IMPROVING THE METHODOLOGY OF TEACHING ASTRONOMY IN SECONDARY SCHOOLS

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ABSTRACT

This article describes the methodology for organizing practical lessons on the subject of astronomy based on the Stellarium program, the methodology for conducting observations, in particular the method for in-depth study of the constellation of the Zodiac. This technique can be used by teachers in teaching the subject of astronomy, students and students interested in astronomy.

Keywords: Astranomy, a new teaching method, Ecliptic, Jupiter, Polar, Sirius, Fomalhout, Aldebaran, Zodiac, Pisces, Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius, Zodiac constellations, Moon, Sun , Stars, Orbit, Stellarium program.

INTRODUCTION

The content and quality of education are considered today as one of the urgent problems and priorities of society, ways of developing education, increasing its effectiveness. The introduction of modern innovative pedagogical technologies into the educational process is gaining popularity. For this reason, one of the most pressing problems is to distinguish between known methods and explain them correctly. Currently, a lot of work is being done to develop new methods of teaching astronomy and astrophysics. For example, in higher educational institutions, academic lyceums and secondary schools, it is desirable to organize not only theoretical studies, but also practical classes. By conducting visual observations with students and schoolchildren in the open air, the results of the observations can be used to stimulate students' interest in the science of astronomy through circle work and conferences.

Astronomy is the oldest academic discipline. The requirement for practice has long led to the need to teach the younger generation some methods of orientation by the heavenly bodies. The general development of the material life of society, culture, the expansion of business ties between the peoples of the Mediterranean coast, the need to draw up geographical maps, all this required the creation of a theory of celestial phenomena and the structure of the planets, the Sun and the Moon. Scientists of the medieval East, relying on this theory of antiquity, were among the first to introduce the study of astronomy in madrasahs.

In the medieval Near and Middle East, the centers of education and science were religious educational institutions-madrasahs. Studies of domestic and foreign orientalists have proven that educational institutions - madrasahs arose precisely in Central Asia and from here spread to other countries. The first concrete mentions of madrasah are found in the "History of Bukhara" by the famous Arab historian Narshakhi. He wrote about the Farjak madrasah, which existed even before the major fire in Bukhara in 936 [1].

Bukhara was the capital of the centralized feudal state of the Samanids, a major scientific and economic center of Central Asia at that time. Under the Samanids, about 20 madrassas functioned in Samarkand alone. In these educational institutions, not only religious doctrine was taught, but also secular sciences - mathematics, astronomy, etc., scientific research was carried out, scientific schools were formed.

In the cultural centers of the countries of medieval Central Asia already in the IX-X centuries. a tradition has developed that obliges major scientists to teach in madrasas. The experience of teaching sciences in madrassahs was gradually enriched and spread throughout the countries of the Muslim world, assimilated and improved by individual scientists[2]. So, back in the 9th century, Khorezmi synthesized in his work and activities the main ideas, principles and methods of scientific education that were used before him.

Farabi's ideas were very valuable regarding educational subjects. In the treatise "Words on the Classification of Sciences", he subdivided mathematics into seven sections (arithmetic, geometry, optics, mathematical astronomy, music, the science of gravity and the science of skillful techniques), defined the subject of each of them, gave recommendations for teaching and self-teaching them [3].

The great Uzbek scientist Beruni was a real teacher in the true sense of the word. In his scientific and pedagogical activity, he relied on all the achievements of science known in his time, used a wide variety of methods and himself developed the research and teaching methods, paid special attention to the content of scientific education, its goals and methods. He wrote in "India": "In the beginning, among Indian astronomers, I occupied the position of a pupil in relation to a teacher, since among them I was a foreigner, I was not sufficiently familiar with their achievements and methods. When I made some progress in acquaintance with them, I began to explain to them the true methods of mathematical sciences, and they began to flock to me in great numbers, expressing surprise and striving to get useful knowledge from me" [4].

Materials and methods
Beruni showed deep interest in the problems of pedagogy, attached particular importance to teaching mathematics. His essay "The Book of Enlightenment to the Beginnings of the Science of the Stars" played an important role in the development of mathematics and astronomy in the medieval East [5]. It contains the most important information on arithmetic, algebra, geometry and astronomy. The book, as a basic textbook, was studied in all madrasahs of large cities of the medieval East.

