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Questions as Pedagogical Tools for Increasing the Intellectual Activation of Students

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Abstract Educators all over the world, in search of ways to solve certain educational problems, always face the problem of the correct formulation and precise formulation of questions that directly affect the quality of the knowledge gained. Cognitive questions that awaken the natural curiosity of students help arouse interest in learning and motivate students to further active participation in the educational process [**3**]. The ability to ask questions helps to collect objective information about the level of knowledge of students, which further helps the teacher to build effective educational trajectories. The funnel of questions can become a concrete implementation of the Socratic method, which is based on a dialogue between two individuals for whom truth and knowledge are not given in a ready-made form, but represent a problem and involve the search for answers. The Socratic method aims to orient the teacher towards self-knowledge and understanding of what had previously remained unclear and difficult to understand. Using correctly adjusted questions in specific pedagogical situations, it is possible to influence the formation and development of all student learning competencies.

Keywords: Socratic method, Miller's law, funnel of questions, type, strain, clone.

Introduction. When I was a biology teacher at school, I noticed that students absorb information better if they use different examples to explain the educational material. This is especially effective if students are asked logical questions related to the material of the lesson. During brainstorming, students are actively involved in the learning process, and in the course of finding the answer, they remember the moments associated with new information for a long time. I'll give you an example. The author of these lines happened to read a Czech fairy tale in childhood, it said the following. “Once a king issued a decree that he would give his half of his kingdom and, in addition, a beautiful daughter, to the young man who would bring him the most beautiful flower in the world.” Based on this tale, I built a logical question that covered one of the topics in botany.

During the passage of this topic, I briefly stated this tale, and then asked the pupils a question. What is the most beautiful flower in the world brought to the king? Based on the plot of the story, the students tried to find the answer to the question asked. This offers a wide range of color options. The most commonly mentioned are rose, dahlia, lily, etc. There are also completely exotic options, an orchid or a rafflesia. Thus, the creation of bright and memorable images of various colors occurs. Through logical deductions, and various hints, such as the fact that the most beautiful flower was brought to the king by an ordinary peasant guy, and this flower is known to all students in the class, etc. some guess that this flower is an ear of wheat. Many are simply unaware that wheat also has flowers. Therefore, it is necessary to explain to students that insect pollinators are not needed to

pollinate wheat. After all, the beauty of flowers was created to attract various insects, and not for us people. And wheat, which is a self-pollinating plant, does not need bright and noticeable flowers.

And, of course, why the ear of wheat is the most beautiful flower for us, it is not necessary to explain for a long time, it is enough just to mention the importance of bread for all people. Thanks to this technique, I was able to arouse a genuine interest in botany among students. After some time, during the survey, I was convinced that this topic evoked vivid associations among all students, in connection with this riddle, and they could answer the question on the topic of pollination of flowers over a long period of time. The task of assimilation and consolidation of new information was achieved [**9**].

Materials and methods. The spirit of rivalry is inherent in almost all people; this, in due measure, can contribute to the activation of the creation of a learning atmosphere in the classroom when discussing various issues. Moreover, questions can be formulated in such a way that each of the participants in the discussion is interested and would be the first to find the answer. This can be helped, for example, by a technique called small group work, which is one of the most popular strategies, as it gives all students (including shy ones) the opportunity to participate in work, practice skills of cooperation, interpersonal communication (in particular, the ability to actively listen, develop a common opinion, resolve disagreements). In any case, one way or another, excited listeners in search of answers to non-standard questions will make a lot of efforts, during which their motivation to study will be strengthened, and in addition, the answers found together will contribute to long-term memorization of new information.

In the course of the studies of teaching practical classes in microbiology in small groups, it was found that interactive teaching methods, unlike traditional ones, generally have a more effective effect on the process of assimilation of a complex of clinical knowledge. In addition, they clearly differed in the individual nature of the impact on the formation of well-known levels of knowledge. So, if traditional teaching methods influenced the development of mainly initial I (knowledge - acquaintance) and II (knowledge - a copy) levels, then interactive teaching methods to more advanced III (knowledge - skill) and IV (knowledge - creativity) of their forms [**1**].

