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Organization of astronomy hometasks with the use of informational and communicative technologies for cognitive activity increase

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Abstract. The method of astronomy homework organization in order to increase students' cognitive activity is described in the article, as well as the possibility of individualisation and differentiation of homework is shown. Modern methods offer a lot of techniques and innovative forms of teaching methods in order to improve students' knowledge. These innovations are aimed at applying activity-based and person-centered approaches to learning that will help to intensify students' training activities therefore it will be engaging and productive. Examples of independent practical tasks of different types and use of information and communication technologies are given. The article gives examples of such kinds of work on astronomy classes as: preparation of a textbook, preparation of supporting notes, practical tasks, solution of astronomical problems and creative tasks.

1. Introduction

The work of astronomy teachers should be aimed at the development of each student's personality, mastering basic astronomical concepts, the use of information and communication technologies in the educational activity. Nowadays the issue of necessity and importance of homework is often discussed [6], [30], [34], [35], [37], [42]. Homework is an integral part of disciplines study, it has an educational value and should contribute to the consolidation of the acquired knowledge and skills improvement. The necessity of students' homework is determined not only by solving of purely didactic tasks (knowledge consolidation, skills improvement, etc.), but by the tasks of formation of independent work skills and students' preparation for self-education [14], [18], [39], [40]. One of the important tasks of a school is to teach the child to learn (preparation for lifelong learning), so the statement does not have basis that homework is unnecessary as essentials of the material must be studied during the lesson. The necessity of homework is also determined that knowledge, skills and abilities are absorbed not immediately but after a periodic repetition.

Besides educational significance a homework has also an educational value forming a sense of responsibility for the task involved, producing neatness, diligence and other socially valuable qualities. Students' homework is essentially different from the classroom one as, first of all, it is held without teachers' direct guidance, although on their recommendations. Students determine time of task accomplishment by themselves, choose the most appropriate rhythm and work pace.

Visibly, it is impossible to master a school programme in astronomy as well as in other subjects on the proper level. High school students are conscientious about studying interesting and necessary disciplines, in their opinion. Astronomy refers to the so-called "unimportant subjects", because it is



studied only in 11th class (or in 10th and 11th classes within physics), it is often conducted in the last lessons and most importantly, because there is no STA or testing in astronomy. Accordingly, students either do not do their homework in astronomy or do it partially and irregularly (from 25 surveyed 11 respondents do homework sometimes, 12 respondents do it very rarely and only 2 respondents do it always). Little attention is devoted to homework and independent work in astronomy in the methodological literature. The teacher has a difficult task – to make the study of astronomy to be interesting for students [2], [16]. And to solve this problem it is necessary to answer the following questions:

1. How to make the tasks effectively help students to learn basic knowledge and skills in astronomy?
2. What is necessary to do in order to increase the motivation of traditional astronomy tasks accomplishment?

The aim of this work: to consider different approaches to homework organization that will enhance students' cognitive activity, namely: to use individual approach more, to use information technologies and cloud environments services both for homework accomplishment and its checking.

2. Homework organisation

Homework should teach children how to organize their time, to choose the place and method of learning, to build their own work pace, to search, to select, to analyse and to use information as a result – to be able to apply acquired knowledge and skills. So, homework is students' independent work that can be performed both at school and at home.

2.1. Differentiation of homework

In some cases, homework must be the same in content for all students, however, these tasks also can be differentiated. If one child has learnt better the material during the lesson, then it is enough for him to refresh knowledge during next lesson, however, some students will need to repeat the material at home more seriously. So while organizing homework in astronomy a teacher should contemplate tasks for students with high and low levels of academic achievements and a teacher should actively use students' various hobbies and interests such as using computer technology, design, drawing, etc.

As the experience shows, decreased interest to homework is also caused by the use of the same type of tasks for a long period of time. Homework should contain an element of novelty and provide new options for their accomplishment. In some cases, it is advisable to give students individual tasks that help to eliminate gaps in the knowledge of weak students and support the interest of more motivated students.

