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Astrolabe alternative learning based on software and interactive application

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ABSTRACT

Technology-based Teaching and Learning (T&L) is currently a highly discussed matter. Using technology as optimally and maximally as possible in the T&L process is seen to be greatly effective for both students and teachers. This research discusses alternative learning of astrolabe science using software and interactive application. This is qualitative research using content analysis and observation approach. Research results find that some software and interactive application, free or with fees payable, may be used in the T&L process relating to the astrolabe. It is hoped that this research may be helpful for students to understand the use of astrolabe for observation activities and calculations in astronomy, at once improving progress in the development of astronomy in Malaysia.

1. Introduction

Current development in technology may be seen in various fields, especially with the emergence of Industrial Revolution 4.0 technology which is a hot-button topic of discussion around the globe. This Industrial Revolution requires speedy action of all parties in tandem with rapid development in technological products and smart automated systems. Generally, this Industrial Revolution involves using the Internet of Things in almost all aspects of daily life. It is different from the first Industrial Revolution which centered on the use of steam-powered machines, the Second Industrial Revolution which focused on electricity, and the Third Industrial Revolution which was based on the use of information technology.

Malaysia is one of the countries which began to take steps to move forward in facing the development of the Industrial Revolution 4.0. This effort may be seen in various sectors, especially in the education sector wherein elements of the Industrial Revolution 4.0 are framed and applied in the 2015-2025 Education Development Plan. This at once has an effect on the national education system from primary to university levels in order to give exposure to this Industrial Revolution.

Discussion about the Industrial Revolution 4.0 is also perceived in developing advances in astronomy. The corpus of this science which involves much research relating to nature and space requires advanced knowledge and digital skills. Students need to be exposed, nurtured, and encouraged in order that they can indirectly gain adequate knowledge and skills to enable them to develop ideas about technology as early as in primary school level. The need to understand and apply technological concepts of the Industrial Revolution 4.0 in the field of astronomy is very essential as astronomy is mainly based on laws of physics applied to technology using telescopes and cameras to observe celestial bodies and phenomena, and using mathematics and computer models to explain observations and predict what might be (hypothetically or remotely) possible.

The science of astronomy generally encompasses various branches of knowledge, among them, relating to instrumentation. Many instruments have

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been invented and used throughout the development of astronomy. Society today is more exposed to modern instruments such as computers, telescopes, and so on. However, society needs to be given exposure to early traditional instruments which were prototypes of today's modern instruments (Waerden, 1951).

The traditional instrument highlighted here is the astrolabe. The astrolabe was first invented and used during the ancient Greek civilization. However, its use then was quite limited (Ionides, 1904). Later, its capabilities and functions were enhanced during the Islamic civilization for use in the management of worship ('ibadah) affairs of the Muslim community such as determining the Qiblah direction, calculation of prayer times, and set days in the calendar. Additionally, the astrolabe was also used to determine timings of sunrise and sunset, identify the position and movement of stars, measure altitudes of high places, calculate the depth of holes and read the width of rivers (Safiai et al., 2016).

The astrolabe's diverse functions made it the most popular instrument at the time, earning it the nickname of analog computer as its functions were similar to today's computer functions. In fact, most of the astronomical calculations may be solved manually using an astrolabe instead of today's digital computer (Safiai et al., 2017). This shows that learning the science about astrolabe presently is very significant for the purpose of developing the knowledge. Therefore, this research is very crucial in the effort to emphasize and expand the science of astrolabe in order that this instrument may be studied and popularized in the context of learning and cultivating the science of astrofiqh and cosmofiqh in Malaysia.

2. Astrolabe during the Islamic civilization: A literature review

Knowledge gained and ideas triggered by scientists of Ancient Greek civilization were developed from time to time, crossing over physical borders and times into the age of the Islamic Civilization. It cannot be denied that some mathematical concepts in astronomy founded by ancient Greeks began to be studied and applied by Muslim scientists in the 8th Century CE through translations of Sanskrit and Pahlavi texts (Pingree, 1973).

Nevertheless, the outcome of the efforts and wisdom of scientists in the Islamic Civilization made the science of astronomy more interesting through modification and improvement of then-existing theories and concepts. Even today, the improved and established theories and concepts of renowned scientists in the Islamic civilization are still in use to solve certain problems (King, 2012; Neugebauer, 1949).