Discussions about the originality and meaning of statements about the content and methods of teaching can be found in the works of Ibn Sina: "In every science, it is necessary, first of all, to know the definition of objects. And their presence is cognized, in the end, through proof, since they are phenomena that are established by this science ... The student of science must, first of all, master them in order to study this science. In other words, every science has a subject, problems and initial principles" [20].

The famous scientist of the 15th century Giyasaddin al-Kashi wrote in his "Letter about Ulugbek and the Samarkand Scientific School": "Every few days His Majesty Shah Ulugbek is present at classes, on such days there are usually mathematics classes. Your humble servant also began to attend these classes. One of the rules of the classes leading here is the following: a person who comes to the next class of listeners does not know what problem will be proposed

for discussion, while the students of the madrasah receive this question in advance and refresh their knowledge before classes" [6].

By the end of the 18th and early 19th centuries, teaching astronomy was included in the curriculum of all schools. In 1864, the new Charter of the secondary school established astronomy under the name "Cosmography" in classical and real gymnasiums, but teaching cosmography was more limited to spherical astronomy. The methodology of her teaching was verbal, mathematized, without supervision. [7].

In the programs of schools on astronomy of the former USSR and explanatory notes to them, the systematic and consistent presentation of material, the connection between theory and practice have increased. The content of the subject more and more approached the true, living acquaintance with the sky [8, 9]. In the newly developed programs for secondary and secondary specialized educational institutions of the Republic of Uzbekistan, in contrast to the previous ones, an emphasis is placed on strengthening the worldview value of astronomy, highlighting the heritage of domestic astronomers of the Middle Ages and the role of modern researchers-astronomers of Uzbekistan [10, 11].

The general secondary education in the Republic involves two stages on the basis of the Law "On Education":

    - elementary education;

    - general education.

In the primary general education school, the formation of the basic concepts of astronomy and cosmonautics is carried out on the basis of the integrated academic subjects "The World Around Us" and "Natural Science", and in the senior grades on the basis of the subjects of the natural cycle (physics, chemistry, biology, geography, etc.). The formation of astronomical concepts and concepts, on individual astronomical phenomena, is completed in the ninth grade physics course with a ten to fifteen hour section "Elements of Space Physics" [10].

The state of teaching astronomy in schools from the republics of the former USSR, was closely related to the conditions of education in schools .

A number of studies [12, 13, 14, 15] show that the state of teaching astronomy did not correspond to modern requirements.

The teaching of astronomy in many schools is currently unsatisfactory. Often, astronomy lessons are taught by poorly qualified teachers; the time allotted by the curriculum for the study of this discipline is not fully used; most schools do not carry out the prescribed supervision; visual aids and tools available in schools are little used; extracurricular work on astronomy is practically not carried out. Astronomy teaching is not well controlled"[14]. Among the important reasons for such a low level of students' knowledge is the insufficient "stock" of observational astronomical material among students.

The following classes are offered using the Internet, a small telescope and binoculars, depending on the capabilities of the institution. At the beginning of the academic year, general concepts of astronomy are given and problems are posed. The study of the celestial sphere moves from simple observations to complex ones. For example, this can be done in the following order.

    1. Studing the phases of the moon: new moon, first quarter, full moon, last quarter. The teacher gives an idea of the phases of the moon and sets tasks.

2. Observing the topography of the moon. It is especially interesting and accurate to observe the phase of the moon in the first quarter (on the 7th day of the new moon) using a small telescope and binoculars. On the border between the bright part of the Moon and the dark part, the shadows of mountains on the surface of the Moon, the inner shadows of craters, borders are clearly visible. Of course, the results of this observation will be of interest to students.

3. Finding the most prominent constellation in the sky. For example, Ursa Major, Little Bear, Dragon, Orion, Saturn, Libra from the constellations or the famous named stars: Pole Star, Sirius, Fomalhaut, Aldebaran and so on. The appearance of these constellations is described on the Internet, in the literature, and students are given instructions and directions on how to find them in the celestial sphere.

4. Finding the planet and studying their movement. At first glance, it seems that the lights in the sky are more difficult to separate from each other. According to the science of astronomy, the more deeply celestial phenomena are studied, the clearer it becomes that each of them has its own place in the celestial sphere, its own laws of motion. Finding planets in the background of stars and studying their visual movements will arouse greater interest in the reader and student.

