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KEY ASPECTS OF TEACHING OF ASTRONOMY COURSE IN A ELEMENTARY SCHOOL

Obid B. Saydayev
Jizzakh State Pedagogical University
Jizzakh, Uzbekistan
E-mail: obidsaydayev@gmail.com

ABOUT ARTICLE

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Abstract: In this article we discussed the features of the school course in astronomy, as the fundamental basis for the formation of a modern scientific picture of the world for students, in the context of the development of digital technologies. The results of an analysis of the current conditions for teaching astronomy at school are presented: not systematic; The theoretical content of the course is not large in volume; lack of teachers with special subject and methodological training. The problems of key performance indicators are identified: poor participation of schoolchildren in the subject Olympiad, low level of subject knowledge of students, stagnation in the development of specific issues in the teaching methodology of astronomy. At the same time, the authors highlight the methodological attractiveness of the school course in astronomy, its enormous potential in developing interest in scientific knowledge, satisfying natural teenage curiosity, interest in the unknown and as yet unexplained, associated with the possibility of variable presentation of material, active use of modern digital technologies.

INTRODUCTION

We live in the 21st century, and no matter how scientists, engineers, and public figures define its essence, one way or another it is most directly connected with the development of the space sphere, which: is the locomotive of the development of modern science;

synergistically related to defense capability; is increasingly influencing our daily lives, technologically providing the ability to use cellular communications and GPS navigation, the Internet and digital television; has a direct and direct relationship to the development of the economy, since the latter in the modern world is based on monitoring processes on Earth. Today, only countries with weak economies do not participate in the implementation of space programs or experiments based on the use of artificial Earth satellites, including those for purely pragmatic purposes. Gradually, people view Space as an expanded environment for their habitat, and knowledge about it becomes one of the main elements of education and general culture. Almost any problem in astronautics is a related or applied problem in astronomy. As you know, astronomy is a natural science that studies the Universe, the location, movement, structure, origin and development of celestial bodies and systems. Having originated in prehistoric times, as evidenced by numerous artifacts, astronomy, with the advent and active use of micro and nanoelectronic technology and digital technologies, received enormous opportunities for its development. It became possible to get answers to many questions that have interested humanity for millennia, but at the same time, astronomers faced even more questions and problems.

1. Pedagogical analysis of the content of a systematic course in astronomy.

The basis for the idea of what space and space technology are is laid by a school astronomy course. Various scientific and sociological surveys of an astronomical nature among young people and schoolchildren, the data for which are freely available on the Internet, allow us to draw disappointing conclusions about knowledge in this subject area. Respondents cannot answer questions about the name of the star closest to us, how many planets there are in the solar system, and the question: “How did the world around us appear?” the most common answer is created by God. Modern schoolchildren are more aware of astrological concepts and concepts than astronomical ones [1]. And this, despite the fact that all of us from early childhood are faced with astronomical concepts and events: the Sun, the Moon, day and night, constellations, the change of seasons, clocks and calendar, eclipses, northern lights, starfalls, etc. All these phenomena have a strictly scientific basis, and the formation of knowledge about them should not occur within the framework of religious, astrological, numerological or esoteric approaches. A significant period of absence of the subject in the school curriculum had a very negative impact on both the didactics of school astronomy and the issues of methods of teaching it. An analysis of the current situation, after the introduction of the basic course in astronomy, shows that the conditions in which teachers teaching this subject are forced to work today are characterized by the following circumstances:

1. There is a significant break in the study of the subject in basic school: astronomy is presented propaedeutic in the lessons "The World Around us" and as an independent subject "Astronomy" [2]. This leads to the fact that students, especially primary school graduates, develop fragmentary and sometimes distorted knowledge about the world around them, about the Universe. This problem is systemic in nature, its solution is possible by developing a new paradigm for school education in astronomy, based, on the one hand, on the systematic study of astronomy, on the other hand, on a practice -oriented approach to teaching. Planfulness and systematicity are the conditions for the gradual and profound formation of a scientific picture of the world. A practice-oriented approach helps to see the connections of the subject with the practical aspects of students' lives, to show the relevance and necessity of this knowledge in modern society, thereby stimulating the development of cognitive interest in astronomy.