The vast Islamic Civilization encompassed many countries and cultures. During this age, various contributions and achievements were enjoyed as a result of the prolific intellectual activity by scholars of the Islamic Civilization. This proved the exceptionalness or supremacy of Islam as a religion that is able to shape a civilization that elevates human dignity. The Islamic Civilization succeeded in leading the era and has become the reference and excellent model for building human civilizations even in present times (Al-Khalili, 2011).

Under the excellent governance and patronage of the 'Abbasid Caliphs, the field of knowledge, especially science and technology, became very much the center of attention. Numerous Greek works were translated into the Arabic language, encompassing various fields of knowledge including astronomy and astrology. The achievements enjoyed during that time may be seen through the invention of the astrolabe. It was introduced and developed in the early 8th Century CE in the Islamic Civilization (Al-Hassan, 2001).

The astrolabe was the outcome of efforts by the Abbasid Caliph al-Mamun in developing its multiple functions for daily life, including applying it as an instrument to manage daily worship affairs of the Muslim community (Sarton, 1935). The close relationship between Islam and astronomy presented the opportunity for it to be made and developed for diverse functions (Karagözoğlu, 2017). Calculation of prayer times and determining the Qiblah direction were two very difficult matters which needed high astronomical skills. Using the astrolabe, problems related to prayer timings and qiblah direction could be easily and quickly solved (Hayton, 2012).

For centuries, Arab, Persian and Jewish scientists attempted to write and publish treatises about the systematic use of astrolabe in order to facilitate learning and understanding it. Beginning from the 9th Century CE, treatises were published as a guide on how to use them (Seed, 1995). The earliest treatise was the work of Masha Allah, a Jewish scientist from Basrah. Unfortunately, the original work written in the Arabic language was lost. However, its translation in Latin is extant, safe, and readable (Hourani, 1970).

One of the lost original works on astrolabe was that written by al-Khawarizmi. He briefly discussed astrolabe in his writings, namely, Kitab 'Amal al-Asturlab (Book on the Construction of the Astrolabe) and Kitab al-'Amal bi al-Asturlab (Book on the Operation of the Astrolabe). Both these writings discuss the way to construct an astrolabe and its use (Brezina, 2006).

Other figures who were heavily involved in writing about the astrolabe were al-Farghani and al-Asturlabi. Besides writing about it, al-Asturlabi was also involved in observation activity at Baghdad and Damascus under the rule of Caliph al-Mamun. Further, in the early 11th Century CE, there emerged a Persian scientist, al-Biruni with his works, translated into English and entitled Canon of al-Mas'udi and Book of Instruction in the Elements of the Art of Astrology, which discuss in detail the construction, the components of an astrolabe and its functions (Freely, 2015).

As explained, it is undeniable that the earliest astrolabe was originally invented by scientists of Ancient Greek Civilization. However, scientists of the Islamic Civilization also produced their own astrolabe, using the Greek astrolabe as a basic model in constructing their own (Turner, 1994). It is significant that the astrolabe invented by scientists of the Islamic Civilization had enhanced capabilities and functions compared to the earlier Greek model (King, 2005). At the time, the construction of the astrolabe was a highly respected and admired work. Many makers of equipment began to learn the science of astrolabe and developed their skills in constructing it until it became their specialization for many years (Agar and Smith, 2016).

There was no guideline on the shape and decoration in constructing an astrolabe. Usually, the decoration depends on the suitability and taste of the maker. One of the things frequently done was to place the name and signature of the maker on it. However, not all makers did that (King, 2007). In addition, some makers liked to put on it the proof and information about the place and year it was made. With such information, it was easier to trace and identify the maker and determine the relationship between him and the astrolabe, besides learning the characteristics and culture of the place where it was made.

Ibn Al-Zarqali was a Toledo scientist in the Islamic Civilization who made his mark in inventing the astrolabe. He was renowned for his skills in inventing equipment and astrolabes. He also invented al-Safiha as a perfected the astrolabe. Al-Safiha (known as Azafea in the West) is an Arabic word meaning plate. This metal plate known as the tympan has coordinates of the celestial sphere such as azimuth, altitude, ecliptic, and equator, engraved in a stereographic projection. Usually, an astrolabe comes with a set of interchangeable tympans suitable for use at different latitudes. But with al-Safiha al-Zarqaliyya (the Plate of al-Zarqaliya), the perfected universal astrolabe featured only one plate capable of making readings at any latitude (Hill, 1993). In addition, he also wrote a treatise that explains the universal astrolabe, that Western scholars translated into Latin for their reference (Ahmad, 2003).