For effective perception of educational material, the following points are necessary. It is no secret that a person learns the main information visually. Since 85% of the information load is acquired through the visual channel, then, therefore, it is necessary to develop visibility in teaching. That is, in practice, it is necessary to provide students with one or another graphic information. These can be presentations, films, tables, cards, etc.

The next important point is information dosage. That is, it is necessary to select the optimal amount of information without overloading with facts, evidence, conclusions, hypotheses, etc. The speech of the teacher should be concise, this is especially important in teaching, as it is associated with the peculiarities of human memory. According to Miller's law, short-term human memory, as a rule, cannot remember and repeat more than 7 ± 2 elements [**5**].

Also, if possible, do not forget about a sense of humor, one of the forms of intelligence, with the help of which academic material loses its monotony. The ability of the intellect to use funny sides in solving certain issues directs a person to a higher level of problem resolution, increases cognitive potential, enriches spiritually [**2**].

At the same time, it is very important that there is feedback between the teacher and students, which leads to figurative live communication and, as a result, memorization.

As the American mathematician and popularizer of science George Polya said, “The best way to learn something is to discover it yourself.”

Therefore, it is necessary not to forget that the best form of education is when the student independently and actively participates in the educational process. To do this, there are a lot of different methods designed to involve people in an exciting way in solving certain issues [**6**].

According to this, at practical classes in microbiology, 2 groups of the same direction (medical business) were selected. During the classes, the students of the first group were explained the educational material by the traditional method without the use of visual material, in academic language and without focusing on some details not directly related to the topic of the lesson. The second group of students was first of all offered a number of questions for discussion, both the topic itself and some points that were covered during the lesson. After some time, after several classes, the survey revealed that the students of the second group had a much higher percentage of assimilation and memorization of information than the first group. Thus, the active participation of the students themselves in the search for answers to the questions posed led to an understanding of those moments that seemed boring and uninteresting to many, during which the knowledge gap that had formed in this area was filled.

Results and discussion. Often many students do not distinguish between the concepts of species, hybrid, breed, strain, etc. Everything related to the biological nomenclature, initially begins to take place at school. Systematics itself is a complex science. In order for students to have a clear idea of the species, I often ask the following question: - How many species of people live on planet Earth today? As a rule, the answers vary from one to four types. Several groups are formed with several answers. Another chain of questions is brewing, let's say to two groups, the first of which claims that there is only one species and the second, insisting that there are already three species of people on Earth. I ask the listeners of both groups to justify their answers so that each group can prove the other the truth. A fierce discussion begins, which forces them to think about the information, actively seek the answer to the question posed, and not just passively accept the information that is provided to them in a “ready-made” form, like a tasteless semi-finished product. Everything that is obtained by independent labor is always more valuable.

Many refer to the fact that people have anatomical and mental similarities, say internal organs or all people have highly developed thinking, those who claimed that there are three types of people are trying to prove that these are races, but they cannot make a clear distinction between race and species. Someone refers to a textbook in which it was written that at the moment there is only one species of people *Homo sapiens* (Smart man) left on Earth. Other types of people, such as *Homo habilis* (Skillful Man), *Homo erectus* (Upright man) and others have become extinct in the course of evolution.

When students are told that the answer to this question can be found in the textbook on botany for the 6th grade, this leads them to complete confusion. Nothing strange, the concept of a species is first introduced in the 6th grade, when the properties inherent in a species are first described, in this case, plants, but these same properties are also suitable for people, animals, microorganisms. The species as the smallest taxonomic unit is characterized by easy interbreeding (between individuals of the same species) and fertile offspring. Imagine, I say, the following situation. If a person of the Negroid race, let's say from Tanzania, moves to China and meets there a person of the opposite sex belonging to the Mongoloid race. Provided that both are fertile, and their acquaintance ends in a happy marriage, it is likely that they will have healthy offspring. So if one of the offspring, having matured, moves to Russia and meets the Caucasian race person there and history repeats itself, both healthy individuals will also reproduce children, all this will testify to one species, namely *Homo sapiens*.

