Mathematical Logic in Fiqh Learning at Indonesia Islamic Higher Education

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Abstract

This article intends to clarify the role of Mathematical Logic in the study of fiqh at Indonesian Islamic Higher Education. Apart from inheritance, the study of Islamic astronomy (*Ilm Falak*) is in direct contact with this logic for the improvement of fiqh salat and fasting of Ramadan. This is proven by a literature review in that mathematical logic plays a role in the process of determining the initial time for the five daily prayers. Through explanations from literature studies relating to the coordinate system of celestial bodies, a celestial sphere triangle can be formulated in sin, cos and tangent which can be converted into prayer times on earth. So it is not wrong if *Ilm Falak* also knows *Ilm Hisab*. So learning *Ilm Falak*, especially determining the praying time in Indonesia Islamic Higher Education, cannot be separated from the use of mathematical logic that is developing today.

Keywords: Mathematics; Fiqh; The Coordinate System of Celestial Bodies; Praying Time

INTRODUCTION

Mathematics has various meanings, Muniri (2016) has summarized it. Mathematics is related to the science of quantities that measure magnitude; also discussion about interrelationships; but it also includes explanations of abstract forms so it is also called deductive science; the discussion is then limited to the logical structures of things. From these various meanings, there are at least 3 important characteristics of mathematical science. 1) a form of abstraction from reality, 2) expression in simple symbols (numbers), and 3) the source is from a deductive mindset (Abdusysyakir, 2016).

Mathematics as an auxiliary science in the context of Islamic jurisprudence today has begun to develop rapidly. In the past, its position had limitations compared to linguistics and mathematical logic. However, developments in science and technology have provided new understanding of several provisions in several areas of jurisprudence which have important relationships with the study of mathematics.

As in the science of inheritance or also known as *faraid* regarding the inheritance of inheritance left by the deceased. This knowledge relates to who has the right to it and the amount that can be received (Muthmainnah & Santoso, 2019). So in his study, mathematical logic regarding quantities cannot be separated from mathematics as a tool. In fact, this science has primacy in jurisprudence but it was also predicted by the Prophet that it would be forgotten. "O Abu Hurairah, learn the science of faraidh and teach it, because in fact it is half of the knowledge. And that knowledge will be forgotten and it is the first knowledge that will be revoked from my people. "(Hardiyana & Fahrana, 2018; Yansyah, 2020). This connection is not considered by some jurists by placing emphasis on the other side. Fauzan Hakim, n.d.) explained the Prophet's hadith by stating, "Indeed, humans are in two states, namely life or death. The science of faraidh is related to the majority of laws relating to death. Meanwhile, other sciences are related to laws while still alive." (Hakim, n.d.)

This shows that the study of Jurisprudence in Islamic universities cannot proceed solely doctrinally. Students must master it in depth to open up natural, mathematical or social scientific insights that can support the normative side of jurisprudence (Santoso et al., 2023). Islam also has placed a great deal of emphasis on rational thinking, reasoning, learning, seeking knowledge, and studying nature as a sign of God's creation and power. We can see an abundance of references to these points in the primary source of religion for Islam. The Quran strongly encourages human beings to use their intellectual capacity and contemplate all sorts of phenomena in the natural world, everything from the movements of the sun and the moon to the benefits of honey. Similarly, sayings of the prophet Muhammed, called hadith the Islamic tradition which is the second source of religion in Islam, contain many examples that emphasize the value of seeking knowledge

(Aydin, 2021). So learning that encourages students to think interdisciplinary must begin to be prioritized.

Nowadays, interdisciplinary research has been bridging disciplines have much to teach regarding how to combine analytical tools to tackle problems and questions that cross traditional disciplinary boundaries (Youngblood, 2007). The development of science and technology has an important influence on every element of society, from children to adults and even the elderly. Thats also participates in changing the habits of daily life patterns starting from lifestyle, and interactions, especially in the world of education, social skills, religion and so on (Santoso et al., 2023; Sharma et al., 2021).