Further, as a scientist, he was also renowned for his observation activity. He was skilled in determining when a solar eclipse would occur and invented the compass to determine the distances between the moon and the earth and between stars and the sun. Besides that, he compiled the Toledan Tables which originated from the works of Ptolemy and al-Khawarizmi and contain abbreviations of geographical information (Samsó, 1994).

3. Result and discussion

Efforts to sustain teaching and learning the science of astrolabe require indeed a high level of earnestness. The reason is that it is a traditional astronomical instrument used for observation activity or calculation relating to the position and movement of celestial objects, which is manually operated and thus complicated to use (Safiai et al., 2020). Research results find that some digital media may be referred to and used to learn and master the science of astrolabe. Some of the media, both software and interactive applications, are as follows.

3.1. Shadows pro

Shadows Pro is a computer software constructed as a special package for the calculation and making of sundial and astrolabe. This software was developed in the year 1997 by Francois Balteyron, a French amateur astronomist. Some of the information relating to this software displayed on the website are as shown in Fig. 1 and Fig. 2.

Fig. 1: Front page of website displays information about software

Fig. 2: Description of software usage and calculation functions

This software may be found and downloaded free at the website https://www.shadowspro.com/. However, payment is required for access to full use of functions. Latest, there have been some improvements done for a new 2020 version compared to that before this. This software is compatible with Windows 10, Windows 8, and Windows 7, for both 64-bit and 32-bit versions. Some of the displays of the software are as shown in Fig. 3 and Fig. 4.

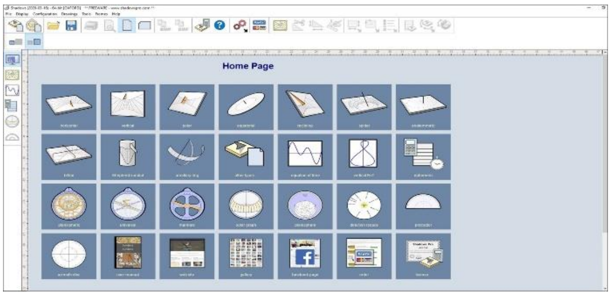

Fig. 3: Software front page display for selection by a user

With this software, the user may create an astrolabe based on any location, especially his own location. In addition, this software is also equipped with information about astrolabe regarding the history of its development, the concept of its construction, and functions in the activities of observation and calculation found on the website. Included are pictures relating to astrolabe for the purpose of disseminating knowledge through the photo gallery provided on the website as shown in Fig. 5.

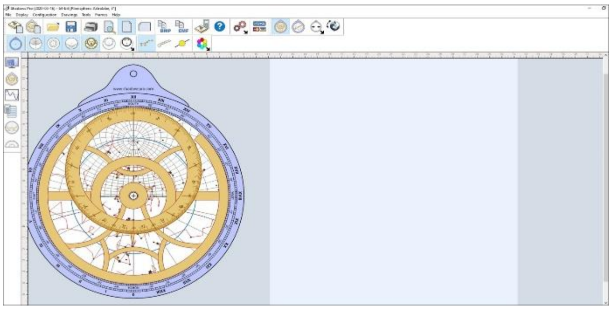

Fig. 4: Making an astrolabe based on latitude 2ºN Malaysia

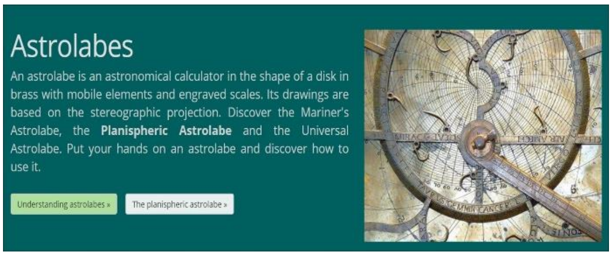

Fig. 5: Additional information on the astrolabe and its usage

3.2. The astrolabe generator

The Astrolabe Generator is computer software developed by Richard Wymarc. His deep interest in astronomical instruments led him to re-create various types of astrolabe and rubu'mujayyab in various designs. Besides that, he also frequently participated in exhibitions to display the replicas of instruments he himself built. In order to use this software, the user has to first ensure that his computer system is equipped with Java as this software functions with it. This software can be found and downloaded free at the following website http://www.astrolabeproject.com/the-astrolabe-generator as shown in Fig. 6.

