammad Zuber Abdul Abdul Karim Gresik, Hisab Hakiki by KRT. Wardan Diponingrat, al-Qawa'id al-Falakiyyah by Abd al-Fatah as-Sayyid at-Tufi al-Falaki, and Badi'ah al-Misal by Muhammad Ma'shum Jombang. The next category is reckoning haqiqi tadqiqi, which is a computation system that uses a calculation method based on modern astronomical theories and spherical triangle measurement science and based on new observations, but the level of accuracy is higher than haqiqi tahqiqi. Among the books by scholars that fall into this category are ad-Durr al-Aniq by Ahmad Ghazali Sampang Madura. Meanwhile, those which include beautiful or contemporary haqiqi reckoning are

the al-Mawaqit method by Khafid, the Ephemeris Hisab of the Ministry of Religion, al-Falakiyah by Sriyatin Shadiq, Nautical Almanac, Jean Meeus, New Comb, and Astronomical Almanac.

Judging from the qualification aspect of the study, if we look closely at the books studied, especially in the salaf pesantren, not all of the celestial scientific arts show uniformity. Some are still using the system of reckoning haqiqi taqribi, haqiqi tahqiqi, haqiqi tadqiqi, and haqiqi asri. An example that still uses reckoning haqiqi taqribi is the Al-Falah Ploso Islamic Boarding School, Mojo, Kediri, which uses the book Sulam an-Nayirain. Although this pesantren has adopted various systems of computation, from classical to contemporary, including its software systems, and has been proficient in calculating it, but for official teaching at the pesantren it still uses the book of Sulam an-Nayirain. This is a form of pesantren local wisdom to respect the author of the book and the policies of previous caregivers who have been implementing the book. Even in determining the beginning of the qamariah month, such as Ramadan, Shawwal, and Dzulhijjah, Pesanten Al-Falah uses its own calculation system. If the calculation results differ from the PBNU taqwim and or the Indonesian Ministry of Religion, then this pesantren will still use its own calculation results, so that in starting the month of Qamariyah it is often different from the PBNU and the Government. However, recently Al-Falah Ploso has begun to open up and participate in rukyat activities from the Ministry of Religion and has started to use the contemporary computation system.34 Even one of the pesantren's lecturers for Islamic studies created the Maktabah Syamilah program, the science of falak.35 The same is also applied at Pesantren Hidayatul Mubtadi'in Lirboyo Kediri who still uses the same book. However, in determining the beginning of the month Qamariyah tends to follow the PBNU or the results of the Indonesian Government Isbat session. Meanwhile, Pesantren Tebuireng (Jombang) teaches astronomy by using many references, according to the level. The Madrasah Tsanawiyah level uses the Durus al-Falakiyyah book, the Madrasah Aliyah level uses the Fath al-Rauf al-Mannan book, and for student lectures at Hasyim Asy'ari

University (UNHASY) uses the Ministry of Religion's Ephemeris reckoning system with the Phalanges in Theory textbook and Muhyiddin Khazin's practice. The learning of astronomy at the Tebuireng Islamic Boarding School has also been integrated with the practice of astronomy, such as the practice of the Qibla direction using the location goal and compass. Pesantren Tebuireng also publishes its own calendar with the result Kiai Ma'muri, in which the taqwim is also used by several pesantren and educational institutions around Jombang. Rukyat activities are usually held at Tanjungkodok Beach in Lamongan and Balai Rukyat Condrodipo Gresik. In determining the start of the month of Qamariyah, the Tebuireng pesantren tends to follow the PBNU and the Government. Several large Islamic boarding schools around Jombang also still teach falak, such as the Muallimin Denanyar and Muallimin Tambak Beras Islamic Boarding Schools which teach the book Sulam an-Nayirain, and the Pacul Gowang Islamic Boarding School which teaches the book Fath ar-Rauf al-Mannan. In addition to some of the pesantren mentioned above with learning models and reference books at the same time, there are also pesantren that teach falak with the Ephemeric system, such as Pesantren Mamba 'al-Ihsan Karanganyar (Kebumen). In determining the beginning of the month of Qamariyah, this pesantren follows the PBNU and the Government. In addition, there are also pesantren that still use the book Fath ar-Rauf al-Mannan in teaching at the pesantren, but in the initial determination of the month to follow the PBNU and the government, namely Pesantren al-Ittihad Poncol, Salatiga.

In general, there are two kinds of astronomy or the science of reckoning, namely 'ilmi and' amali. The science of astronomy is the science that discusses the theory and concept of celestial bodies, for example in terms of their origin (cosmogony), their shapes and sets (cosmology), the number of members (cosmography), their size and distance (astrometric), motion and attraction (astromechanical), and content of the elements (astrophysics). This astronomy is called a theoretical astronomy. Meanwhile, the science of astronomy 'amali is the science that discusses calculations to determine the position and position of

celestial bodies from one another. This cosmic astronomy is called practical astronomy. Science of astronomy 'amali is what the general public is known as the science of astronomy or the science of reckoning. 'Amalively, this science must be developed at the level of computational accuracy. For this reason, it is necessary to strengthen the science of falak at the level of essential tahkiki and contemporary calculations, no longer falak books that are urfi or taqribi in nature. Meanwhile, astronomical science which is 'scientific' must be done with enrichment of astronomical theories. In this case it can be done, including the provision of supporting media such as computer science so that the knowledge of hisab can be developed in making programs and software that can prepare data so that it feels younger, in addition to ensuring the accuracy and accuracy of the results of calculations, even in current developments, astronomical science must be developed on an android-based astronomy program. Factually, astronomical science can use Contectual Teaching and Learning (CTL). CTL is a learning approach that emphasizes the process of full involvement of students in order to get the material being learned. Then relate it to real situations and realities. In the end, this can encourage students to be able to apply it in everyday life. The concept of CTL has been applied in several universities where Falak Science courses are included in the curriculum, especially the Sharia Faculty. Contextual learning can help and even make it easier for learners to interact with natural phenomena, in addition to being assisted by supporting equipment.

