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# Development of teaching material for Moon phase observation using Julian day calculation

The Moon phase is an astronomical phenomenon showing the Moon shape in a sunlit portion as viewed from the Earth and can be observed worldwide. This relates to the position of the Moon in its orbit around the Earth. Thanks to the evolution of human intelligence and technology, it is nowadays easy for astronomers to calculate and predict the lunar phases: full moon, waxing or waning gibbous, first or last quarter, waxing or waning crescent, and new moon. However, this topic is not obvious for people outside the astronomical field. This work aims to develop a teaching material in astronomy for Moon phase observation based on Julian day calculation. The Julian day or Julian day number (JDN) is the number of days that have passed since the initial epoch and is defined as noon Universal Time (UT) on Monday, 1 January 4713 BC in the Julian calendar. Our equipment model is inspired from a circular sky map which can rotate from 0 to 360 degrees. Instead of dates and times marking at the circumference of the equipment, we attach the numbers starting from 0 to 1 to indicate the lunar phase and the decimal numbers obtained from the division of JDN by synodic period (29.53 days) which is the number of days that the Moon takes to return to the same position on the celestial sphere as referenced to the Sun. To find the phase of the Moon for a given date, we calculate the corresponding JDN and divide it by 29.53 days to get a decimal number. Then, we rotate the map to that decimal number which will indicate the phase of the Moon as shown by picture on the map. Additionally, the QR code of the summary of the theory implicating the Moon phase is included in the equipment. To verify the usability of our equipment for people aged more than 15 years old, we study an independent sample test by comparing the test scores between a group of 12 persons (group 1) using the equipment before taking the test and another group of 16 persons (group 2) taking the test without using the equipment. Then, we employ a statistical method to analyze the obtained results using SPSS statistics software. We found that the mean test score of group 1 is higher than that of group 2 of statistically significant difference (level of significance = 0.001). Furthermore, we also study paired samples statistics by comparing the test scores of people in group 2 taking the test before using the equipment (group 2.1) and after using the equipment (group 2.2) to see the progress of participants. We found that the mean test score of group 2.2 is higher than that of group 2.1 of statistically significant difference (level of significance = 0.05). Moreover, paired samples correlations were studied and showed low correlation level about +0.5. The difference between the test scores of group 2.1 and 2.2 is at level of significance 0.001. This implies that the test score of each person has been improved after using the equipment. In conclusion, we have created a new teaching material appropriate for observation of the Moon phase that could be used in astronomy class. In the future, we will improve the model of our teaching material, study other factors that could predict the lunar phases more precisely, and test the usability of our teaching material in a higher number of participants and more specific groups of participants.

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