2. Analysis of the content of a systematic course in astronomy and its presentation in textbooks on physics [2] and astronomy [3] demonstrates a significant conceptual load in a relatively small volume. Taking into account the average level of knowledge of students in physics, without which astronomy as a science loses its natural scientific physical meaning, it can be assumed that schoolchildren are not particularly interested in studying this subject. Astronomy expands and deepens physical knowledge, demonstrating its universality and universality; it is it that can demonstrate how far our knowledge and our experience extend on a spatiotemporal scale. Unlike other subjects, astronomy (despite the fact that it is one of the oldest areas of human knowledge) does not and should not create in schoolchildren the idea that a solution has been found to all questions. This is the ideological feature of the astronomy course, its attractiveness and enormous potential in developing interest in scientific knowledge, satisfying natural teenage curiosity, interest in the unknown and as yet unexplained. One of the methodological features of the course is the ability to present material at different levels of complexity, by varying the relationship between clarity, descriptive approach and strict physical interpretation of astronomical phenomena. In addition, the use of modern digital technologies makes it possible to make the course attractive for all ages to study it, both in basic and additional education.

2. Methodology for teaching the astronomy section "Fundamentals of Astronomy" in high school.

Astronomy as an academic subject is specific; it is this feature that distinguishes it from other natural science disciplines studied in secondary schools. In terms of content, this subject contains material of an ideological nature, which ends with the study of natural sciences. Emphasis on its broad subject connections with physics, mathematics, geography, history and other subjects is mandatory in mastering the basic concepts of the subject. At school, the methodology for teaching astronomy is so far based only on the level of empirical data, that is, on the knowledge and skills of individual teachers and methodologists. Students do not develop a general picture of their worldview, which is due to several factors:

- discrepancy between the content, which includes all educational material, which includes ideas about a variety of astronomical laws and phenomena, and the availability of comprehensive research on the content and scope of the training course provided to high school students.
- disagreement between the existence of an educational and methodological complex, which includes curricula, textbooks, teaching aids, material and technical base of the training course, development of laboratory and practical work, etc.;
- the contradiction between the variety and complexity of the content of the astronomy curriculum and the very limited number of hours allocated to its study
- lack of an astronomy room, which includes all the necessary modern equipment and reference material on astronomy. The most necessary equipment includes: a telescope, an armillary sphere, a quadrant, a moving star chart, a school astronomical calendar;
- irrational use of information computer technologies and digital resources (Internet, educational modules, virtual laboratories, computer planetarium);
- lack of special professional training among astronomy teachers, whose role is most often played by physics and/or science teachers.

3. Forms and methods of studying astronomy at school

The uniqueness of the methods of teaching astronomy is associated with the unity of educational material and observations and with the extreme limitation of time allocated for studying astronomical material in secondary school.

The study of astronomy consists of several elements:

- presentation of new material;
- observation of an astronomical phenomenon or process;
- problem solving;
- consolidation of the studied material;
- testing students' knowledge.

The effectiveness of teaching astronomy is achieved through coordination and interaction between various methods and forms of teaching. In some cases, inexperienced teachers often confuse the concepts of “form” and “method”; for this reason, we specify these concepts. The main thing here is the nature of the interaction between the teacher and students (or between students) in the course of their acquisition of knowledge and the formation of skills. Forms of education: full-time, correspondence, evening, independent work of schoolchildren (under the supervision of a teacher and without), lecture, seminar, practical lesson in the classroom (workshop), excursion, practical training, elective, consultation, exam, individual, frontal, individual - group . They can be aimed at both theoretical training, for example, a lecture, seminar, excursion, conference, round table, consultation, various types of independent work of students, and practical training: practical classes, various types of design (design and research work).