The characteristics of contextual learning can be done in several ways including: (1) emphasis problem solving (emphasizing problem solving); (2) recognizes that teaching and learning need to occur in multiple contexts (recognizing the need for teaching and learning to occur in various contexts); (3) assist students in learning how to monitor their learning so that they can become self-regulated learners (helping santri as students in learning how to monitor their learning so that they can become regular independent learners); (4) anchors teaching in the diverse life context of students (linking learning with the diverse life contexts of the students); (5) Encourage students to learn from each other

(encourage students to learn from each other); (6) employs authentic assessments (using authentic assessments). This CTL concept can be applied in providing learning about direct observation of the phenomenon of solar or lunar eclipses. Learning in this form can be started with a review of the legal basis or arguments that discuss eclipses. Furthermore, following up on this legal basis even more to find out what suggestions should be done by Muslims when an eclipse occurs. This can be used as a first step to provide an understanding of the real nature. Astronomers are invited to understand the legal basis of the reasons for recommending the implementation of several series of worship during an eclipse. Furthermore, it can be taught about how to use tools such as telescopes to make direct observations and ensure the occurrence of these natural phenomena. Learning Falak Science directly in the field can be used as a practical and effective learning method. This also depends on the subject to be studied.

An example is by providing intensive training on telescopes to students in Sumenep Regency two days before the onset of GMT on March 9 2016. However, in this case the learning process is carried out directly with a limited number of students. The aim is that the material presented can be absorbed easily and the learning can feel more focused. The learning process about telescopes begins with an introduction then direct practice of telescope installation. Each participant representative is given a similar tool, so there is no difference in the tools used between one student and another. After the process of introducing and installing the telescope, they were guided by the procedure for operating the device, of course, guided by several experts in their fields. The progress and development of pesantren in this scientific study of falak will make a real contribution to the rukyat reckoning debate in the archipelago, both theoretically and practically determining the start of the hijri month, especially the beginning of the month of Ramadan, Shawwal and Dzulhijjah, as well as efforts to unify a single hijriyah calendar internationally.

2. Falak Scientific Study at Seminar, Training and Workshop Momentum

Seminars are generally a form of academic teaching, either at a university or given by a commercial or professional organization. A seminar usually has a focus on a specific topic, in which seminar participants can participate actively. Seminars are often conducted through a dialogue with a moderator, or through a presentation of research results in a more formal form. Usually, participants are not newbies to topics discussed at the university, seminar classes are usually reserved for students who have reached the upper level. The seminar system has the idea of bringing students closer to the topic being discussed. This seminar forum is a medium for transfer of knowledge in all scientific disciplines, including the science material of astronomy.

Among the organizations implementing the seminar with a theme related to astronomy is the Falak Science Department Student Association (HMJ). HJM Falak Science, Sharia and Law Faculty UIN Walisongo held a national seminar with the theme "Searching for New Criteria for Rukyat Imkanur" on Tuesday, November 12, 2019 at Auditorium II, Campus 3, UIN Walisongo. This seminar was attended by prof. Dr. Thomas Djamaluddin M.Sc. (Head of the National Aeronautics and Space Agency (LAPAN), Drs. KH. Slamet Hambali, M.SI. (Research and Development Coordinator of the PBNU Falakiyah institute), H. Nur Khozin, S.Ag. (Head of Sub-Directorate for Syari'ah Development and Hisab Rukyat of the Indonesian Ministry of Religion), and Dr. H. Ahmad Izzuddin, M.Ag. (Chairman of the Indonesian Falak Lecturers Association.

A similar activity, the National Seminar on Spatial Science which was held at UNISBA on Monday, May 30, 2016. The theme of this activity is "Revitalization of Phallic Science in the Modern Era of Approaches to Phantom Studies from various Aspects (Astronomy, Social, Culture, Philosophy of Science, Education, Economics, etc.)). This activity presented national figures such as Prof. Dr. Thomas Djamaludin M.Sc, Prof. Dr. Juhaya S. Praja, MA and Mr Tb. Hadi Sutikna. This activity was held, considering that today, science and technology are increasingly developing. Research related to Spatial Science

(Islamic Astronomy) is not only limited to argument and calculation, but also needs to be studied from various existing scientific aspects.

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Another institution that holds seminars is Islamic boarding schools. such as Pesantren Salafiyah Seblak Jombang. This pesantren held the National Falakiyah Mudzakarah or National Seminar on Falak Science on September 7, 2019. This seminar raised an important theme related to the state calendar institution, which is expected to play a role in determining the fall of important days such as Eid and important religious holidays in Indonesia, to the schedule. Hajj and its management. The Falak and Astronomy scientists who attended the seminar agreed that the state calendar institution had long been awaited and was indeed needed. Every time before Eid, people are always beating up their feet, for example, waiting for the announcement of exactly when Eid al-Fitr will fall, and people have long been trapped in different ways of determining Eid.