Fig. 6: Website display for downloading process of software

This is open-source software that can function in Windows, Mac, and Linux operating systems. This factor makes it easy to learn and use. This software is also improved from time to time compared to the previous version. The software displays are the following Fig. 7 and Fig. 8.

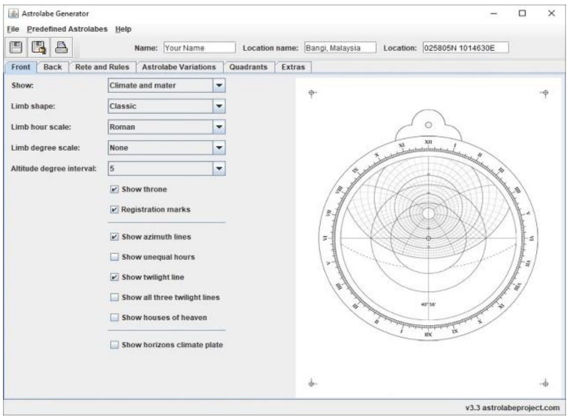

Fig. 7: Frontpage display of software for selection of user

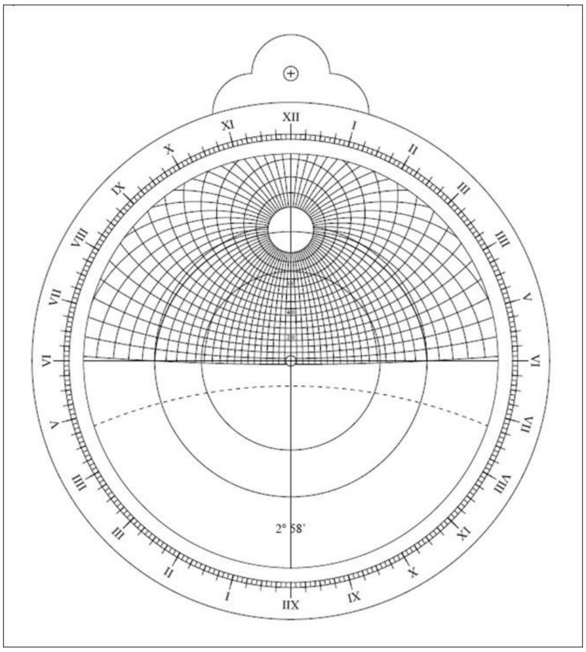

Fig. 8: Making of astrolabe based on latitude 3ºN Malaysia

3.3. In-the-sky

In-The-Sky.org is a website oriented towards astronomy education to the public. It was developed in the year 2012 and managed by Dominic Ford, a lecturer at the Institute of Astronomy, Cambridge University, United Kingdom. He is widely experienced in the field of astronomy and has once led a project for observation of the Milky Way Galaxy, operating at Lund Observatory, Sweden.

Through this website developed by him, users need not download software to learn about astrolabe. The user has only to surf the website and enter related information to print an astrolabe according to the desired location.

This website was developed especially to give exposure to the public about celestial objects. There is much-shared information through this website such as the latest facts and information, night sky observation guide, rules for making instruments, weather forecast, and so on. A few displays of the website are shown in Fig. 9, Fig. 10, and Fig. 11.