A method is a way of studying natural phenomena, an approach to the phenomena being studied, a systematic path of scientific knowledge and establishing the truth; in general - a technique, method or manner of action; a way to achieve a goal, a certain ordered activity; a set of techniques or operations for the practical or theoretical development of reality, subordinated to the solution of a specific problem. The method can be a system of operations when working on certain equipment, methods of scientific research and presentation of material, methods of artistic selection, generalization and evaluation of material from the standpoint of a particular aesthetic ideal, etc. According to the form of the lesson, one can distinguish lecture, seminar, practical lesson, laboratory work, etc.

a) Lecture.A lecture is the main form of conducting a lesson, which in the educational process performs a number of functions such as: informational, orienting, methodological, stimulating, educational. Like any other form of teaching, a lecture has its advantages and disadvantages. A lecture in an astronomy lesson is necessary if there are no textbooks for new courses or not all content is reflected in the textbook, the lesson includes a large amount of educational material, independent study is impossible due to the complexity of logical constructions. The weak point of this form is the passivity of learning and the lack of feedback from the audience. Almost any question can be made the topic of a lecture or conversation. However, lectures should be avoided if the group requires active work or if learning is through sharing of experiences.

b) Seminar. Seminar is a type of training session where students, under the guidance of a teacher, discuss messages and reports they have prepared. Using such a form of conducting a lesson as a seminar is best suited for studying the section “Physical nature of celestial bodies” since the degree of complexity of the material does not require the teacher to analyze the content of the section. Using workshops, students can independently explore the characteristics of planets and small bodies in the solar system. If you follow the methodological rules of the two-way learning process, the desired result will be achieved: a strong and deep assimilation of knowledge on the topic of the lesson. Practical classes are forms of organizing training in which students perform practical work on assignment and under the guidance of a teacher. They are carried out in classrooms, laboratories and workshops, at training and experimental sites. Such activities, for example, include creating your first astronomy instrument - a moving star map.

The main didactic goals of such classes are experimental confirmation of the studied theoretical principles, mastery of experimental techniques, the ability to solve practical problems by setting up experiments, the formation of practical skills in working with various devices, equipment, installations and other technical means.

c) Excursion. An excursion is a form of organizing training in a natural landscape, production, museum, exhibition with the purpose of observing and studying by students various objects and phenomena of reality. A characteristic feature of the lesson is that the study of objects is associated with the movement of students.

In the course of the educational subject "Astronomy", the objects of excursions can be planetariums, observatories, latitudinal and actinometric stations, various museums and exhibitions dedicated to the achievements of mankind in space exploration. Before the excursion, preparation is required for both teacher and students depending on the location and purpose of the excursion. Thus, observatories and planetariums can be visited before studying the educational material presented in the data of the complex, and already, based on the knowledge acquired by students, base an explanation of certain issues in the astronomy course. To optimize the quality of assimilation of acquired knowledge, the teacher needs to familiarize students in advance with the technical base (instruments, building design) and methods (methods) of research work of an observatory or planetarium.

f) Observations. Modern pedagogy gives special place to the use of the visualization method in the classroom. The use of various visual aids in astronomy lessons provides the following opportunities:

1. Supplementing students' independent observation with things that cannot be seen with the naked eye (photos and computer models of cosmic bodies and phenomena).

2. The opportunity to study the essence of many observed phenomena with the help of drawings, drawings, films, digital educational resources (DER).

3. Simplifying the process of students understanding the methods of astronomical research, a visual representation of the methods of operation of astronomical instruments (diagrams of installations, photographs, models of instruments, virtual laboratory work).

Observations, as stated above, are essential for understanding and understanding the information given in the astronomy course. In the educational process, school astronomical observations are as important as demonstrations and laboratory work in physics. At the same time, the organization of these observations has its own specific features that differ from the principles of physical experiment. Observations cannot be organized during the lesson (with the exception of observations of the Sun), due to the location of the celestial bodies and the inappropriate time of day. At the same time, students must retain some short-term perceptions in their memory in order to use them in subsequent astronomy classes, so the teacher is required to be attentive to the organization and conduct of observations.

e) Extracurricular activities. Elective courses are courses taken by choice. The federal basic curriculum proposes the organization of extracurricular and project activities for schoolchildren for two hours a week in high school. The teacher can choose an elective course program from ready-made ones or create his own based on the classroom equipment.