Another thought is the potential to expand the benefits of Falak Science for the good of human life. One issue that arises is the role of Falak Science in studying natural disasters. Falak Science can be developed to study the possibility of a disaster that is not at all from a predictive perspective. Falak science can also be developed to study climate change until the rain that used to fall only during the last "er" months — from September to December, now it can fall in July to

August. Falak Science can also be used to calculate the impact of climate change on the agricultural industry, livestock, climate change. This potential requires a common perspective that the ability of Falak Science so far has been focused only on determining the direction of the Qibla, determining prayer schedules, and determining the fall of the beginning of the Hijri month, especially in relation to Eid.

Several associations were also held in the form of seminars, including the Indonesian Falak Lecturer Association (ADFI). This association is classified as very routine for conducting seminars, including seminars held at IAIN Madura and IAIN Ponorogo. At a meeting in Madura, the Association strengthened its understanding of the beginning of prayer times. While at IAIN Ponorogo, this association develops ideas about the importance of the Falak Observatory in universities. For that, ADFI invited Prof. Dr. Thomas Djamaluddin, M.Sc., (Head of the National Institute of Aeronautics and Space / LAPAN) for the inauguration of the IAIN Ponorogo observatory. IAIN Ponorogo as an agency that has a vision as a center for the study and development of superior Islamic science in the context of realizing civil society in 2030, held a National Falak Lecturer Gathering which was attended by Falak lecturers who are members of the Indonesian Falak Lecturer Association (ADFI) on the 25th. September 2018 and the National Falak Seminar with the theme "Revitalizing Observatories and Laboratories for the Advancement of Phallic Science in Indonesia" with the resource person Prof. Dr. Thomas Djamaluddin, M.Si., Head of the National Institute of Aeronautics and Space / LAPAN and Dr. Ahmad Izzuddin, M.Ag., Chairman of the DPP Indonesian Falak Lecturer Association / ADFI. This seminar revived the treasures of research in the field of Spatial Science and Astronomy, especially in Indonesia to obtain the ideal concept of the observatory of falakiyah as a center for astronomical observation and scientific research.

The stretching of celestial scientific studies has appeared in various regions throughout the archipelago. Seminar activities such as the one held by the Center for Falak Studies at the Faculty of Sharia and Law UIN Ar-Raniry

Banda Aceh on Thursday 31 October 2019 carried the theme "New Direction of Falak Science: Technology for Determining the Direction of the Qibla and the Beginning of the Kamariyah Month". The activity which was supported by the Rukyat Hisab Agency, the Regional Office of the Ministry of Religion of Aceh, presented Ustaz Alfirdaus Putra, SHI., MH, who is one of the best alumni of the Faculty of Syari'ah and Law who joined the BHR team of the Ministry of Religion in Banda Aceh.

The study of astronomy in the form of seminars in various perspectives was carried out by the Islamic University of Bandung. The seminar with the theme "Revitalization of Spatial Science in the Modern Era: Approaches to the Study of Falak Science from various Scientific Aspects (Astronomy, Socio-Culture, Philosophy, Education, Economics, etc.) presented three resource persons, namely Prof. Dr. H. Thomas Djamaluddin, M.Sc (Professor of Astronomy-Astrophysics LAPAN), Prof. Dr. KH. Juhaya S. Praja, MA. (Professor of UIN Sunan Gunung Djati Bandung) and Hendro Setyanto, M.Si (Expert Observatory of Imah Noong Lembang).

Studies on the solar eclipse are also lively carried out by several competent institutions, such as universities and other institutions. The Ring Solar Eclipse, which is a rare phenomenon in Indonesia on December 26, 2016, made Tanjungpinang City Development Planning Agency hold an Astronomy Seminar with the theme "Earth-Moon-Sun". The seminar activity which presented speakers from Penyengat Island, namely Raja Malik Hafrizal and Dra. Hj. Raja Suzanna Fitri, M.Pd, both of them are local cultural observers who understand the history of the science of Falak or astrology which is contained in the ancient books of the Riau Lingga kingdom. The use of astronomy is familiar in Malay land and has been used by fishing communities as a guide and guidelines for seeing wind direction and weather before going to sea. This astronomy seminar activity is additional knowledge about celestial bodies, one of which is natural phenomena about celestial bodies, namely the ring solar eclipse.

In addition to factual scientific studies carried out in the form of seminars, many of these disciplines are also found in the Education and Training forum. There are several institutions that hold science education and training such as Higher Education, LFNU and MUI. In order to form cadres who are qualified in the field of astronomy or astronomy, Lajnah Falakiyah Nahdlatul Ulama (LFNU) organized "National Education and Training III Hisab & Rukyat Basic Level Zone I" on 15-17 September 2006 at the Pondok Gede Hajj Dormitory Jakarta. Zone I covers the areas of DKI Jakarta, Banten and West Java. The participants came from representatives of autonomous bodies (banom), institutions and lajnahs, as well as representatives of regional administrators (PWNU), and branch administrators (PCNU) who are in Zone I. There are three important materials to be taught. First, regarding the position and relationship of falaq science with fiqh science, and about the NU Falakiyah Lajnah which will be delivered by KH. A. Ghazali Masroeri. Second, about the calculation of the Qibla direction by KH. Muhyidin Hazin. Third, regarding the method of calculating prayer times that will be cared for by Drs. Sirril Wafa, MA. This activity resulted in the cadres having deep insight and knowledge in the field of hisab and rukyat, and were able to face the challenges of the times. The process of intense knowledge transfer towards astronomy through formal and non-formal teaching must continue.