Even 5000 years ago, people noticed that 5 planets do not move like stars. In previous articles, we studied the motion of planets using the moon. Below is one of the practical observations on the study of the constellations of the Zodiac using the planet Jupiter. ... Every month the Sun is in the constellation of the zodiac stars, or, as they are also called, the constellations. There are 12 constellations: Hat, Hamal, Saurus, Javza, Cancer, Assad, Sanbula, Meson, Akrab, Kaus, Juddi and Dalv. [16; 17]

It seems that these constellations on the celestial sphere are much more difficult to distinguish from other constellations at first glance, but we know that any observer can easily distinguish the Moon from other lights. The moon is in the constellation of the zodiac for 29.5 days. Likewise, since the planets' orbital planes are close to the ecliptic plane, they also pass through the constellations of the zodiac during the sidereal period. The movement of the moon in the celestial sphere can be used to study the constellations of the zodiac. We have covered this method in previous articles. We have also discussed the use of Mars motion in studying the zodiacal constellations in previous articles [18].

Studying the constellations of the zodiac through visual observation of the movement of the planet Jupiter in the celestial sphere has its advantages. The average radius of Jupiter is about 11 times the radius of the Earth, 69,150 kilometers. Jupiter orbits the Sun at a distance of 778 million kilometers. Jupiter revolves around the Sun at a speed of 13 kilometers per second and revolves around the stars every 12 years. [16]

In terms of clarity, Jupiter is the Moon after Venus and is visible in the sky all year long (11 months). Since the illumination of Jupiter is much less than that of the Moon, small lights can also be seen around it. This can be seen from the following calculations.
The stellar magnitude of Jupiter relative to the Earth observer is $m\_y = -2.94 \, ^\wedge m$ in its brightest state, and the stellar magnitude of the full moon is $m\_oy = -12.7$ microns. If we use Pogson's formula, we get the following expression: [17]$m_{oy} - m_y = 2,51 \lg \frac{E_y}{E_{oy}}$ if we add values to it $\left| -12,7^m - (-2,94^m) = 2.51 \lg \frac{E_y}{E_{oy}} \right|,$

where E_y is the illumination of Jupiter, and E_oy is the illumination of the Moon on the Earth's surface.

$$-9{,}76 = 2{,}51 \lg \frac{E_y}{E_{oy}}$$

if we divide both sides of the equation by 2.51, we get the following:

$$-3.89 = \lg \frac{E_y}{E_{oy}}$$

we can write this expression as follows.

$$\frac{E_{oy}}{E_y} = 10^{3.89} \approx 10^4$$

This expression shows that the luminosity of Jupiter is 10,000 times less than the luminosity of the Moon. Therefore, if with the help of the Moon you can see the brightest stars of the zodiacal constellations a, b, g, and with the help of Jupiter, you can easily observe even dimmer stars such as d, m, p, ē. ... In this case, Jupiter is in the constellation of the Zodiac throughout the year. You can study this constellation as much as you like in convenient situations.

With the help of the Stellarium program, you can plan in advance the movement of Jupiter along the constellations of the Zodiac. Below is a 12-year planning schedule. [19]
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Zodiac constellation names	Date of entry of Jupiter into the constellation	Dates of the departure of Jupiter from the constellation	Planets near Jupiter and the so-called stars, lights, during the observation period
Sagittarius	19.11.2019	18.12.2020	28.11.2019 at 17:25 goes to the Moon. 13.05.2020 04:20 goes to Saturn, Mars and the Moon.
Capricorn	19.12.2020	16.12.2021	22.12.2020 at 21:00 goes to Saturn,
Aquarius	17.12.2021	17.04.2022	-
Pisces	18.04.2022	25.05.2023	30.04.2022 at 21:00 goes to Venera. 29.05.2022 at 17:00 goes to Mars.
Aries	26.05.2023	29.04.2024	14.06.2023 at 12:30 goes to the Moon.
Taurus	30.04.2024	12.06.2025	23.05.2024 at 6:30 goes to Venera. 04.06.2024 at 17:00 goes to Mercury.
Gemini	13.06.2025	23.06.2026	12.08.2025 at 16:00 goes to Venera.
Cancer	24.06.2026	16.05.2027	12.08.2026 at 4:00 goes to the Moon.. 15.08.2026 at 20:00 goes to Mercury
Lion	17.05.2027	23.07.2028	20.08.2027 at 1:00 goes to Mercuryi.

			26.08.2027 at 19:00 goes to Venera.
Virgo	24.07.2028	01.11.2029	at10.11.2028 at 7:00 goes to Venera.
Libra	02.11.2029	07.11.2030	-
Scorpio	08.11.2030	01.12.2030	20.11.2030 at 21:30 goes to Venera.