The content of the elective course may:

- offer an in-depth option for studying astronomical material;
- provide an introduction to one of the sciences or professions (astronomy, astrophysics, astronautics, etc.);

The club is the main form of extracurricular work in astronomy. The main participants of the circle, in most cases, are students of general education institutions who are interested in astronomy. The methodology for organizing circle work is based on voluntariness, the connection of circle work with academic work, expanding the student's zone of proximal development, and the development of creative abilities. Entertaining "theoretical" classes form the basis for starting work in the circle. Such classes may be accompanied by lectures from the leader and reports from the circle participants. The main principle of theoretical classes is maximum activity of participants. When conducting lectures and reports, you need to use the equipment and visual aids on astronomy available at the school. The content of students' circle work can be the manufacture of simple astronomical instruments, preparation of reports, observation of astronomical phenomena and objects, etc. The role of observations in a circle is quite large. Schoolchildren carry out simple practical work in astronomy throughout the year. Through observations, students develop skills in tracking the Sun, Moon, stars and meteors. With a regularly working circle, schoolchildren conduct observations that, in their methodology, are close to the research work of amateur astronomers.

The result of the circle's work, first of all, depends on the organization, control and accounting of the work performed. It is advisable to record the results of completed work in a special journal. At the end of the year, it is reasonable to hold a reporting conference, an exhibition of photographic reports based on the observations of the circle participants. Today, there are two different educational systems (described in the first paragraph of the first chapter) aimed at studying astronomy. These educational complexes include developed methodological recommendations for teachers, which contain a description of the forms and methods of conducting classes in astronomy. However, the presented manuals do not fully disclose each of the topics of the astronomy course; for this reason, this work will propose a methodology for teaching the section “Fundamentals of Astronomy”, which contains the features of studying theoretical material (modern forms and methods), a set of qualitative and computational tasks, laboratory and research work.

4. Modern equipment for studying astronomy at school

To successfully implement teaching and conduct practical classes (observations) in astronomy, in a secondary school it is necessary to equip an astronomy corner or an astronomical training area with portable equipment in the physics classroom. When disassembling and repairing astronomical equipment, older schoolchildren can be involved in the work; this activity will benefit students, in addition to developing interest in many theoretical issues in spherical and practical astronomy. Let's consider the necessary equipment of an astronomy classroom when studying the section “Fundamentals of Astronomy”:

- Seasonal star charts.
- Moving star map.
- Devices for approximate determination of noon lines by the North Star.
- Tellurium.
- G nomon - to determine the noon line along the Sun.
- Model of the celestial sphere (armillary sphere).
- A device for determining the noon altitude of the Sun.
- Telescope.
- A device for approximate determination of the meridian and observations of culminating luminaries.

All these devices can be made by students under the guidance of a teacher. A detailed description of the device and its manufacturing process is given below.

The set of maps includes fifteen maps of the northern (circumpolar) and southern (equatorial) sides of the starry sky for all four seasons of the year. You can purchase seasonal maps in any bookstore in the form of a star atlas. You can make similar maps on your own, find star maps in good quality on the Internet, print them out and stick them on thick paper.

The device for approximate determination of the midday line according to the North Star consists of two slats, to one end of which cords with plumb lines are attached, and the other is pointed. By sticking the slats into the ground so that both cords and the North Star are on the same straight line, you can draw a line between the plumb lines, which will be the desired plumb line. When studying astronomy, the first model one comes across is the armillary sphere. Through it, students become familiar with the main points and lines of the celestial sphere, the system of celestial coordinates, without knowledge of which the process of studying astronomy is impossible. Acquaintance with the indicated elements of the sphere takes place first of all in the office, and only then on the astronomical site. However, the armillary sphere is not always present in schools, so sometimes the teacher has to make the device himself.

The image shows a model of the celestial sphere, with the help of which the teacher will be able to describe the main elements of the celestial sphere. Let's consider the main components of the proposed device:

- a glass spherical flask filled halfway with a weak solution of copper sulfate, which does not produce sediment;
- an axis directed along the symmetry of the flask, made of a metal rod, so it does not react with the solution;
- a stable stand that allows you to change the angle of the axis and at the same time the angle of the axis to the horizon;
- fixing the angle indicator;
- the main elements of spherical astronomy: the celestial equator (black line) and the ecliptic (yellow line), known constellations, spring and autumn equinoxes, celestial meridian.

Using this model, you can observe the movement of celestial bodies relative to the horizon. By changing the angle of inclination of the axis, it is possible to track the movement of stars at different latitudes and poles. You can also monitor the length of the day at different latitudes by fixing the Sun on the ecliptic, explain various astronomical phenomena, polar days and nights, twilight, etc.