The East Java Indonesian Ulema Council (MUI) also held a astronomy training. This training was held on 26-27 February 2011 at the Sukolilo Hajj Dormitory, Surabaya. This training is to remind the public about the important role of astronomy in guiding humans to worship. The science of astronomy plays an important role in guiding Muslims to worship because it is used as the basis for determining the direction of the Qibla, the beginning and end of the month of Ramadan. For this reason, MUI presented highly competent professional trainers from IAIN Sunan Ampel Surabaya, namely Drs Mukarrom and Nur Cholis Madjid. From this activity, the practical ability of the participants from

community organizations, mosque takmirs and general participants can apply it in their daily life.

Not wanting to be outdone by other institutions, universities also carry out training and training, such as the one held by the Sharia Faculty Falak Laboratory, UIN Maliki Malang. This university holds contemporary education and training and practice of rukyatul hilal to try to contribute to facilitating the formation of a vehicle for sharing and exchanging information and experiences in order to deepen and sharpen Falakiyah scientific insights both theoretically and practically for the general public, especially from the pesantren environment and from the Ministry. Religion that is concerned about Falakiyah Science. This effort was carried out in collaboration with the Falakiyah Study Institute in the form of Education and Training on the Contemprer Phalanges Application in the context of preserving and developing Falakiyah science, especially in East Java and Indonesia in general.

Islamic boarding schools also take part in promoting the science of astronomy. One of them is the training activities held by the as-Salam Islamic Boarding School. This pesantren held activities for two days (Saturday-Sunday, 7-8 May 2016) at the Assalaam Observatory. The Falak Science Education and Training is intended for Islamic Boarding School Caregivers throughout Sukoharjo Regency, covering 4 materials, namely Qibla Direction, Taqwim, Prayer Times and Eclipses. Among the participating pesantren were the Al-Mukmin Ngruki Islamic Boarding School, the Imam Suhodo Islamic Boarding School and the Al-Barokah Islamic Boarding School.

Education and training activities are also taught to ustadz, santri and students. Apart from teaching, the teachers of Pondok Modern Tazakka are also required to increase their capacity as teachers. On this occasion, PM Tazakka held a science training for teachers on May 27 2014 with the resource person Ustadz Farid Wajdi, S.H.I, MA. In this training, it is explained how we can find out when the times for prayer, fasting and Eid are coming. And we can find out

why in Indonesia there is a different time for Eid because there are different ways of calculating it. With this knowledge, the times of entry and exit of prayer times can be accurately determined. Likewise, in determining the beginning of the month of Ramadan as the first day of the obligation of fasting and the determination of the beginning of the month of Shawwal as the Eid al-Fitr which has often been controversial among Muslims in Indonesia, the role of Phalangist science is very prominent.

Training activities for students are carried out in Islamic boarding schools in collaboration with universities, such as that carried out by the Islamic Boarding School Boarding School (API) Sabilul Muttaqien Pekalongan Batealit Jepara in collaboration with the Technical Implementation Unit (UPT) of the Aswaja Study Center of the Nahdlatul Ulama Islamic University (Unisnu) Jepara on the day Friday, 19 July 2019. This training activity is filled with material on the Making of a Calendar in the Field of Falak Science and Graphic Design Sciences. It is important for Islamic boarding schools to be aware of the importance of scientific knowledge for students, especially with regard to making calendars, as well as providing provisions in marketing or distribution in a more attractive format.

Various activities to increase scientific understanding of falak, including the world of schools or madrasas, were also carried out at SMAN 1 Jombang. The school, which is located north of Jombang Square, East Java, is actually holding a science training course. The resource person who was presented was Ustadz Abdul Majid, a science teacher at the Al-Mahfudz Seblak Diwek Islamic Boarding School, Jombang. The activity was held for two days. Participants who took part were all students of class XI and XII. On Monday, July 6 2015, all male participants participated and Tuesday, July 7 2015, followed by all female participants. In this training students are made aware of the different conditions in determining the beginning of the month and the direction of the Qibla, calculating the direction of the Qibla and its measurements. And the musalla which is used as a measurement practice is musalla al-Barqi.

Astronomical scientific studies are also carried out in workshop forums. A workshop forum is a learning medium aimed at people who will discuss a particular problem and find a solution. There are 3 things that need to be considered in conducting the workshop, namely; first, the topic of discussion to be the basis for determining appropriate resource persons, second, the place of the workshop to create a comfortable workshop atmosphere for participants, and third, the layout to achieve maximum objectives in its implementation. This workshop forum is also used for the study and scientific study of astronomy for the general public. Usually credible institutions that are able to hold this event such as Islamic Community Guidance, Islamic Boarding Schools and Higher Education.