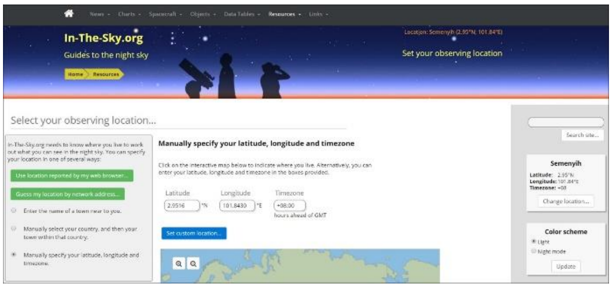

Fig. 9: Option to manually set coordinate of a user according to location

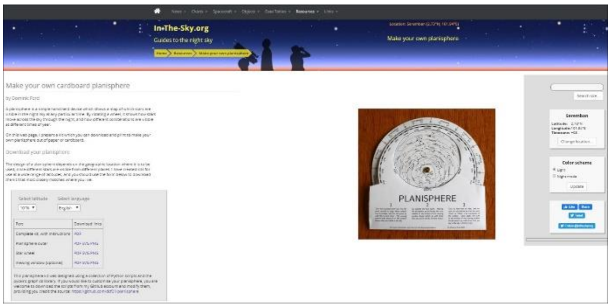

Fig. 10: User can enter latitude coordinates according to location

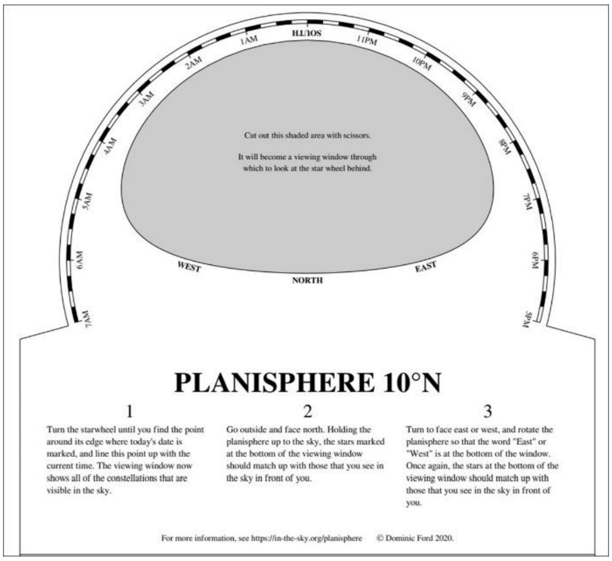

Fig. 11: Print display based on latitude 10ºN Malaysia

3.4. Astrolabe compass

Astrolabe Compass is a smartphone application with a compass function. It is said to be a pocket astrolabe application easy to carry and use. It was developed by an individual named Ahmed Sousane. This application does not fully function as an astrolabe but only as a simulator for the compass. Nevertheless, knowledge relating to design and basic elements of the astrolabe is featured through this application. This application can be downloaded free using Google Play Store. The following Fig. 12 and Fig. 13 are the display of the application.

3.5. Euclidea

Euclidea is a smartphone application based on a game that gives exposure to the user on learning geometry.