Individual and differentiated homework can help to realize the development of each student's individuality and to take into account their abilities. In order to study the role of individualized homework in the formation of strong knowledge in the work by Syrotiuk [36] a survey of teachers and students was conducted and it was found that the learning material is absorbed better when individual homework is accomplished, preferring to accomplish creative work, but 4-15% of students receive such tasks.

2.2. Development of cognitive interest

During teaching a teacher should influence on all areas of students' motivation [43]: from the formation of the need for new information, new ways of action and activity in general to the formation of dependence on the results (product) of educational and cognitive work. The main high school student's motivations in the training process are self-affirmation, self-development and cognitive interest.

The presence of a student's cognitive interest prompts him to set his own learning goals, except those that a teacher sets. It means that cognitive interest provides search, creative character of educational activity in any form. Homework should help to increase cognitive activity, only then a student starts to study effectively when he is an important active component of the educational process, as we know, it is impossible to teach, it is possible to learn. Reproductive tasks (to read textbook or synopsis) do not have such efficiency but it is impossible without them to absorb the studied material better. When

preparing homework based on the textbook a teacher should take into account that some students are able only for semi-mechanical reading of the material, they cannot divide it into separate knowledge parts and do not make out self-control on the knowledge mastering, that is why in addition to the task to read the material self-control tasks should be provided. Such tasks are compulsory for all students, that is why everybody of them must be checked, accordingly, it is preferable that answers to the questions for the stating a level of material absorption should be in the form of notes or a text. In this case a teacher can easily and quickly check them in the classroom. As an example, a teacher can use the collection of independent work in astronomy [17].

The use of electronic resources and cloud environments services will diversify and modernize the educational process [4], [8], [12], [13], [15], [19], [22], [24], [27], [28], [33], [38], [41], [44], [45]. Implementation of information and communication technologies in order to check the level of learning will simplify teacher's work and will reduce time for this kind of work. For example, ordinary electronic testing allows a teacher to control students' learning level and promotes students' self-control. Although there are warnings that test results do not allow to estimate students' real knowledge and skills. There are many electronic resources which are available for test preparation: <https://quizizz.com/join/>, Moodle [1], [26], [31] or Google Classroom [3].

2.3. Types and forms of tasks

The study of astronomy must be accompanied by practical and astronomical tasks. Most part of these tasks is usually done during the lessons but in order to increase interest to discipline learning some additional practical works or homeworks can be offered. We increased the number of practical astronomy tasks and students immediately began to demonstrate better understanding of the studied material. In addition, teachers noted more fair homework. Mostly, it is to make an observation (for example, during a week or two to mark the rising and setting of the Sun or the Moon), another task may be to use Internet resources, computer or mobile applications with a purpose to study and explore this or that phenomenon [25]. Most observatories provide data on solar activity; there are solar system simulator programmes that allow you to "go" on a virtual journey to different planets or even around the universe, to study the phases of the Moon with appropriate applications. To get acquainted with the stellar sky, we offered students tasks using mobile applications, such as Sky Map, Star Walk, Sky View, or computer programme Stellarium [22], [23], [32]. When students use a computer or mobile applications, they need to know not only the name of the application but also to have clear instructions for their use. As well as those tasks have to give new knowledge in astronomy, the students will be able to analyze the results and their own conclusions. Here is an example of such a task. The students have to use the mobile application Phase of the Moon to compile a table: date, time of Moon's rise and set, phase, and the constellation in which the Moon is located. Then they analyze the conditions, place and time of observation The Moon, the motion of the Moon during the month on a stellar map. Students do actively such tasks, analyze the results and make their own conclusions.

Solving astronomical problems is one of the most popular type of homework among surveyed students, but it is not the favorite one. The number of tasks in the astronomy school course is small, so it is impossible to abandon them, on the contrary, it is necessary to increase their amount in order to understand practical and mathematical components of astronomy. It is also possible to diversify this type of work by presenting tasks and solutions in an electronic form, however, it is necessary to take into account students' abilities, and for some students it may be sufficient to check the results of solving problems by including these tasks in tests.