Among the institutions that hold the science workshop is LP2M (Institute for Research and Community Service) UIN Walisongo Semarang in collaboration with the Master of Science Study Program at the Faculty of Syari'ah and Law UIN Walisongo Semarang, namely the Ramadhan 1440 H. Imsakiyah Workshop. In this activity, LP2M presents two great resource persons, namely Drs KH Slamet Hambali MSI (Rukyat Research Agency of the Ministry of Religion of the Republic of Indonesia) and Dr. KH Ahmad Izzuddin MAg (Head of Master's Program in Phalangist Science, Faculty of Sharia and Law UIN Walisongo Semarang). The forum was attended by students, the Regional Office of the Ministry of Religion, the Religious Courts, the Indonesian Ulema Council, the Head of Nahdlatul Ulama Branch, Semarang Muhammadiyah Branch Heads, Semarang BMKG (Meteorology, Climatology and Geophysics Agency), and various Semarang media. Likewise, the workshop was held jointly, between the Directorate General of Sharia Development of the Indonesian Ministry of Religion and the Assalam Astronomy Club (CASA). This activist, observer and astronomer throughout Indonesia held a National Workshop, as well as a Gathering of the Indonesian Falak Science Community which took place in the Assembly Hall of the Assalaam Office. The workshop and gathering of the falak science community was attended by 160 participants consisting of

representatives of the falak community from all over the archipelago, including Palembang, Jambi, Lampung, Kalimantan, Sulawesi and most of Central Java and East Java. The activity is divided into several commissions including the institutional commission and the Public Relations communication and information commission. Several commissions have come up with ideas and input from participants for the development of astronomy in Indonesia. In this national gathering event was also attended by the Director General of Islamic Community Guidance of the Ministry of Religion of the Republic of Indonesia, Prof. Dr. H. Abdul Djamil, MA. The Director General of Islamic BIMAS gave tremendous appreciation for the activities of the astronomy community with the hope of contributing to the development of astronomy in Indonesia. In this workshop it was decided that the institutional declaration of the astronomical science community throughout Indonesia was named DPP Astro Physics and was elected by acclamation by the General Chairperson of the Astro Physics DPP, namely AR. Sugeng Riyadi, S. Pd, 2013-2016 with the Head Office at PPMI Assalaam. The results of the workshop recommendations from the astronomical science community throughout Indonesia formulated various proposals, inputs and formulations of activities that could be forwarded to various relevant parties, including the government (Ministry of Religion, Kominfo, BMKG).

D. Scientific Formulation of Falak on Virtual Reality

1. Falak Scientific Learning through YouTube

YouTube is a video sharing website created by three former PayPal employees in February 2005. This website allows users to upload, watch and share videos. Most of the content on YouTube is uploaded by individuals, although media companies such as CBS, BBC, Vevo, Hulu and other organizations have uploaded their material to the site as part of the YouTube partnership program. Unregistered users can watch videos, while registered users can upload an unlimited number of videos. Videos deemed to contain offensive content can only be watched by registered users aged 18 years or over. This YouTube website is very effective if it is used for enlightenment and learning

scientific fields such as astronomy. And this science of astronomy is easily found on this site with a variety of content.

Video about reckoning the time of midday prayer. This video was presented by the AHS Study Program, Faculty of Islamic Religion, Islamic University of Indonesia in 2017. This video is termed an online astronomy lecture. The presentation is like giving a test in class by displaying the formula and the calculation method on a laptop screen highlighted by the camera. This video contains an explanation of the reckoning of prayer times, especially the noon, asr and maghrib prayers starting from preparation to counting steps. This lecture teaches about reckoning prayer times part 1. The data used are ephemeris data. Thus, the system used is the ephemeris system. In his explanation, the latitude and longitude used is the Yogyakarta area. And in another video also presents continuation material, namely determining and calculating the direction of the Qibla.

Unlike the video about the initial reckoning of prayer times with Excel. This video explains the reckoning of prayer times using Excel. The tutors were Ihzan Zakian and Ismail Mufti from the Bandung Islamic Union Islamic Boarding School. The presentation is like giving a test in class by displaying the formula and the calculation method on a laptop screen highlighted by the camera. This video specifically explains the reckoning at dawn using the Ministry of Religion's criteria, namely a sun height of -20 degrees. However, the practice compared between -20 and -18 degrees of croteria with the result that there was a difference of 8 minutes. There are 8 editions with sequential explanations in the reckoning of this prayer time using two formulas.

Astronomical videos also circulate about prayer times. This video contains a guide to astronomical prayer times. The tutor is Prof. Dr. Thomas Djamaluddin, M. sc. This video was uploaded 9 years ago, but astronomically it becomes a guide for determining the current prayer times. The presentation is like giving kuiah in class by displaying verses and hadiths, and all the material is

displayed on the laptop screen which is highlighted by the camera. This video explains specific guidelines for the use of dawn time using the Ministry of Religion's criteria, namely sun altitude - 20 degrees, zuhr, asar, maghrib and evening. This video shows the calming of the sun with an emphasis on its height at the beginning of each prayer time based on the Prophet's hadith regarding prayer times. The time of dawn from dawn to sunrise, the time of midday is when the sun is slipped by determining the time of midday, dividing the difference between sunrise and sunset plus 2 minutes. Meanwhile, asar time, add the height of the shadow at midday time to the height of the object. The maghrib time is marked by the time the sun sets plus 2 minutes until the loss of the red light or syafaq, which is a sign of the arrival of the evening prayer time. In order to avoid differences between prayer schedules, the same criteria should be used as used by MoRA is 508872.