One of the most practical and useful instruments for studying astronomy is the theodolite. It serves to simultaneously measure the azimuth and altitude of a celestial object.

5. Laboratory work on “Fundamentals of Astronomy”

The connection between theory and practice is the basis for the formation of the ability to develop for each person; first of all, this rule also applies to the younger generation. Laboratory work increases interest in the subject being studied, develops in the student such qualities as attentiveness, accuracy, perseverance, and expands his scientific picture of the world.

In the case of astronomy, all practical work in this section can be divided into 3 large groups: observations, frontal laboratory work, research/design work.

Due to limited time (5 hours are allocated for the “Fundamentals of Astronomy” section), the teacher and students cannot fully study all the theoretical material along with all the practical work presented in Table 4. For this reason, the teacher needs to rationally combine classroom and extracurricular activities. Some of the educational material can be given out for independent study, and students can perform some observations of celestial objects that do not require special equipment at home. The content of lessons should be focused on complex concepts and the most painstaking laboratory work. The table presents various practical works on each topic of the section, which are performed with the necessary equipment available. If an educational organization does not have the necessary equipment, then you can construct it yourself, or use a virtual planetarium, for example, the Stellarium computer planetarium [5].

Stellarium is a software project that allows people to use their home computer as a virtual planetarium. It calculates the positions of the Sun and Moon, planets and stars and draws how the sky will appear to an observer depending on their location and time. It can draw constellations and simulate astronomical phenomena such as meteor showers or comets, as well as solar or lunar eclipses. The program can be used as an educational tool for studying the night sky, as an observational aid for amateur astronomers who want to plan night observations. So Stellarium works on high quality graphics, it is used in some planetariums and museum projection installations. Some amateur astronomy groups use it to create sky maps to describe regions of the sky in articles for newsletters and magazines, and the "shifting sky cultures" feature suggests its use in cultural-astronomical research and outreach.

Based on two different laboratory works with a single topic, we can conclude that the content of the work does not depend as much on the topic as on the goal. In the first case, when using the equipment, the goal was to determine the geographic latitude of the area, and in the second, to study the equatorial coordinates of various celestial bodies already at a given latitude. In fact, each method has its own advantages: determining geographic coordinates using a theodolite strengthens the connection between theory and practical skills, and finding equatorial coordinates in a virtual planetarium visualizes the celestial sphere and its main circles, lines and points. Also, the specificity of each of the works makes it possible to carry them out in parallel; laboratory work with real equipment is carried out in an educational institution, and with virtual equipment at home using a computer.

6. Methods for organizing virtual laboratories

Modern practice of teaching astronomy courses in higher educational institutions requires, in addition to well-equipped stationary teaching laboratories, the presence of a mobile laboratory workshop, which is especially necessary for work in out-of-town branches of universities, where often there are no laboratory classrooms at all. Naturally, this can only be a virtual computer laboratory workshop, launched without first installing the program on the computer. In addition, it is desirable to use elements of this workshop both as lecture demonstrations of astronomical phenomena and as an element of practical classes (virtual laboratory work). Finally, such a workshop turns out to be indispensable during periods of “peak” teaching loads on classrooms, when regular laboratory classrooms may not be enough to conduct laboratory classes according to the calendar-thematic plan of the academic discipline.

The virtual workshop is both a lecture demonstration and a simple laboratory work on the study of damped oscillations; the interface is extremely laconic (there are almost no controls and settings), which again contributes to the efficiency of work and improves the learning process. There are quite a lot of Internet portals offering virtual laboratory work on a variety of topics, and they can be performed both online and offline [9]. For example, the free online resource Stellarium [8]. This is one of the developed specialized portals dedicated to virtual educational laboratories. The site presents educational interactive works that allow students to conduct virtual experiments in physics, chemistry, biology, ecology and other subjects. However, to conduct this kind of laboratory workshop, it is necessary to ensure constant access to the Internet. In addition, it is necessary to adapt the workshop within the framework of the course being taught (depending on the direction of the students' training), which in principle is not possible. This leads to an understanding of the need to create and develop a virtual laboratory workshop, adapted for students of a particular university. Moreover, it is very useful to involve students themselves in this work, since this will stimulate the development of their engineering, physical thinking [9]: during modeling, they become familiar with the basic technical means used in constructing the model, which facilitates the understanding of astronomical phenomena, increases interest in the discipline being studied, expands the research component in the study of natural sciences, and also teaches how to use information technology as a modern and convenient tool. Students get the opportunity to observe the modeling process, independently form its parameters, and analyze graphical information reflecting changes in astronomical quantities that describe interactions [10-12].