It considers the fallacy of nomothetic claim as well as the fruitful production of solutions by viewing process (methodology), not domain (academic turf), as the key to interdisciplinary success. Staking claim to interdisciplinarity is shown to be unproductive while finding the need for interdisciplinary approaches and following the mandates of that need strengthens both the disciplines and interdisciplinary studies interdisciplinary approaches and following the mandates of that need strengthens both the disciplines and interdisciplinary studies. (Okamura, 2019)

Interdisciplinary research is the synergistic combination of two or more disciplines to achieve one research objective. Interdisciplinary research integrates research methods, knowledge, assumptions, and frameworks from separate disciplines to address a shared research question. Another categories are intradisciplinary, multidisciplinary, cross-disciplinary, anda transdisciplinary. Within intradisciplinary research, investigators use norms within a single discipline to address research questions applicable to that discipline. Multidisciplinary research draws on knowledge from different disciplines but stays within their borders providing various perspectives to address complex, real-world problems. Cross-disciplinary research involves using single disciplinary methods and assumptions to cross borders to address questions about a topic outside the scope of the discipline without any integration from other disciplines. And transdisciplinary research occurs when ideas from a discipline(s) offer insights that transcend the discipline's traditional borders. (Carr et al., 2018; Daniel et al., 2022)

Its use is also recommended in Sharia, especially the science of Falak. There is a great need for this knowledge to be strengthened with other scientific research so that its application can satisfy the faith and piety of the people. (Imratun & Santoso, 2021) Like implementing one of the pillars of Islam, namely salat (prayer). The obligation to worship during these five times, apart from punctuality. (Muthmainnah, 2015) is to face the direction of the *Qibla*. Performing prayers in a deviated or opposing direction can be invalidated. The legal basis is the Koran in Surah Al-Baqarah (2: 149-150) (Arifin, 2020; RI, n.d.). The face of prayer has undergone changes along with the *Israk Mikraj* incident where the prayer direction changed direction to the Kaaba until now (Muthmainnah, 2017; Sudibyo, 2015). In the early days of the obligation, prayers still faced Palestine,

namely the Al Aqsa Mosque. Sudibyo has explained the history of the first Qibla direction, namely Baitul Maqdis. Baitul Maqdis was the main part of the Prophet's journey to Sidrat al-Muntaha during Israk and Mikraj. At that time, Muhammad saw. had time to pray two rak'ahs with Prophets Ibrahim, Moses and Isa before climbing the stairs fixed on the stone of Jacob to the seventh heaven.(Sudibyo, 2015)

The application of mathematics as an auxiliary science in the context of jurisprudence is also felt in the science of astronomy which focuses on prayer times and the direction of the Qibla, including the implementation of the Ramadan fast (Hendrifalak et al., 2023; Muthmainnah, 2016). The need for the application of mathematics in it is increasingly felt after the conveniences can be felt due to the development of related science and technology (Muthmainnah & Santoso, 2020). Now, in learning at Indonesian universities, the portion of mathematics has begun to be balanced in order to strengthen students' skills (Solikin, 2016). Mathematical analysis and interpretation of the rules of fiqh in it have also appeared in many publications (Hayat & Utama, 2018; Solikin, 2016).

METHODS

This article aims to strengthen the need for mathematical knowledge in the study of astronomy, which still needs to be addressed until it gets the position it deserves in the large field of jurisprudence studies. Through literature studies, this is expressed, especially in reading the astronomical movements of the solar system in mathematical units. This discussion is limited to the coordinates of celestial bodies in determining the start of prayer for which the criteria have been determined according to jurisprudence. So literature research on mathematical astronomy and several fatwas from religious sects regarding prayer times became important instruments in collecting data. The data is then analyzed deductively after going through reduction and classification so that conclusions can be formulated.

RESULTS AND DISCUSSION

Calculation of Time in an Astronomical Perspective

To state the location of a celestial body, a coordinate system is needed that can state with certainty the position of the celestial body. There are four coordinate systems for determining the position of celestial bodies, namely: horizon coordinate system, equatorial coordinate system, ecliptic coordinate system and hour angle coordinate system (Maskufa, 2019, hal. 68). However, in this discussion we will introduce the ecliptic coordinate system and the equatorial coordinate system, followed by the transformation between ecliptic and equatorial coordinates.

In this system the position of celestial bodies is determined by declination and ascension. The two large circles used as references in this system are the equator circle and the declination circle. Asensio recta, or in English called Right ascension (RA), with

the symbol α, is an astronomical term associated with the equatorial coordinate system (*Asensio rekta - Wikipedia bahasa Indonesia, ensiklopedia bebas*, n.d.). RA can be compared to longitude, measured from its zero point which is at the Aries point or vernal equinox point. RA is measured in hours, minutes, and seconds; with one hour equal to 15 degrees (Anugraha, n.d.; *Asensio rekta - Wikipedia bahasa Indonesia, ensiklopedia bebas*, n.d.).