In line with the previous one, this video explains the calculation of the beginning of dawn. This video is somewhat unique in that it is practiced directly on the boat. The speaker, a woman, asked YouTubers to calculate the beginning of dawn on the boat. The tutor explained it using the nautical almanac system. Therefore, the calculation of the initial dawn of time in this video uses nautical almanac data. The practice was carried out in the Central Java Sea on October 1, 2019 by using a camera that highlighted how to calculate it. From the results of his calculations, it appears that dawn is currently at 04.08 WIB.

Other material is obtained about sundials. Many videos about the manufacture and use of sundials are found on youtube. These videos contain explanations on how to make sundials and their uses. The presentation is in direct practice form. Each video features a different tutor, how-to and material. However, the making of this sundial uses the same principles and objectives, namely capturing or using the sun's rays in a concave or flat plate vehicle and the sun's shadow will point to a number on a certain line to be used as a reference for the entry of prayer times. This sundial reference is called dengat bencet. Sun clocks in the form of bencet can be found in ancient mosques so that this

treasure has become a symbol of past Islamic civilization. Through these videos, anyone activist or observer of celestial science can follow this learning to become proficient.

Videos about tools can also be learned about rubu 'mujayyab. These videos contain tutorials on how to practice and use the rubu 'mujayyab, especially in measuring the height of the sun and the direction of the Qibla. The presentation is in the form of direct practice by students who are getting assignments and lecturers who are explaining to students. Each video features a tutor explaining the term and how to put it into practice. Rubu 'mujayyab, which literally translates to a quarter, is a counting tool in the form of a quarter circle to calculate geniometric functions such as the degree of object height. This tool is made of brass and there are several parts that need to be understood before use, namely; Markaz, (a point located on the 90 degree rubu 'mujayyab elbow, which has a small hole and there is a counting thread), Khoit, (the thread found in the markaz hole and extending beyond the rubu' mujayyab's body which ends with a pendulum (syakul) which functions as a counting tool, and between the two there are muri '), Syakul, (the pendulum at the end of the khoit functions as a counterweight so that the thread becomes erect and does not change during the calculation process), muri, (a small thread attached to the khoit, which functions as a marker and brain in calculating rubu 'mujayyab), Qous al-irtifa' (main arc that is worth 0 to 90 degrees in two directions (back and forth / back and forth), Jaib al-Tamam (line on the right side rubu 'mujayyab which connects markaz with the beginning of qous), as-sittiny (line on the left side of rubu' mujayyab connecting markaz with the end of qous), Juyub al-Mankusah (straight lines drawn from the tilapia pad a jaib Tamam towards the value of qous on qus al-Irtifa '), juyub al-Mabsuthoh (straight lines connecting the jaib value of jaib al-Tamam with the value of qous in Qous al-Irtifa'), Hadafatain (two protrusions that are located above as-Sittiny), Hadafah's hole (the inner hole which is located in line with the al-Sittiny line (between Markaz and the end of the qous), Dairot al-Mail al-A'dhom (in the form of a quarter-circle arc depicting the sun's

maximum declination of 23 ° 27 ' (= 23 ° .45), Qows al-Ashr (curved line drawn from the beginning of the qous to the as-sittini on jaib 42.3) and the setatif rod (a support pole consisting of a pole and a stative leg which functions to make it easier to measure , especially altitude). Using this rubuk is very easy and practical in measuring the height of the sun. This measurement can be done with two events, first, aiming directly at the sun and second, entering the sun's light into a small hole on the rubu 'then marking the khait or thread at the degree that is in qausul irtifa'.

Other materials can be learned about determining the day and market of the Hijri calendar. An explanation of the determination of the day and market of 1 Muharram 1437. This video is presented as a presentation of course material displayed on a layer and contains an example of a calculation by answering the question "when is the 1st of Muharram 1437 H". This video is guided by a tutor with an audible voice. The calculation starts from the number of days that have been running. Then determine the day and the market. If you are looking for 1 Muharram 1437, then the number of days is 508872. Then the number of days is divided by 7 to determine the day and divided by 5 to determine the market. The result is 0 after dividing by 7 which indicates Wednesday, and the remaining 2 is for markets that represent legi markets.

Another video can be found with different materials and tools, namely a video about practicing the direction of the Qibla for students using this istiwa. The implementation is assisted by four students, two as narrators are female students and two other assistants are students. The practice is carried out at the al-Fajar mosque Montorna Magetan on the day of the Prophet's Qibla. The practice of determining the direction of the Qibla in this video is done twice, first, using this istiwa'i tool and second, the shadow of the Prophet's Qibla. In using this term, the narrator begins by explaining the components used. The istiwa components consist of two gnomons which the inventor calls two istiwa sticks', a dial plane called the base circle of the iswand ', a level plane which is the base for the basic circle of the iswand', and threads. The two gnomons on this is

made of iron with a length of 10 cm and a diameter of 0.7 cm. The tip of the gnomon is pointed so that the shadow that falls on the focus dial becomes a point and is easily seen. The dials are made of plywood wrapped in a 360 ° sticker with a scale written as five degrees, so there is no need for an arc to help determine the azimuth of the Qibla and the azimuth of the sun. Likewise, the level plane is also made of plywood in the shape of an octagonal supported by three bolts which function as a tripod support and regulator of this level. The thread on this istiwa serves to draw the Qibla line. Istiwaaini is not equipped with a compact disk component as the calculation software, so to measure the Qibla direction with this istiwa have to do the calculations manually first. The calculations that need to be done are the azimuth of the qibla and the azimuth of the sun. The result states that the slope of the mosque is around 10 degrees. Meanwhile, in the practicum of using Rasdul Qibla, it is explained that the events of Rashdul Qibla only occur twice a year, namely May 27 at 16.18 WIB and July 15 in leap years around 16.27 WIB. In determining it, a practicing practitioner can take advantage of the window in the mihrab or something else. Whereas in the video, the practitioner uses this content directly. The results of the practicum carried out resulted in the same bias, namely 10 degrees.