Another case known to many is an animal called a mule. This animal appears as a result of crossing a donkey (*Equus asinus*) and a mare (*Equus caballus*), and these are different species, although they are closely related.

An explanation follows that this is a hybrid - an organism obtained as a result of crossing different species. The essential difference between hybrids is their sterility, that is, it is impossible to get offspring from them, thus they are a dead-end evolutionary branch that appeared as a result of chance. There are, of course, cases of obtaining offspring from hybrids. For example, from ligers. A liger is a hybrid between a male lion and a female tigress. The parents of ligers belong to the same genus *Panthera*, and although tigers are purely "Asian" animals and it is impossible to meet lions with tigers in nature, they nevertheless artificially produce offspring in the form of the largest representatives of the cat family on Earth. Ligers are the largest cats in the world today. Occasionally, ligers also have offspring, female ligers can give offspring, which is unusual for hybrids. The fact is that, according to Haldane's rule, male hybrids in mammals are always sterile, while females can be fertile (sterility is more common in the XY heterogametic sex). Thus, the exception only confirms the rule.

Another example is the beloved pet dog (*Canis familiaris*). As an independent biological species, the dog was described by Carl Linnaeus back in 1758. Since then, there have been about 400 different breeds of dogs in the world, completely different in appearance, from a Chihuahua weighing 1 kg to a Great Dane weighing more than 100 kg. The colossal number of dog breeds does not give us the right to classify them as different species, because a breed is an animal of the same species that was artificially created by man. The breed is characterized by certain hereditary characteristics of the animal, which are specially selectively selected by man during artificial selection. It is unlikely that many breeds of domestic dogs could survive in the wild without human help, for example, hairless dogs, etc. [**4**].

Giving a general idea of the species, one can smoothly move on to more narrowly specific concepts used in microbiology, for example, the concepts of clone and strain.

Clones will be 100% genetically identical organisms. If we talk about microbes, then a huge number of descendants obtained from one bacterial cell will be clones of that one single parental cell sown by the experimenter on a nutrient medium. But how do we ask, the situation is with people. Do humans have clones in nature? Many begin to give a negative answer, because they read and know that human cloning is prohibited. Not everyone thinks that we are talking about natural clones created by nature itself. Namely, identical twins. After all, identical twins in humans are natural clones, because the key concept for all clones without exception is their one hundred percent genetic identity. Everything is much easier to understand with examples. Especially on examples that everyone once saw and knows.

A strain, unlike a clone, is a concept inherent only to microorganisms, say bacteria. This concept includes a pure culture of microbes isolated from a specific source. Since many microorganisms reproduce without the participation of the sexual process, in essence, the species of such microorganisms consist of clonal lines that are genetically identical to the original cell. A strain is not a taxonomic unit, like a species, and the main difference between a strain is that the same strain cannot be isolated a second time from the same source at another time, due to the fact that the evolutionary process in microorganisms is much more rapid than in more complex multicellular organisms [**8**]. For example, bacteria go through as many generations in a day as a human does in 5 thousand years.

Thus, a consistent explanation based on vivid and lively examples creates an associative array among the listeners, thanks to which they not only easily assimilate the “dry” educational material, but also remember it for a long period.

Paradoxicality, that is, at first glance, the strangeness of the judgment, can also take place in various pedagogical situations. The previous example can be supplemented with another. Everyone is well aware of such primates as orangutans. From the Malay language, the word orangutan means "forest man".

Based on this, an interesting parallel can be drawn with taxonomy, which is associated with a person. From the previous material, it was found out that there is one kind of person today - *Homo sapiens*. It remains to find out from the listeners to what genus we belong? Many translate the word *Homo* as a person, but this kind is not, as many translate the generic name literally. In order to have a semantic meaning, it is necessary not so much to know the language, but to capture the semantic load of a particular word.