Based on this table, you can trace the movement of the planet Jupiter in the constellations of the Zodiac for about 12 years. Photos of interesting celestial events that can be observed can also be provided in advance in the form of handouts.

01/04/2022 is shown in the table above. A picture for a date. Figure 1 depicts Saturn, Jupiter, Mercury and the Moon converging in the sky at 18:00.

Jupiter Dalv at this time will be in the constellation of Jupiter. This can be seen with the naked eye. [19]
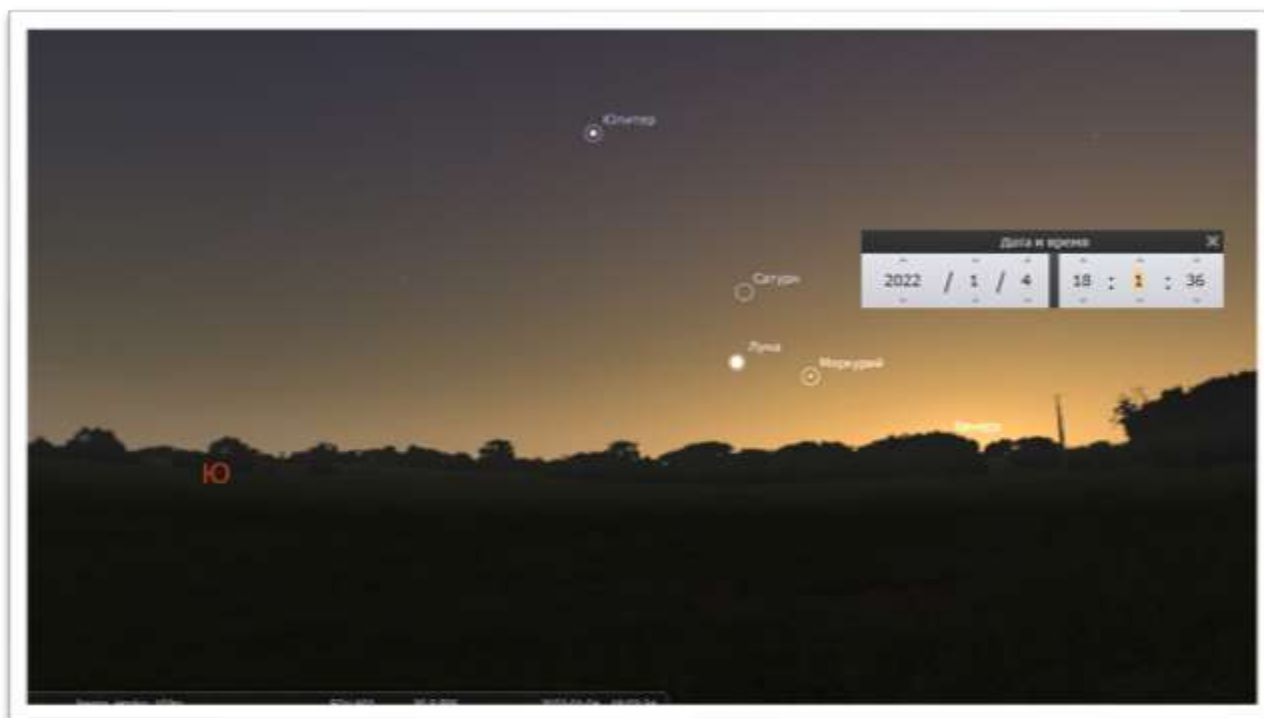

Fig. 1. View to the west, January 4, 2022, 18:00.