2. Scientific Knowledge Falak Facebook, Instagram and WhatsApp

Facebook is one of the social media of the many Social Networks or Social Networking Sites in the world of websites. Facebook first appeared in February 2004 with Mark Zuckerberg as its founder. In its early days, Facebook was only intended for Harvard University students. Facebook opened membership for school children in 2005. A year later to be precise in 2006, Facebook opened a universal membership, from anywhere in the world, people can join Facebook. Benefits of Facebook has become the largest social networking site today, there are so many benefits of Facebook that we can use. The benefits of Facebook that are very felt in human life today are firstly, a place for promotion for those who are currently serving or doing business, second, a place for discussion in the form of a forum, and

third, a place to learn to study fields of science that we have never found before, including is Falak science.

In the scientific study of Falak, many groups were found in the Facebook media, including; first, the Falak Science Study Group. This group has 21 thousand members. To join this group, you must comply with the 4 disciplines of learning astronomy, namely, the main study material is to focus on hisab and other material is secondary, other materials such as announcements and advertisements are required related to reckoning science, words and sentences based on the principles of qaulan sadida and akhlakul karimah, members are entitled and encouraged to write, upload, ask as well as answer. As for the various materials for the study of astronomy that have been communicated, namely the practice of measuring building height and depth of wells, study of taqribul maqsod treatises held in Malingping sub-district, Lebak Banten district every Monday, socialization and studies of books and astronomical instruments, computation data- early reckoning of hijri month and application introduction. Second, Gorup Center for Hisab and Falak Muhammadiyah Studies. This group, which was created on November 28, 2018, has 12 thousand members. This group is an open group because anyone can find it and contains a variety of information from PP Muhammadiyah announcements about the determination of the beginning of the month of Ramadan, Syawal and Dzulhijjah to general recitation, such as the recitation of Muhammadiyah tarjih to other types of activities. Third, the Rukyatul Hilal Indonesia Group. The group that was founded by Mr. Mutoha Arkanuddin and created on December 31, 2017, has 6,015 members. This group is an open group for anyone who wants to know and provide information about celestial science, especially regarding observations or rukyatul hilal. Some of the information and studies that can be obtained are debates about rukyat and reckoning, different calendars, the movement of the sun, moon and asteroids, reference books about astronomy, results of reckoning and hilal observations.

Apart from Facebook, WhatsApp Messenger is the best media to use. This media is a messaging application for smartphones (smartphones) with a basic similarity to BlackBerry Messenger. WhatsApp Messenger is a cross-platform messaging application that allows us to exchange messages without the cost of SMS, because WhatsApp Messenger uses the same internet data plan for email, web browsing, and so on. By using WhatsApp, we can chat online, share files, exchange photos and others. Initially, WhatsApp was made for iPhone users, then along with its development, the WhatsApp application is also available for BlackBerry, Android, Windows Phone, and Symbian versions. The WhatsApp application can only work for fellow users who have the WhatsApp application. This WhatsApp application can be downloaded for free on its website. This application uses the cellphone number that we use to interact with fellow WhatsApp users. This application allows BlackBerry, Android, iPhone and Symbian users, as well as Windows Phone to communicate with each other, including being used for learning and discussion. Therefore, each whatsAap user will have their own group, the same and or even different from one another, as many Falak Scientific WhatsApp Groups are found in East Java such as LFNU East Java, Halaqah, ADFI, BHR Pamekasan and so on.

As for Instagram (also called IG or Insta) is a photo and video sharing application that allows users to take photos, take videos, apply digital filters, and share them on various social networking services, including Instagram's own. One unique feature on Instagram is that it cuts the photo into a square shape, so that it looks like the result of a Kodak Instamatic and Polaroid camera. This differs from the 4: 3 or 16: 9 aspect ratio that is commonly used by cameras on mobile devices. Instagram can be used on any version of the iPhone, iPad or iPod Touch with the iOS 7.0 or later operating system, any Android mobile phone with the operating system version 2.2 (Froyo) and above, and Windows Phone 8. This application can be downloaded via the Apple App Store and Google Play. Unlike other applications, this application can only provide photo and video information about activities related to

astronomy, such as sharing reference photos, observation activities and study videos. There are many Instagrams that can be followed, such as @ if_walisongo.ac.id with 1099 followers and 280 posts (this IG provides information on programming classes, rukyatul hilal, Pale Blue Dot, quotes), @if_UINSA with 1090 followers and 110 posts (this IG can provide information about this GI provides information about rukyatul hilal activities, eclipse observations, theodolite practices and prayer times), @ if_pasca.walisongo.ac.id with 120 followers and 26 posts (this IG provides information about national seminars and workshops, rukyatul hilal at al-Husna Tower, check the direction of the Qibla of the Great Demak mosque).