A teacher has to use various methods, techniques and tools in order to activate the external actions and internal processes of students' development, thereby encouraging them to become independent in learning. The main methods of development of cognitive interest are known in psychology: stimulating by interesting content, making situations for creative search on the basis of revealed contradictions, creating a game plot around educational material, presenting educational material in the form of achievement results in the corresponding science [16], [29].

In order a student to become an active participant of the educational process, an important type is

interesting tasks for logical thinking development, creative tasks (creation of comics, puzzles, writing composition, drawings, forming education and visual books, developing animations, etc.). All these forms of work can be easily used in astronomy classes, but students must have skills and ability of work with different applications [5]. Nowadays there are many opportunities, for most of them it is even not necessary to install specific applications, it is possible to use the Internet resources and to perform tasks online. For comics creation the resource: <https://www.storyboardthat.com/> can be used and for riddles making: <http://rebus1.com/ua/> can be used.



For example, when students study the structure of solar system, they can prepare a comic book about traveling to planets, during their work they have to tell about distances to planets, describe the peculiarities of physical conditions on various planets. Similar tasks can be also offered while studying the structure of the Universe for students to present legends about the stellar sky. For better memorization new terms or names it is advisable to offer students to prepare puzzles or rebuses in advance and to solve them together in the classroom. Such tasks are interesting for students, and the implementation of such tasks has led to an increase the number and quality of the completed homework.

2.4. Long-term homework

Long-term tasks (month or half a year) may be important and interesting. Such tasks can be used for: making training and visual textbooks; preparing reports and their defending it in the classroom; holding an exhibition; making observations. Work of this type can be both individual and group. This kind of tasks will contribute to student's longer involvement in the learning process and it will increase his responsibility. Differentiated group homework solve another important task, they can and must reveal the preference of collective activity (one of four important competencies such as creativity, critical thinking, communication and cooperation) to students. For example, nowadays project-based learning and preparing projects in the form of presentations and reports are a widespread: in the astronomy lesson the first group of students will present interesting information about scientist's life and activity, the second group will tell about this scientist's scientific contribution to the development of astronomy, the third one will offer information about the technical means used by this scientist, and the fourth group will inform about the significance of this work for the further development of science and technology. Alternatively, one group reports about an astronomical phenomenon, the second one explains how this phenomenon can be observed, the third one reports about research results, and the fourth group informs about research prospects. Summarizing the contemplated task, a teacher can emphasize the effectiveness of a group work and evaluate the contribution of each student. Students' groups should be heterogeneous i.e., they should include "strong" and "weak", active and less active students. Individual homework allows to experience a sense of success also by those students who have low and average levels of educational achievements in most subjects. Such tasks give these students an opportunity to prove themselves, their strengths, thus to create a positive attitude towards schooling (the principle of successful learning).

Individual tasks must not be given from time to time. Their thoughtful system will enable unsure students to strengthen themselves in their abilities, as well as it will enable sure students to develop their interests, to increase enthusiasm and to teach them both to learn independently.

From didactic goals homeworks can be divided into three types:

- it has a beforehand studying (preparing for the adoption of new material, learning a new topic);
- continuing the work that was begun in class (aimed at consolidating knowledge, developing skills);
- consolidation the material that has been studied in class (requiring application of knowledge in practice).

Depending on the didactic purpose and type homework may be compulsory for all students or individual task "for those who want", in any case they are differentiated because each of them works according to their abilities and competence.

There is also a model of learning which is named Flipped Class [9]. The Flipped Class training model

is a kind of blended learning [3] whereby students learn the new material at home. Instead, in the class children discuss learned material with their teacher, also they perform tasks to check their level of learning and understanding of the studied, they do exercises, conduct laboratory and practical research etc. In this form of homework students may work in online environment, read a textbook, watch educational videos or information resources in order to study new learning material. A teacher becomes an assistant-consultant and coordinator from the main translator of knowledge. Consequently, it promotes close collaboration with students in the classroom. Students' role also changes and they are no longer just observers. Students themselves are responsible for the obtained knowledge, direct an educational process, look for practical application of the received information.

As a result of using homework for preparing to study new material the following issues are solved:

- Increasing students' realization of a need to do homework.
- Saving time for learning new material at the lessons.
- Students acquire the skills to systematize the learned and to deepen their knowledge through systematization.
- Creating a success situation and opportunities for students' intellectual and personal growth in the realization of homework.