The *accensiorecta* (α) is the length of the arc calculated from the Aries point or also called the gamma point (g) on the celestial equator circle to the foot point with a tracing direction to the east, with a range between 0 to 24 hours or 0^0 s.d. 360^0 (Fahrurrazi & Ma'ruf, 2020, hal. 55). Meanwhile, declination (δ) is the arc length from the foot point on the celestial equator circle towards the celestial poles to the location of the object on the celestial sphere. The declination is positive if it is towards KLU and negative if it is towards KLS, with a range between 0^0 to 90^0 or 00 s.d. -90^0 (Anugraha, n.d.).

Like longitude, right ascension is calculated along a circle parallel to the equator. The direct ascension is calculated towards the east starting from the Aries point or Vernal Equinox point which is one of the intersection points between the ecliptic plane and the celestial equator, where the Sun is located on March 21 (Wikipedia bahasa Indonesia, n.d.). Latitude is the same, declination is measured from the equator towards the poles. Declination is positive if the celestial object being observed is in the northern celestial hemisphere, and negative if the celestial object being observed is in the southern hemisphere. Declination is denoted by "δ" and is expressed in angular units (degrees, minutes, seconds) (Fahrurrazi & Ma'ruf, 2020).

The earth revolves around the sun in an elliptical path. This path is called the ecliptic. The ecliptic axis is perpendicular to the ecliptic plane (Villanueva, 2018, hal. 2). The ecliptic is the path traversed by an object around a certain center point of a coordinate system. On the celestial globe there is an imaginary line called the ecliptic circle, if observed from the earth. The ecliptic of celestial bodies is a plane of orbit in the form of an imaginary line which is the path of celestial bodies around a central point of the solar system. If the earth is made the center point of the coordinate system, then the ecliptic is the plane of orbit through which celestial bodies such as planets and the sun circle the earth, and if the sun is made the center point of the coordinate system, then the ecliptic is the plane formed as the path of the earth's orbit which in the shape of an ellipse with the sun at the center of the ellipse (Wikipedia bahasa Indonesia, n.d.).

In Azhari's explanation (2007:31–33) of the ecliptic coordinate system, the ecliptic circle is the main base circle, while the origin point is the spring point (Aries point) as used in the equatorial coordinate system. A celestial body located on the celestial sphere, its position in ecliptic coordinates is determined by ecliptic latitude and longitude. Ecliptic longitude is given the symbol λ, and ecliptic latitude is given the symbol β. Ecliptic longitude is the angle formed by the line connecting the observer with the spring point. Ecliptic longitude is calculated from 0° to 360° and is measured from the point tracing the

ecliptic towards the east. Ecliptic latitude is the angle formed by the line connecting the observer and the projection of celestial bodies on the ecliptic circle. The ecliptic circle is measured from the ecliptic to the north pole of the ecliptic for celestial bodies located to the north of the ecliptic or from 0° to 90°. Meanwhile, for celestial objects located to the south of the ecliptic, measurements start from the ecliptic to the south pole of the ecliptic (0° to -90°).

Mathematical functions in determining prayer times

Among the mathematical functions of this transformation is to calculate the position of the sun for determining prayer times. Data and Formulas Used to calculate the beginning of prayer times. It has been described by several experts (Al Falaky, 2013; Solikin, 2020).

a. Data that must be known
   1). Latitude of place (φ)
   2). Longitude of place (λ)
   3). Sun declination (δ^o)
   4). Equation of time (e^o)
   5). Sun height (h^o)
   6). Regional time correction (RTC): (λdh - λtp)/15
   7). Ikhtiyat
b. The formula used
   1). Solar time angle formula
   Cos t = - tan φ tan δ + sin h / cos φ / cos δ
   2). Beginning of time formula
   12 – e + t + Kwd + i
   3). Sun height formula (h^o)
   Ashar : Cotan h = tan zm + 1 atau zm = [p – d]
   Maghrib : - 1^o
   Isya : - 18^o
   Subuh : - 20^o
   Rise : 1^o
   Dhuha : 4.5^o
   4). Regional time correction formula
   RTC = (λdh - λtp)/15
c. Formula description:
   1). To calculate the beginning of Dhuhur time, formula (b) is used without t, so it becomes: 12 – e + Kwd + i

2). To calculate the beginning of Asr time, formula (b) can be used completely, whereas when using formula (a), ho should be calculated separately using the formula: Cotan h^o = tan zm + 1 atau zm = | φ – δ |
12 – e + t + Kwd + i

3). To calculate the start of Maghrib, Isha, Fajr, Sunrise and Dhuha, formula (b) can be fully used, formula (a) ho is adjusted according to the time. With special note for the times of Fajr, Sunrise and Dhuha (subtracted), the formula becomes: 12 – e – t + Kwd + i. Meanwhile for Issue i is subtracted, the formula becomes: 12 – e – t + Kwd – i