Depending on the educational topic, the goals set for the computer program for simulating the astronomical process, a virtual workshop can simulate a real laboratory installation as completely as possible or, conversely, almost completely abstract from its unnecessary details; makes it possible to carry out work, including demonstrating consequences that are unattainable or undesirable in a full-scale experiment (fuse blown, electrical measuring device; change in the polarity of switching on devices, etc.). Thus, virtual laboratory work has undeniable advantages, namely the possibility of conducting a laboratory workshop when setting up a real experiment is difficult, when it is necessary to instantly process the results obtained. The above circumstances encourage many teachers to independently create educational computer programs, including virtual laboratory workshops. Of course, they will not differ in the quality of programs made by professional programmers, but there will be no violations of the methodological plan. It is worth noting that the excessive “beauty” of program elements only distracts the student’s attention from the physical essence of the phenomenon being studied - everything is good in moderation. Attempts to develop our own software products, taking into account the specifics of teaching a general physics course, have been made; all of them were carried out within the programming capabilities of a standard office suite of any computer, so the programs run directly and do not require preliminary installation, which is necessary for the development of a mobile laboratory workshop. Some of the listed programs are as close as possible with their interface to a real stationary laboratory installation, i.e., the devices shown on the screen are equipped with all the necessary controls - switches, regulators, toggle switches, etc.

7. Methods and techniques for conducting a demonstration experiment

It is absolutely clear that the effect of any experiment primarily depends on the quality of school astronomical instruments. First of all, the following requirements are imposed on them: high technical qualities, simplicity of design, sufficiently large sizes, aesthetic design. The demo installation should be as simple as possible. This is important for understanding the experience and drawing conclusions from it. Installations should use devices that are known to students or whose operating principles are understandable to them. However, as the history of the development of astronomy teaching methods testifies, the simplicity and complexity of a particular demonstration are relative concepts. Thus, until recently, experiments showing the properties of the motion of celestial bodies were considered complex and almost never carried out in high school. With the advent of such instruments in the arsenal of astronomical offices as a set of instruments for studying the properties of astronomical bodies and movements. Meanwhile, for the needs of everyday practice, it is useful to at least approximately define the concept of "simple demonstration installation". Obviously, this can be done this way: a demonstration installation that is as close as possible to its circuit diagram is considered simple, but only so much that this does not noticeably reduce the quality of its work. It is clear that natural scientists, the creators of experimental installations, when creating them, do not set themselves the task of making them suitable for teaching; they pursue a different goal. In the methodology of astronomy, the process of adapting experiments first carried out in scientific laboratories to the tasks of teaching is carried out. This process proceeds by simplifying experimental setups, eliminating from them everything that does not serve to clarify the essence of the astronomical phenomenon being studied (only simplifications that vulgarize scientific results are unacceptable). The success of a demonstration experiment depends not only on the quality of the instruments themselves, but also largely on the astronomy teacher's knowledge of the device, technical data and skills in operating these instruments, the conditions of the experiment itself, and the intensity of the demonstrated physical process.

CONCLUSION

This paper examines the methodological aspects of teaching astronomy in high school. The main problems of studying astronomy in modern society and some ways to solve them have been identified, through analysis recommended by the federal list of educational and methodological complexes in astronomy and the available modern forms and methods of teaching astronomy in secondary schools. In addition, modern equipment for conducting observations, laboratory and research in the course of studying astronomy is considered. The content of the methodology for studying the section "Fundamentals of Astronomy" is analyzed, which includes an analysis of the features of studying theoretical material, the system of recording knowledge on the topics of the section, laboratory and research work. Experimental research work was carried out to study the effectiveness of the developed methodology: a survey sheet was compiled to identify the educational needs of students and their initial level of knowledge of the elements of the section "Practical Fundamentals of Astronomy"; based on the survey results, adjustments were made to the created methodology, which was later introduced into educational process. During the control stage of the experimental search work, the research hypothesis of this work was confirmed.

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