Differentiated homework should be used to consolidate a material in order to develop students' individual abilities and to use it for the benefit of the whole class. Individual homework can be used for educational purposes as well as for development of each student's abilities.

One of the possible options for keeping the level of preparation, initiative, assimilation of content and volume of educational material is writing support notes for peculiar topics, sections, paragraphs. Supporting notes should serve not only as a solid means of memorizing learned material based on visual images and associative relationships but also they should contribute to the development of thinking as well as general and special abilities. Such a task can be: preparing for the study of new material, then in the lesson a teacher will check the level of understanding of this material and therefore it can possible to devote more time to the practical application of the acquired knowledge. Supporting synopsis is often used to consolidate new material and to continue work begun in the lesson.

In order to compile supporting notes a student must have a sufficiently high level of skills to work with educational literature. Therefore, at first, it is necessary to identify the skills level of independent work with a textbook and additional literature. For this aim a teacher can propose students to draw up a plan and synopsis of a paragraph from the textbook or a part of it and then to analyze the work from these positions:

- ability to highlight the main;
- ability to divide material into semantic parts;
- ability to summarize the read, using visual images, signs.

To simplify the compilation of the supporting syllabus students can use prepared forms in which they fill the appropriate columns. Printed notebooks or electronic notes can be used. When drafting the use of prepared forms a teacher controls an amount of material learned: terms, laws and definitions that students need to know [21]. For example:

1. Fill in the table in figure 1

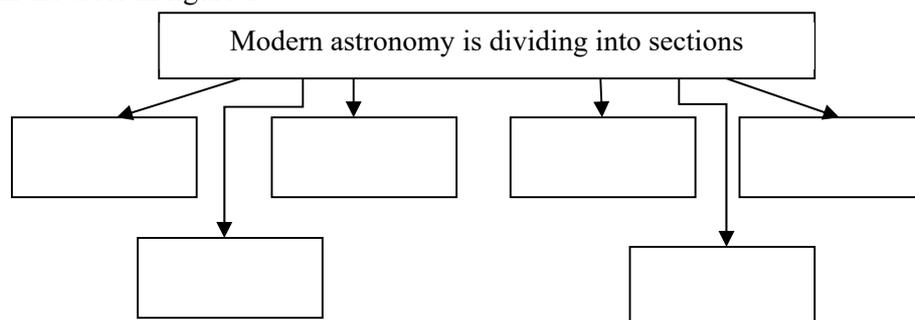


Figure 1. Table with task for students.

2. Fill in the scheme in figure 2.

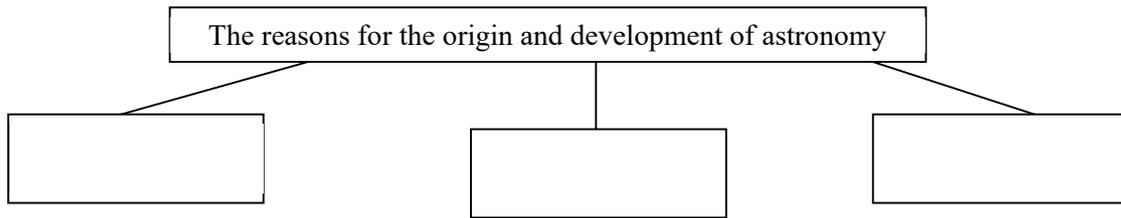


Figure 2. Scheme with task for students.

3. Identify the images of the first astronomers and write their achievements in astronomy from table 1.

Table 1. Astronomer and achievement.