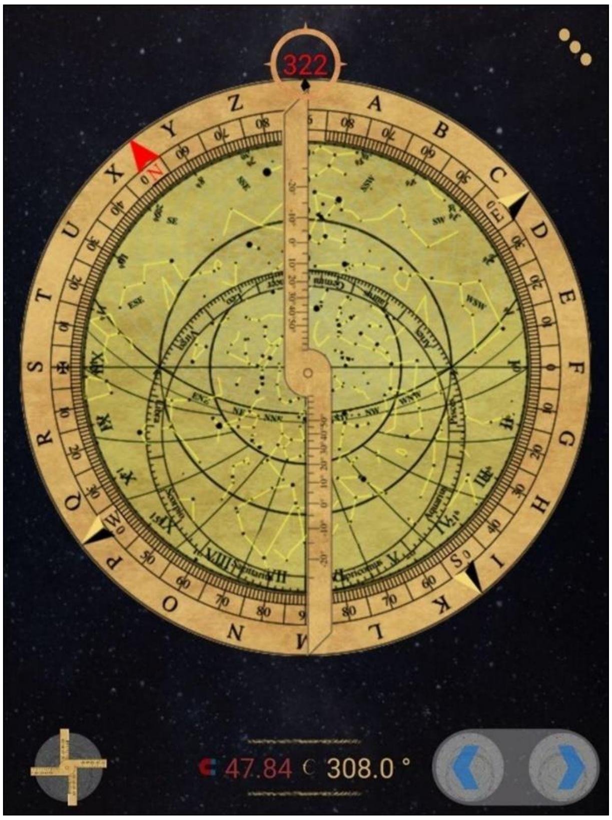

Fig. 12: Front display of application

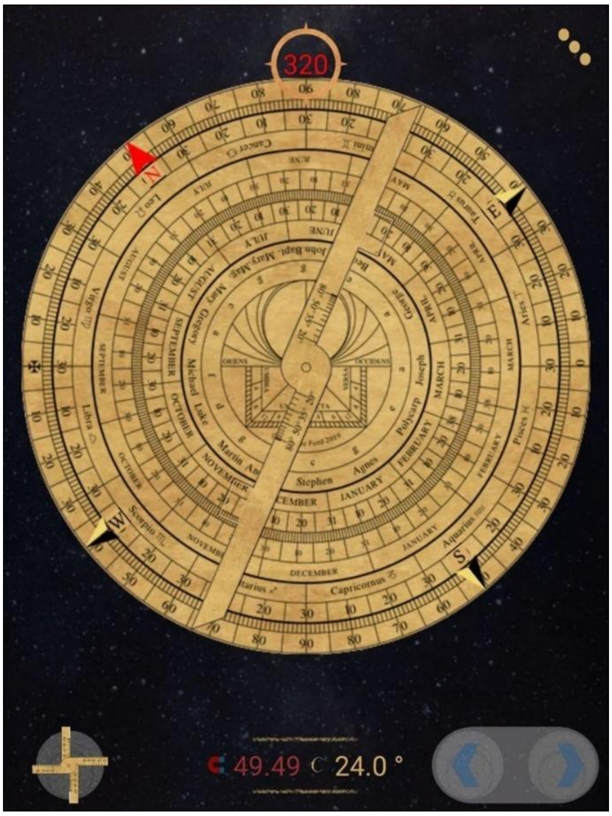

Fig. 13: Back display of application

This application is very useful to understand and master the concept of astrolabe creation based on the geometry of the local sky. It was developed by Horis International Limited in the year 2016. In the year 2020, this application was improved and enhanced to a more interesting and user-challenging Version 4.40. It can be downloaded free using Google

Play Store and Apple Store. The displays of the application are shown in Fig. 14 and Fig. 15.

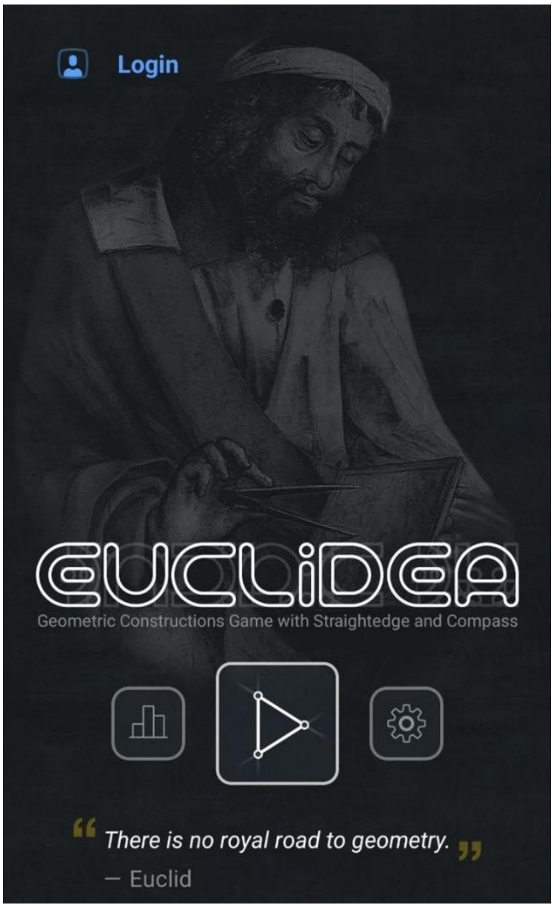

Fig. 14: Frontpage display of application requires registration of user account

Fig. 15: User is required to pass through each level to continue the game

4. Conclusion

The Islamic civilization was vast, encompassing many countries and cultures, as a result of prolific intellectual activity by its scholars or scientists then, various contributions and achievements were enjoyed. This proved the exceptionalness of Islam as a religion that was able to shape a civilization that elevated human dignity. The Islamic Civilization was leading the times and became the reference and excellent model for building a human civilization even till today. The continuity of creating the astrolabe in the Islamic Civilization may be seen even today, although it is not currently as recognized and popular. There are efforts to sustain the science of astrolabe in a modern form such as through developing software and interactive application. Upon close examination, it is found that software and applications relating to astrolabe are very lacking compared to other instruments.

