Scientific Methods of Cognition in Teaching Students Majoring in Astronomy in the Context of Higher Education

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Abstract: This article investigates some methods of scientific cognition: observation, analysis, reflective experiment, scientific experiment that are used in teaching students majoring in Astronomy in higher education.

Key words: Astronomy, universities, experiment, observation, reflective experiment, analysis, scientific methods.

Introduction

Astronomy is a science that forms the worldview and systemic knowledge of the world in students' minds [3]. Methods of scientific knowledge assist students to effectively master astronomical concepts, terms, and understand the processes of some occurrences happening in the universal set, for example, in the depths of stars and in the Universe as a whole.

Scientific methods are a set of system regulatory principles, techniques and methods by which objective knowledge of reality is achieved within the framework of scientific and cognitive activity in congruence with these principles [1].

The main results and findings

Astronomy is the science of the celestial bodies. It is impossible to know astronomy deeply without making astronomical observations of celestial objects.

Observation is the ability to see and recognize the various signs, properties, distinctive features of the celestial objects being viewed and examined [2].

The ability to see, notice, and discern is a distinction of a cognitively developed mind. Studies conducted by psychologists show that students described as "high achievers" can distinguish about 12, 5 signs, and "low achievers" can differ - 6, 5, and "undeveloped ones" acquire 4,5 [4].

Those students who can and have desire to observe are able to become good observers, astronomers and even make scientific discoveries in the field of astronomy. Here are some examples:

Kai Li, an amateur observer, succeeded to discover Jupiter's eightieth satellite in 2003 with the help of the Canadian and French telescope CFHT, located in Hawaii, [5].

Artem Novichonok and Vitaly Nevsky, amateur astronomers, discovered a new comet. Artem Novichonok believes that the prevalence of their success is to be able to look, observe, work hard and then you will definitely acquire a long-awaited result. "To find a comet, you have to take pictures of some parts of the sky within the different intervals. Then

these pictures are compared and contrasted with each other. As it is known, the stars are stationary and the asteroids are moving objects. The task is to identify whether the object found by you, has been discovered by someone or not," says Artyom Novichonok. [6].

Scientific observation is a conscious and purposeful perception of information about elements of nature or human society [7].

The method of observation includes elements of preparation:

- preliminary acquaintance with the object of observation;
- specific objectives of the observation;
- a description of the observation conditions;
- development of an observation plan.

When observing celestial bodies through a telescope, the following features of the scientific activity can be realized by students of higher education.

1. Accumulation of facts and information about the observed celestial object or astronomical phenomenon.

2. Systematization of information and identification of patterns (i. e, building a hypothesis on the basis of information obtained by observing information about a celestial object).

3. Establishing the causes, existing patterns.

4. Making a report on the study of a celestial body during astronomical observations through a telescope.

Basic requirements for scientific observation

1. Clarity of purpose, intention of observing celestial objects.

2. Establishment and observance of order according to the conditions (for example, the culmination of the luminaries), and the interval of observation times, etc.

3. Objectivity of registration of the observed facts about the celestial body (brilliance, luminosity, stellar magnitude, etc.).

4. The reliability and validity of conclusions based on observations of celestial bodies.

When observing celestial objects with telescopes, students need to keep in mind some points:

- the duration of the observed objects must be well justified;
- when processing the results of observations of celestial bodies, it is necessary to take into account the measurement errors of quantities (noise, background, etc.)

In general, observation is a common research method. It is used in research not only in astronomy, but also in physics, chemistry, biology, psychology, etc.

When studying Astronomy as a science, second-year students majoring at Pedagogical Universities of Uzbekistan, as their laboratory classes, they observe planets and their satellites through a telescope, as well as study the orbit of Jupiter and its satellites [8]. In their third year, students of the same universities observe the Pleiades stars and other celestial objects through a telescope in their evening classes. Astronomical observations carried out with a telescope, outside the classroom at educational and scientific observatories, acquire a deeper understanding of the nature of celestial objects [9].

Analysis method.

The goal in teaching students Astronomy as a subject is that, it enables students to consider facts, ideas, events, elements from all perspectives, identify cause and effect relations between them, uniform and distinct features, generalize and qualify them by similar indicators and form provisions arising from abovementioned aspects. Students can develop their analytical mindset via planning their academic, scientific tasks for a day, semester, etc. When researching, it is advisable to conduct analysis in conjunction with synthesis. When doing the analysis, the research student can immediately make some generalizations, then generalize them again. The researcher makes several such steps until he or she establishes the most important characteristics of the studied objects [2]. For example, stars, galaxies, cause and effect relationships and functions of their parts.

Comparison is considered to be one of the options of analysis. It is a technique for studying an object by establishing similarities and differences. With the help of comparison, quantitative and qualitative characteristics of objects are revealed, evaluated, classified and identified [10].

For example, the luminosity of giant stars, white dwarfs are compared with the luminosity of the Sun. The comparative size of the planets of the solar system compared to the Sun, etc.