In order for understanding, assimilation and memorization of the material to occur, I offer students a riddle of the following content. In Malay, orangutan, as mentioned above, means a forest man, how can the word orang-orang be translated from Malay into Russian? The most interesting thing is that, as a rule, the literal translation of words begins. The very first answers sound: man-man, humane man, human man, etc. Sometimes connecting the answer with the translation of *Homo sapiens*, students translate orang-orang as Homo sapiens, although the word reasonable is not in these two words. The answer to this question is very simple, the duplication of words means plural, in this case orang-orang is translated as people. To answer, I bring the meaning of the word *Homo*, that is, we all together belong to the genus People.

Subsequent surveys show that students consolidate the concept of the systematics of living organisms, which is important when studying various groups of microorganisms.

Moving directly from the general concept of a species, it can be explained that each species has particular characteristics inherent only to it. For example, you can ask a question that at first glance is not related to a specific species, but during the discussion leads to the correct answer related to a bacterium, which will be discussed below. The question that was asked to the students has the following content. Imagine a situation, I tell them, if a young mother with a seven-month-old baby turns to your future doctors with the question: - Is it possible to give a small amount of honey as a healthy product for a baby of 7 months old? What will you say in response?

As always, the search for the right answer causes a flurry of different answers. Students are divided strictly into two groups, one for allowing honey to be fed to the baby, the other against. Please share both opinions. As a rule, those who are in favor of giving honey to a baby argue that honey is useful, those who speak against argue that honey can be a strong allergen and it is harmful to give it at such a young age. There are no clear specifics in the answers of both groups, and the students themselves feel this.

Going towards, and most importantly, trying to intrigue them even more, I offer students the following condition: if you, I suggest, were given the correct answer to this clinical situation, could you, without the support of the mighty know-it-all Mr. Google, find a logical explanation for the answer? After everyone agrees, I announce the correct answer. Children under one year old should not be given honey for food, and it is advisable to abstain until they are 2 years old. Here I focus on the words categorically impossible.

And again, a "brain storm" begins in the course of which, again, many are inclined to the theory of an allergy in a baby. I offer them a hint that could enlighten the way to the answer, but the main thing is even more interesting. The hint refers to ancient history.

According to one of the most common versions, after the death of Alexander the Great in 323 BC, the body of the commander was placed in a golden coffin and filled with honey. Herodotus also points to the custom of smearing the dead with honey in Babylon: “The Babylonians bury the dead in honey, and their funeral rites are the same as the Egyptian ones.” One of the ancient authors reports

that the planning and creation of a proper funeral procession to transport the body from Babylon took two years from the time of Alexander's death. The distance from Babylon to Memphis (the original burial place of Alexander the Great) is about 1,400 kilometers in a straight line. Maybe this information, I inform the students, somehow can clarify the situation.

Linking the disparate puzzle pieces into one chain is a very interesting task. And someone manages to tie everything together and find the answer. According to the reasoning, if honey is a conservation agent, then either harmful microorganisms or their spores can be preserved in it. What food poisoning is the most dangerous? What types of bacteria are most commonly associated with canned food poisoning?

Of course, the species of the bacterium *Clostridium botulinum*. Honey may contain botulism spores, but these spores cannot grow in a highly concentrated sugar solution. However, in the digestive system of infants, when these foods are diluted with low acid, low oxygen digestive juices, the spores can grow and produce the toxin.

Therefore, honey is not recommended for children under 1 year old. Once children start eating solid foods, the digestive juices become too acidic for bacteria to grow [**7**].

Conclusion. Entertaining, coupled with activity in search of an answer to the task, a non-standard approach and paradox, clarity and a healthy spirit of competition, sometimes humor and conciseness - all these points that help to cope with the most seemingly difficult to assimilate informative material. Summing up, I would like to note that in the case of teaching students of medical universities, it is especially important to convey the meaning of the educational material, since the life and health of many people are in the hands of future doctors. Information must be conveyed in such a way that students can remember it, and in the current, real clinical situation, not to get confused and apply the received theoretical knowledge in practice. This will have a fruitful impact on the training of creatively thinking specialists who will be in demand in the future, due to their readiness, to quickly and efficiently solve problems that they will have to face in their professional practice.

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