Astronomer		Achievement
	<p>Claudius Ptolemy</p>	
	<p>Nicholas Copernicus</p>	
	<p>Johann Kepler</p>	
	<p>Galileo Galilei</p>	

4. Sign the planets of the Solar system. Arrange in order of distance from the Sun in figure 3.

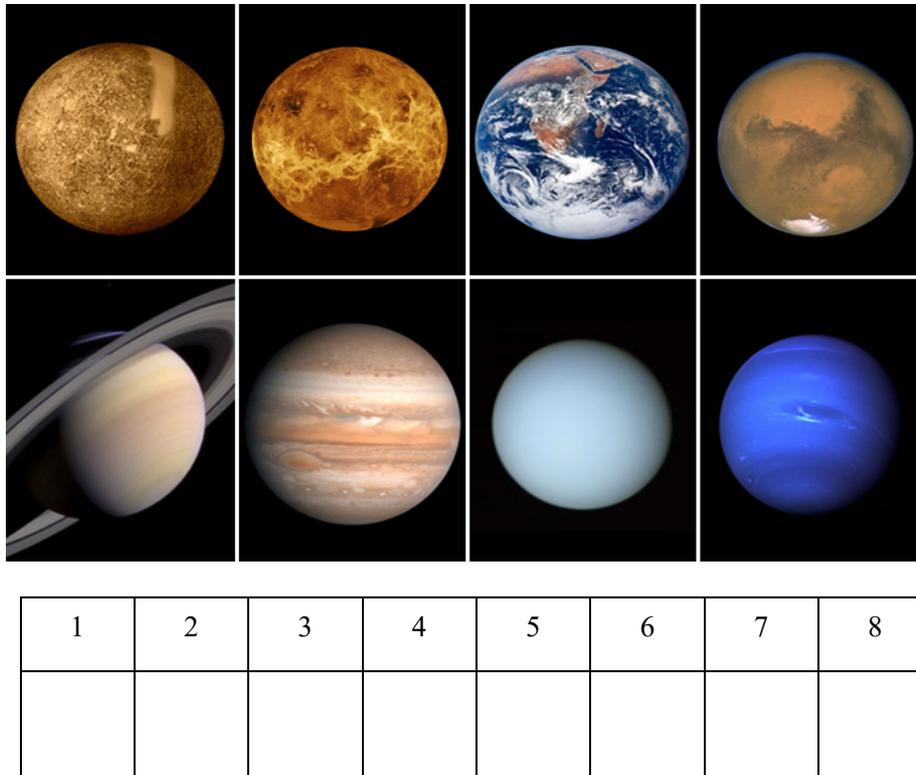


Figure 3. Planets of Solar system.

2.5. Homework estimation

Taking into account the number of hours to study astronomy at school the most often final mark consists of the scores for 2-3 tests and one or two essays / reports / presentations / projects. This approach appeals to students because it does not require additional effort, but does not motivate or enhance their cognitive activity. Implementing different types and kinds of tasks for students it is appropriate to use such form of assessment as students’ portfolio. It is a way of recording, accumulating and evaluating student’s individual achievements over a study period. Different types and kinds of tasks imply a different approach to assessment. A portfolio can contain both current marks and marks for completed and submitted creative, project and research works. The effectiveness of assessment depends to a great extent on its comments by a teacher, because the humanization of education “requires” that during learning it should be free from pressure on students, psychological discomfort caused by biased assessment. The evaluation of portfolio’s materials is carried out in accordance with the tasks for which they are directed, with the use of quantitative and qualitative evaluations.

Forming a portfolio helps:

- to discover child’s individual capabilities;
- to monitor the dynamics of the student’s educational achievements over a period of time;
- to determine the effectiveness of the tasks and their relevance to the child’s abilities;
- to monitor the development of socialization and the formation of a student’s personality.

However, it is important to control the number of tasks that a student performs in order to encourage a student to learn during the whole period, not just to do interesting tasks. For this purpose, such tasks are planned at the beginning of astronomy study and immediately for the whole year.

Olena V. Gozbenko proposes to develop a homework grid plan and to present it to students in order to motivate their activities [10] (table 2).

Table 2. Homework estimation.

No. of a lesson	Standard homework (compulsory for all)	Additional homework	Reports, presentations (view or form)	Projects

3. Discussion

In addition to the standard tasks of developing cognitive activity, there are also interesting individual tasks that can be offered to all students, but not obligatory for everyone.