This research more or less discussed some software and applications relating to astrolabe and may be taken as a basic guide for learning about the astrolabe such as Shadows Pro, The Astrolabe Generator, In-The-Sky.org, Astrolabe Compass, and Euclidea. Further exploration may be done to search and obtain more software and applications which may be used to master the science of astrolabe, free of charge or through payment for access. It is hoped that this research will trigger improvement and progress in developing software and applications for astrolabe in the future. The need to develop such software and application for learning and acquiring skills relating to astrolabe is essential for research to understand the order, position, and movement of celestial objects. It is also hoped that this research will at once highlight the past contributions of scientists who lived in the Golden Age of the Islamic Civilization to the development of astronomy so that they will not be forgotten by the times.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Agar J and Smith C (2016). Making space for science: Territorial themes in the shaping of knowledge. Springer, Berlin, Germany.

Ahmad Z (2003). Influence of Islam on world civilization. Adam Publishers and Distributors, New Delhi, India.

Al-Hassan AY (2001). Science and technology in Islam: The exact and natural sciences. UNESCO, London, UK.

Al-Khalili J (2011). The house of wisdom: How Arabic science saved ancient knowledge and gave us the Renaissance. Penguin Books, London, UK.

Brezina C (2006). Al-Khwarizmi: The inventor of algebra. The Rosen Publishing Group, New York, USA.

Freely J (2015). Light from the East: How the science of medieval Islam helped to shape the western world. I.B. Tauris, London, UK.

Hayton D (2012). An introduction to the astrolabe. Available online at: http://www.astrolabe.ch/

Hill D (1993). Islamic science and engineering. Edinburgh University Press, Edinburgh, UK.

Hourani GF (1970). The early growth of the secular sciences in Andalusia. Studia Islamica, (32): 143-156. https://doi.org/10.2307/1595215

Ionides SA (1904). Description of an astrolabe. The Geographical Journal, 24(4): 411-417. https://doi.org/10.2307/1775947

Karagözoğlu B (2017). Science and technology from global and historical perspectives. Springer International Publishing, Cham, Switzerland. https://doi.org/10.1007/978-3-319-52890-8

King DA (2005). In synchrony with the heavens: Studies in astronomical timekeeping a. instrumentation in medieval Islamic civilization. Brill, Leiden, Netherlands.

King DA (2007). Astrolabes, quadrants and calculating devices. In: Fleet K, Krämer G, Matringe D, Nawas J, and Rowson E (Eds.), Encyclopaedia of Islam, Brill Publishers, Leiden, Netherlands.

King DA (2012). Islamic astronomy and geography. Ashgate Variorum, Farnham, Surrey, UK.

Neugebauer O (1949). The early history of the Astrolabe: Studies in ancient astronomy IX. ISIS, 40(3): 240-256. https://doi.org/10.1086/349045

Pingree D (1973). The Greek influence on early Islamic mathematical astronomy. Journal of the American Oriental Society, 93(1): 32-43. https://doi.org/10.2307/600515

Safiai MH, Ibrahim IA, Jamsari EA, Ahmad MY, and Nasir BM (2016). The continuity of astrolabe as a multipurpose Astrofiqh instrument. International Journal of Applied Engineering Research, 11(9): 6081-6086.

Safiai MH, Ibrahim IA, Jamsari EA, Nasir BM, and Ahmad MY (2017). Astrolabe as portal to the universe, inventions across civilizations. International Journal of Civil Engineering and Technology, 8(11): 609-619.

Safiaia MH, Ab Rahmanb NI, Ismailc K, Kashimd MIAM, and Jamsarie EA (2020). The modern dimension of the astrolabe as an innovation of ancient technology. International Journal of Innovation, Creativity and Change, 13(5): 61-75.

Samsó J (1994). Islamic astronomy and medieval Spain. Aldershot, Hampshire, UK.

Sarton G (1935). Book of instruction in the elements of the art of astrology by Abu al-Rayhan Muhammad ibn Ahmad al-Biruni. ISIS, 23(2): 448-450. https://doi.org/10.1086/346975

Seed P (1995). Ceremonies of possession in Europe's conquest of the New World, 1492-1640. Cambridge University Press, Cambridge, UK.

Turner GLE (1994). The three astrolabes of Gerard Mercator. Annals of Science, 51(4): 329-353. https://doi.org/10.1080/00033799400200301

Waerden VDBL (1951). Babylonian astronomy, III: The earliest astronomical computations. Journal of Near Eastern Studies, 10(1): 20-34. https://doi.org/10.1086/371009