3. Through the Application or Falak Program
   a. Digital Falak

      The Digital Falak application, hereinafter referred to as DF, is a prayer time application built to make it easier for Muslims to know the entry of prayer times. This application was made by an al-Falah student al-Falah Ploso Kediri, Ahmad Tolhah Ma'ruf. The idea of making DF was initiated in 2011, and was only uploaded to Playstore in 2015. Digital Falak has a vision, namely the habituation of Muslims in using the Islamic calendar with the hijriyah standard without having to completely abandon the Gregorian calendar. With the existence of DF, it is hoped that Muslims will at least know the hijri calendar that is running, recognize and use the Istiwak time (WIS) which is the main reference in determining prayer times without having to forget the local time which is the international standard, providing convenience in knowing accurate prayer times, and gradually reducing carelessness in entering prayer times due to ignorance, changing the perception that the difference between Istiwak time and local time is 30 minutes, and changing the perception that Istiwak time starts at 12pm as local time. While the Digital Falak mission can be seen from its design in the form of a wall calendar to make it more familiar, DF dressings with features related to Islam and nationalism, reminding of lunar and solar eclipses to then carry out eclipse prayers according to the provisions in fiqh science,

providing WIS and Adhan notifications , provides options related to astronomy for those who know it to adjust the standards they adhere to, and for those who are not in the field of astronomy, provided the default value which is the standard of software developers, providing a qibla direction compass for urgent purposes, and not for finding errors. This DF application provides 19 features that can be used by Muslims.

b. Mizwandroid

The Mizwandroid application is a collaborative product between Waluku Studio and Mizwala Falak Instruments as a tool for calculating and finding the direction of the Qibla. This application uses a compass to determine the direction of the device. Calibrate the correct direction of the compass north, and use the position of the sun or moon will get more accurate data. Thus, this application is a tool to find the Qibla direction and calibrate it with the position of the sun or moon.

c. Qibla (Qibla Direction & Prayer Times)

This app contains Qibla Direction, prayer times, sun and moon (sunrise & sunset). Qibla direction in three ways, namely first, a compass. The qibla direction in this application is calculated with high accuracy, taking into account the value of the deviation of magnetic north from geographic (real) north. Second, to find the sun or moon, if a phone does not have a compass feel, then the owner of the phone can know the Qibla direction from the position of the sun or moon. Third, a map showing the Ka'bah site and the mobile phone owner's site, and connecting the two with a line. Through this application hanphone owners can find out prayer times, sunrise and sunset times and the disappearance of the sun and moon, hijri history and different phases of the moon, determine the location of the sun and moon, the exact position and provide information about GPS and Glonas satellites and calculate the speed at which can be used when riding a bicycle, car or roaming while calculating speed.

d. Usholli

Usholli is an application that provides prayer schedules with data taken from the official website of the Indonesian Ministry of Religion. This application was made deliberately without annoying ads, hopefully this is useful. The complete list of Usholli's features is as follows; Prayer schedule data comes from the Ministry of Religion website, attractive appearance and themes that can change according to prayer times. There are schedules: Imsak, Fajr, Terbit, Dhuha, Dhuhr, Asr, Maghrib, and Isha. Types of notifications that can be set for each prayer time: None, Silence, Vibration, Default, Takbir, and Adhan. Reminder before prayer time will be entered (can be set for 5 to 30 minutes each prayer time). Prayer times cover 30+ provinces and 500+ cities throughout Indonesia. Detect the closest city and change the prayer schedule automatically. Application widgets are vertical and horizontal. Qibla direction compass taken from GPS location. Map of nearby mosques, and without ads.

From these applications, minilennials can easily access the science of astronomy and many other applications that can be used, such as the Book of Falak Science, Abu Ma'syar al-Falaki, The Astronomical Society of Brunei Darussalam. Those are the scientific innovations that are developing in society in facing the development of the realities of the modern era and the digital era in line with the birth of the current 4.0 industrial revolution.

E. Conclusion

The era of the industrial revolution 4.0 is the era of the most advanced information technology and digitization. Machines and other tools can self-correct to provide the best service, including scientific systems, which include celestial science. Knowledge that is no longer scarce, the experts are a generation who prefer to read and learn in printed material in factual reality, while the activists and observers are the millennial generation who are called digital natives who are very familiar with virtual reality. Therefore, astronomical science must need new innovations to integrate printed science with information technology that has experienced automation and virtualization. In the context of arousing celestial scientific interest, the author has found that in the first place several patterns of digitalization of

celestial science were found. In terms of content, the digital scientific material of celestial science is in the form of calculating the direction of the Qibla, prayer times, the beginning of the month and the eclipse and the practice of determining it. From the aspect of media, the science of astronomy is presented through social media, such as Facebook, Instagram, Whatsapp and Youtube; through website-based media, such as bimasislam.kemenag.go.id, and if.walisongo.ac.id., in the form of Smartphone applications, such as the Digital Falak application, Mizwandroid, Kiblat, Usholli and so on. While the presentation design varies, namely in the form of text, video, images and pdf. Second, each of these patterns has made a valuable contribution to the virtual learning of science for millennials in the current era of the industrial revolution 4.0. For this reason, as a recommendation, more attention is needed from several related parties, both formal institutions such as schools, madrasahs and universities as well as non-formal institutions such as Islamic boarding schools and community organizations, to develop and expand its distribution massively, so that this science can be accessed more affordable by society, not only in actual reality, but also virtual reality.

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