4.) To calculate the declination of the sun using the transformation formula, namely:

$$\sin\lambda\cos\beta = \sin\delta\sin\varepsilon + \cos\delta\cos\varepsilon\sin\alpha ,$$
$$\cos\lambda\cos\beta = \cos\delta\cos\alpha ,$$
$$\sin\beta = \sin\delta\cos\varepsilon - \cos\delta\sin\varepsilon\sin\alpha .$$

$$\sin\alpha\cos\delta = -\sin\beta\sin\varepsilon + \cos\beta\cos\varepsilon\sin\lambda ,$$
$$\cos\alpha\cos\delta = \cos\lambda\cos\beta ,$$
$$\sin\delta = \sin\beta\cos\varepsilon + \cos\beta\sin\varepsilon\sin\lambda .$$

5.) calculate the equation of time with the formula

$$E = -105.8\sin(\lambda_\Theta) + 596.2\sin(2\lambda_\Theta) + 4.4\sin(3\lambda_\Theta) - 12.7\sin(4\lambda_\Theta)$$
$$-429\cos(\lambda_\Theta) - 2.1\cos(2\lambda_\Theta) + 19.3\cos(3\lambda_\Theta)$$

6.) calculate the sun's longitude

$$\lambda_\Theta = 280.46645^\circ + 36000.76983^\circ\ T + 0.0003032^\circ\ T^2$$

Where T is Julian Century time with epoch 2000

$$T = \frac{JD - 2451545.0}{36525}$$

With the explanation above, it can finally be agreed that the *ilm Falak* is also known as *Ilm Hisab* which includes calculations in making the Hijri calendar due to the strong intervention of mathematical logic. Mathematical contributions are also often found when determining the direction of the Qibla (*azimuth*), the shadow of the direction of the Qibla (*rashdul qibla*), determining the beginning of prayer times, the beginning of the Ramadan fast and the beginning of the month of *Shawwal* and the estimated time of the Solar Eclipse and Lunar Eclipse. (Luthfiyah, n.d.; Muthmainnah et al., 2019).

CONCLUSION

we can draw the conclusion that mathematical analysis is also used in solving jurisprudential problems in the field of worship. However, its role is a supporter that

must be strengthened by the main sources of jurisprudence. This was revealed especially in the area of determining the beginning of prayer times through astronomical studies. Through the celestial spherical coordinate system, it becomes the basis of reference for knowing the position of celestial objects, then between the coordinate systems it can be transformed into the spherical triangle formula, from the spherical triangle we get the formulas for sin, cos and tangent, all of this is then transformed to calculate times. on earth. A mathematical view of the position of a star (in this case the sun) for example has really made it easier to calculate initial prayer times because the data needed is; calculate the declination, height of the sun, angle of time of the sun. Apart from that, the transformation also calculates ecliptic longitude, ecliptic latitude, solar longitude. The position of the sun can be used to calculate the Qibla direction, determine the beginning of the month and eclipses. So this transformation turns out to be the main thing in subsequent calculations.

Learning *Ilm Falak*, especially determining the praying time in Indonesia Islamic Higher Education, cannot be separated from the use of mathematical logic that is developing today. So, Its interdisciplinary study. Like a theodolite, this tool is also commonly used by geodesists and geologists, but its use can be extended to measuring the direction of the *Qibla*. The method is after measuring it using the *rasyd al-Qiblah* method or the sun's shadow when in Mecca. Theodolite is then used to validate it. It turns out that modern science and technology can be accepted by some groups. However, there are those who think that the direction of Indonesia's Qibla is west so that the direction of mosques and prayer rooms does not need to change, which of course actually causes unrest. Despite the fact that mosques in Indonesia face west, they do not actually face the *Kaaba* in proper ijtihad.

There is something that needs to be emphasized that every era will experience several advances in science and technology. In the past, equipment to help calculate Qibla direction was still very simple and limited. Public insight into *Ilm Falak* is also limited. Now times have changed where science and technology can be useful in calculating distances and determining the direction of the Kaaba in the city of Mecca and various countries in the world that can be calculated using astronomy. So Ilmu falak lectures in universities should slowly follow technological developments to produce more precise and accurate calculations and measurements in facing the direction of the Qibla in Mecca. Cultivating this awareness of ilmu Falak as interdisciplinary study, requires continuous socialization from various related parties in formal and informal education till higher education.

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