Analogy is the correspondence of elements, the coincidence of a number of properties of objects, processes or phenomena, which provides a basis for transferring knowledge of the properties of one object to another [11]. Examples of using analogy, when teaching astronomy students:

- Gigant planets are united by physical characteristics such as: density, relatively low temperature on the surface, the presence of rings and a large number of satellites, almost the same chemical composition.

Data on comets, according to the hypothesis, appeared 4.5 billion years ago from a gas and dust cloud, from which the Sun and the planets originated. Thrown to the periphery of the solar system, where there are the lowest temperatures, no chemical reactions take place in comets. According to theory, comets are carriers of primordial matter. The discovery of comets is considered very rare. Leonid Yelenin, the first amateur astronomer in the history of Russia, discovered a comet [12]. Applying the method of analogy, Leonid Yelenin proposed to search for comets in the plane of the ecliptic, the highest percentage of the probability of finding new comets and celestial bodies.

In 2007, Bakhodir Khafizov discovered a minor planet, Samarkand, which was enlisted in the International Catalog under the number 210271, and was determined revolving around the Sun, between the orbits of Mars and Jupiter [13].

As a result of the analysis, research students can make logical conclusions. In pedagogical practice, the analysis of the lessons attended is necessarily applied in order to exchange experience between students and trainees, with each other and other teachers in the subject of astronomy in secondary schools, academic lyceums and universities.

We examined in our article another method of scientific knowledge used in the classroom with students in astronomy, this is a reflective experiment

Reflective experiment is an imaginary experience with ideal objects, thanks to which the foundations of a certain theoretical concept are laid and applied or its limits are

established within this constraint [1]. Reflective experiment can be widely used in teaching astronomy students in universities. It is advisable to apply this method when explaining topics in astronomy such as those listed below, we have cited them as the main ones:

1. Fundamentals of spherical astronomy (for example, students present a model of the celestial sphere, basic lines, axes and lines on the sphere).

2. Determination of standard world time (for example, students imagine what time of day and exact time at the opposite point of the globe from them).

3. The concept of the ecliptic (the apparent annual movement of the Sun in 12 zodiacal constellations).

4. The rotation of the Earth around the Sun, and the rotation of the Moon around the Earth.

5. Internal structure of the Sun (model).

6. Influence of solar activity on the processes occurring on the Earth (magnetic storms, solar flares, etc.).

7. Physical processes occurring on the planets of the Solar System and their satellites (for example, imagine that a day on the Moon lasts 4 weeks, the period of Jupiter's rotation is 9 hours 45 minutes for the polar zone, the temperature on the surface of Mercury reaches 500 ^{0} C, etc.)

8. Physical nature of stars (idea of temperature, luminosity and size of stars).

9. The physical nature of quasars (mentally imagine to students that a quasar is a relatively small in comparison with stars, a celestial body, but the radio emission from it comes as from the whole galaxy).

10. Types of galaxies (to represent the shape, structure of galaxies).

11. Types of astronomical length (parsec, light year, astronomical unit, representation of these units).

12. Scientists' hypotheses about the formation of the solar, stellar and planetary systems.

13. Model of a hot Universe.

14. Launches of artificial satellites.

15. Manned satellites and orbital stations.

The use of a reflective experiment in astronomy classes in universities helps to develop students' thinking, their ability to carefully reason and draw conclusions about the astronomical object or phenomenon speculated under certain study [14].

Students can experimentally explore some of the topics in the Astronomy Course:

1. Spectral characteristics of stars.

2. Radiation of the solar spectrum.

3. The main characteristics and structure of the telescope.

4. Fundamentals of stellar photometry.

To conduct experimental research, it is necessary:

1. Develop a plan for the experiment.

2. Formulate more precisely the purpose of the experiment.

3. Prepare control means for measuring the quantities involved in the experiment [15].

Before carrying out an experiment, it is necessary to study the data available about the object speculated under study, for example, a telescope [16]. Describe researcher's actions

during the experiment, for example, when changing the eyepiece, how the visibility of a celestial object in a telescope changes. Based on the experimental data, the analysis of the facts, obtains values and is carried out with following conclusions. The conclusion cannot exactly correspond to the theory, so the experiments are carried out again and refined.

The measurement process is a quantitative comparison of quantities of the same quality. The measured value is compared with a value that serves as a unit of measure [1].

Conclusion

Each measuring device (photometer, CCD camera, telescope, etc.) has its own limitations that determine its accuracy. Therefore, any scientific statement contains an error, absolutely exact scientific conclusions do not exist. A pattern in nature is established by researchers through observations and measurements obtained during experiments, which means that any pattern (law, rule, theory, hypothesis) is characterized by a value with some error.

We can conclude that methods of scientific knowledge such as: observation, analysis, comparison, mental and scientific experiment can be successfully used in enhancing cognitive activity and assimilating new material in astronomy classes with university students.

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