Astronomy education: The Apparent Motions of the Celestial Objects

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Abstract

he present work concerns educational material that refers to the teachers and introduces the teaching of "The Apparent Motions of the Celestial Objects", in Greek-Lyceum, with recent innovative methods.

1 Introduction

In order to give a solution to all these questions round the teaching of Science and especially of Astronomy, we have planned educational material addressed to the teachers which refers to the learning process of the subject " The Apparent Motions of the Celestial Objects" in the Greek Lyceum. In this project the structure, the objectives and what is included in the educational material are described.

2 Educational Material

Consists of: I. Pedagogical guide for the teacher, where there are the objectives, the learning process of the educational material and usage guidelines. II. Essential Astronomical knowledge on the apparent motions of the celestial objects, which are accompanied by revision questions, multiple-choice exercises, and a glossary of the basic concepts. III. Exercises and activities proposed to the students from the teacher, which can take place either in the classroom or outdoors. IV. Proposals for the usage of audiovisual material (Videos, CDs, Slides, Web sites). V. Slides. VI. Sky maps. VII. References for further study.

Objectives: The understanding of the subjects related to Astronomical issues and their social extension, the familiarization with the process of the celestial observation, the development of critical, cooperative and communicative capabilities and the development of the ability of collecting, elaborating, estimating and performing of the information.

The **teaching methods** go through the classical general strategies of the problem solving and the project method as well as the part strategies of discussion, concept mapping, brainstorming, socratic questions and library research.

In the **essential knowledge**, basic concepts are unfolded such as the celestial sphere and the specification of the position of a celestial object using the uranographic, the equatorial, the horizontal and the ecliptic coordinates. The position of a place on Earth is determined, as well as the change of the view of the sky with respect to the latitude of the observer. The motions of the Earth are examined and classical proofs of Earth's rotation (Foucault pendulum, Coriolis effect) and revolution (stellar aberration, Doppler effect) are given. The seasons are determined and their alternation is established. The phases and the motions of the Moon, the eclipses of the Sun and the Moon and the apparent motions of the planets are depicted. Through "choose the right answer" and "true or false" exercises, misconceptions concerning the shape of the earth, the constellations, the every day presence of the sun are expressed. It is recommended to the teacher to be based on the misconceptions in order to schedule his lesson. The revision questions and the glossary are very important as they can be used either at the beginning, as an ignition for conversation, or at the end.

3 Activities

The activities are divided into four units. They constitute a very useful means but not an exclusive one. They are mostly ideas and recommendations that the teacher, using his judgment, experience and creativeness can modify, complete and combine in proportion to the aim and the place where they are to be executed.

Unit A
Issues are recommended which the students work out either in groups or individually and they present to the class using the media of their own choice. The presentation is followed by conversation. These issues can be the contents of a speech at school or an article at the school's newspaper, concerning: 1) The believes of the ancient Greek philosophers about the world. 2) The astronomy through tradition. 3) The phases of the Moon and tradition. 4) Stars and constellations in Homer's Odyssey. 5) Description of a night observation experience.

Unit B
Simple issues which can be discussed in the class with the coordination of the teacher are proposed concerning: 1) The determination of the positions of celestial objects estimating angles. 2) The reasons that astronomical observations must be done away from the city lights etc.

Unit C
Exercises are recommended out of which the teacher will pick up the ones that are in proportion with the class level and class objectives. As an example it is mentioned: 1) The expression in degrees and seconds of the angle diameter of the Sun. 2) The calculation of the relation between degrees and hours 3) What is the maximum height of the Sun at the winter and the summer solstice at a place of 38 degrees latitude 4)The illustration of the celestial sphere as it is seen from the site of the observer.

Unit D
Observation activities are recommended. The teacher organizes night excursions at places that are quite open when weather is good. To ensure the success of the activities sky maps and flashlights with red light are necessary. Some times it is necessary to have points of reference on the earth such as trees, buildings, rocks, hills, antennas etc. During theses activities students are exhorted to: 1) Observe the stars and organize them into groups of their preference. 2) Observe the always seen constellations and recognize the Polestar with the help of the Ursa Major. 3) Recognize the stars of the zodiac. 4) Observe a specific planet in time intervals and depict its orbit through the stars. 5) Observe the Moon for a month and point its position on a map daily in order to examine whether it is possible for a Moon or a Sun eclipse to occur. 6) Estimate the latitude of their site by observing the Polestar and using two wooden sticks and a protractor. 7) Approximately estimate the ecliptic plane. 8) Estimate the celestial poles and the celestial equator using a map of the sky, a 35 mm wide field camera provided with a sensitive film. 9) Observe the changes of the position of the exact point the sun rises and sets on the horizon during a year. The students have to organize their observations and answer to useful questions expanding their knowledge. Finally 10) The existence

of a model of the celestial sphere at the school laboratory gives answers to many questions. Such a sphere is easy to be created by the students using simple elements such as: a table-tennis ball or a globe with the appropriate dimensions, a transparent plastic ball, maps of the south and the north hemisphere of the sky adapted to the interior of the plastic ball, small plastic straws, a needle longer than the diameter of the ball, a piece of foam block, a protractor, a box that can contain the ball and colorful markers. After having completed the construction of the celestial sphere, the teacher should ask from the students to study the daily and annual motion of the Sun, the change of rising and setting points, the duration of the day, the stars daily motions etc.

4 Information sources

Proposals for the audiovisual materials usage
Videos
(MMI Co, http://members.aol.com/mmicorp)
HU9101 Moon: Motions and Phases
HU9103 Earth: Rotation and Revolution
HU9104 Seasons
HU9106 Day and Light
HU9047 Longitude and Latitude.
CD-ROMs:
(MMI Co) CDR 52 Starry Night Deluxe
CDR 45 Universe Explorer
(Sky Publishing Co, http://skypub.com) Real Sky-Northern Sky.

Astronomy on the INTERNET
The teacher can find on the Internet information about tutorial programs concerning Astronomy and the procure of tutorial material at the following sites:

http://aspsky.org/html/naep/naep3-4.html
http://aspsky.org/html/naep5-6.html

More tutorial material can be found at the following site:
http://aspsky.org/html/astro/insites.html

Other useful sites are:
Sky and Telescope, http://skypub.com
NASA, http://nasa.gov
Hubble Space Telescope, http://www.stsci.edn/top.html
The Greek Astronomy Club, http://www.geocities.com/night-sky
International Astronomical Union, http://www.iau.org
Hellenic Astronomical Society, http://www.astro.auth.gr/elaset/index.html
AstroVox, http://www.greek-astronomy.com/

Greek Astronomical Constitutions
A contact with the Greek constitutions related with Astronomy can be very helpful for the teacher to present the recommended subjects. In this project the addresses of the University and other Greek constitutions which you can find in Athens, Salonica, Patras, Ioannina, Heraklion in Crete and Kefalonia are given. It is also given the addresses of amateur astronomical teams which are activated in several sites in Greece like Athens, Salonica, Volos, Katerini, Corfu, Patras, Florina, Chalkis.

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