In Figure 2, at 22:00 03/18/2027. today on the south side, Jupiter, Mars and the Moon are connected in the sky. Jupiter is located in the constellation Cancer and can be observed with the naked eye.
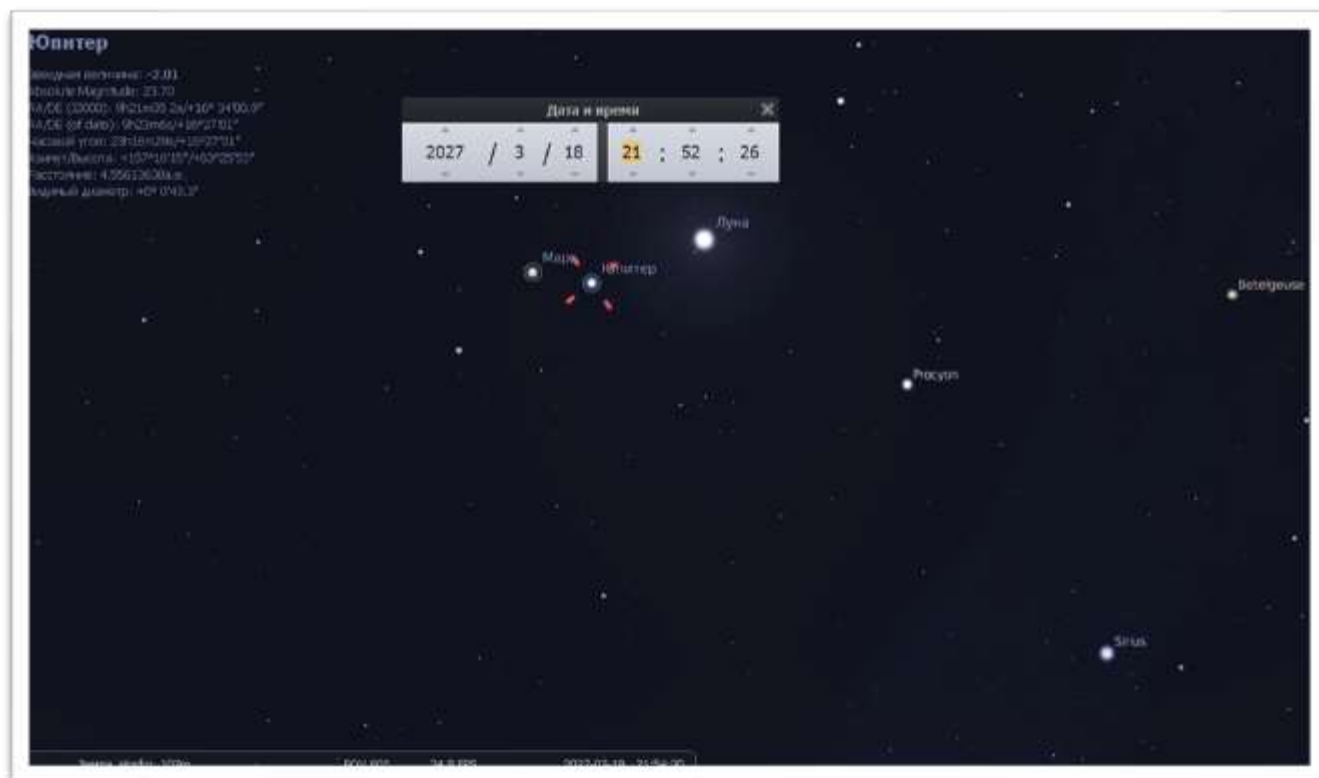
Figure 2. View from the South on March 18, 2027 at 10 p.m.

CONCLUSION

The observation results were analyzed by the teacher in 6 hours of practical classes, electives, circles, conferences on selected subjects in higher education, secondary schools and academic lyceums, using animation and virtual methods.

Comparison of data from surveys of teachers and students shows that most of the teachers understand the need to use historical facts about the development of astronomy in Central Asia in astronomy lessons, but they do not carry out this work effectively enough.

In schools, there is a tendency to decrease the interest of students in astronomy, there are also significant shortcomings in the training of teachers, material and technical base, the quality of textbooks and teaching aids, the content of education, and especially the methods.

- The searches for ways to improve the teaching of astronomy in the education system, and the developed methodology for teaching it, led to the following conclusions:
- It is necessary to strengthen the skills of practical work of students in the classroom. It is necessary to solve a large number of design examples, even the most elementary ones. It should be considered qualitative tasks on the issues of modern astrophysics without fail and more often.

Recommended focusing future attention on the following issues:

- Application of the third updated Kepler's law.
- The relationship between the luminosities of stars and their temperatures.
- Dependence of the type of spectrum on the temperature of the star.
- The chemical composition and structure of the main types of stars.
- Reasons that determine the rate of evolution of stars.

The Pupils and students who are actively involved in observation and practice can be more effective if they are tasked with reporting their findings. Because in this case, the student seeks to use literature, online materials and develops skills. Encourages to speak at conferences. Even in these classes, there has been an increase in the interest and activity of students with a low level of proficiency in subjects..

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