The examples of such non-standard homework related to the student’s self-development technology are the following:

1. To create an advertisement about a law, a section, a concept, etc. (such as promoting astronomy as a science).
2. To make test assignments on the topic for other students.
3. To prepare a crossword or rebus for the topic.
4. To write a story, a poem, a narrative poem (for example it may be about traveling to the Orion Nebula or the Andromeda Galaxy).
5. To make your own observations (it may be moving of the Sun, the Moon or planets without using a telescope).
6. To make a comic book or animation of the topic.
7. To make a device (sundial or homemade telescope) or a model (layout of a constellation or the Solar system) [20].
8. To analyze the possibilities of computer or mobile applications and their correspondence to a theory (Universe Sandbox 2, Celestia, RedShift).
9. To prepare (to make with the help of applications) a puzzle of terms or illustrations for the material studied.
10. To find interesting facts from the world of science, technology, about scientists’ life etc.

The purpose of homework as a form of organizing students’ cognitive activity is to expand students’ knowledge, to teach them to regular independent educational work, to develop skills of self-control, to foster independence, activity, a sense of obligation and responsibility. It is closely linked with the lesson. This connection means that the cognitive activity at lesson requires additional work: practice in applying rules, solving tasks, finding answers to questions in the textbook, etc. While doing their homework students prepare to perceive new material in the next lesson.

One of the ways to reduce students’ workload, which may be recommended for astronomy teachers, is to enhance student’s independent cognitive activity taking into account their natural abilities and aptitude for learning. Depending on the content of training the forms of homework are the following:

- learning material by a textbook.
- performing oral exercises, doing written tasks.
- doing practical and laboratory work.
- project activity (group, pair, individual).
- preparing reports.
- conducting astronomical observations.

The problem with homework for many students is the inability to organize their working hours which leads to hurry in the work and surface learning of the material. One more reason for the failure of doing written tasks is that they are performed without first learning the relevant theoretical material.

Summarizing, it can be concluded that homework optimization consists of the following factors:

- Clear goal setting for homework.
- Variety of homework forms, the sequence and the feasibility of their use.
- Use of modern digital technologies.
- Differentiation of homework due to the level of difficulty.
- Timely, diverse, open control of homework.

- An optimum amount and timing of homework.
- Clear and competent teacher's instructions for homework.
- Linking homework to learning new material.
- Creating a success situation and opportunities for intellectual and personal growth for students in the process of doing homework.

This approach to students' tasks, which begins with a teacher's explanation at the lesson, continues independently by students and ends at the next lesson with their checking, helps to solve basic astronomy teaching tasks at school as following:

1. To provide students with the basics of knowledge and skills in order to understand properly processes and phenomena occurring in the Universe, as well as its structure and evolution.
2. To form the ability to apply knowledge to explain astronomical phenomena, to understand their interconnections in space and time.
3. To show the role of astronomy in the culture and the formation of the natural-scientific picture of the world, the development of scientific and technological progress.
4. To acquaint students with the basic methods of astronomy, to form appropriate cognitive and practical skills.
5. To form the idea of the Universe as a coherent system in a state of self-development and self-organization, and the idea of possibility of the emergence and existence of life in the Universe.
6. To form the ability to perform astronomical observations (visually or using simple astronomical tools), simple calculations and also to solve astronomical and astrophysical problems.

4. Conclusions

The described approach to the organization of homework in astronomy was suggested to school teachers in the city. They used different types and forms of tasks, used computer technologies, practiced long-term tasks (preparation of messages, speeches, drawings, animations, etc.) and "non-standard tasks". Then we interviewed the students and studied teachers' opinions. The questions were as follows: did the students do their homework better, did their interest in studying astronomy increase, and did this approach take into account the individuality of each student? All of them testified that a result of this has increased interest in the process of studying astronomy, the student has become an active participant in the educational process, it also has reduced the problem of doing homework. It is important to practice the individuality of such tasks that will increase students' self-esteem and desire to learn. Homework will promote the development of students' cognitive activity only when the student becomes an active participant of the educational process. Finally, it is concluded that homework (or independent work) is required to be provided in case it is properly organized.

Separately, it can be added that such homework organization is also suitable for the organization of education for children with special needs [11]. What matters is the visualization, the ability to use computer technology and the submission of tasks in logically completed portions.

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