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Developing students' "imagination" and "Full thinking" skills using "Mind Map" to explain the topic of "Electromagnetic Wave Scale

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Abstract:
Studying physics is impossible without "imagination". Because to understand the laws of nature, it is necessary to take into account the interactions between atoms and molecules, to work at speeds equal to the speed of light. Atoms and molecules are invisibly small, and the speed of light is immeasurably large.

Information is obtained indirectly, and feedback is "imagined." So, analysis of physical processes can be the best way to strengthen students' "imagination". The most effective way to develop the laws of physics, "imagination" , "creative thinking" and full thinking is to use the "Mind Map".

This article discusses the use of the "Mind Map" to explain to students the topic of "Electromagnetic Wave Scale", which is widely used in technology and in life today.
Key words: Imagination, creative thinking, full thinking, mind map, electromagnetic waves, scale, radio waves, infrared, light, ultraviolet, X-rays, gamma rays, development.

Introduction

The rapid development of science and technology creates new areas of production. Educational institutions are required to train qualified specialists in these areas.

These experts:

- Ability to distinguish the most relevant from the huge information flow and acquire relevant knowledge;
- Apply existing knowledge in new situations;
- They should be able to find solutions to problems and implement them in production.

Those who meet such requirements are called “creative thinkers” [1].

Full thinking is taught in the educational process [2]. Teaching students «to think fully" begins with developing their "imagination." LS Vigotskiy said that a creative product is impossible without imagination[3].

Imagination is a special form of the human psyche that is in a state between perception, thinking, and memory, and which is different from other mental processes. It's just a human trait, and we still don't know exactly where the brain is.

However, it is through imagination that people create, plan and manage their activities. It also allows a person to leave their current state and travel to history or the future. Its difference from perception is that the images under consideration are not only compatible with real images, but also with elements of fantasy [4]. In the words of A. Einstein, logic can take us from point A to point B, and imagination can take us anywhere. Imagination is proof that the human brain is the most advanced computer. And the computer brain has "electronic literature" about a lot of things.

No wonder these "e-books" are written in our computer brains by some genes. Our life experiences and knowledge awaken and activate these "dormant" e-books. When we call this "electronic information", events happen before our eyes. An inner voice describes events, and we can only record on paper what we hear and see.

Each painter depicts a scene differently. This is because of the fact that the landscape gives them a different impression. Similarly, the "electronic details" of a process in the brains of different people are vary. This is due to the knowledge, experience and, therefore, previously activated "electronic information" of the "computer brain" owner. One can think hardly about a problem, search for news, and activate new "information" that was previously unknown to anyone. This is called "full thinking." This information can be proven in experiments and turned into "scientific discoveries". The famous intellectual experiments of Einstein and Born are good examples of this. These experiments were performed "in the computer brain", their "electronic versions" were activated and only then tested in practice. It is possible to think more about the information activated in the brain, to draw conclusions. Then it goes into long memory and becomes "knowledge." As a result, this information creates a pattern in the brain. Subsequent information is compared with this template, and similarities and differences are noted and converted into new knowledge. The imagination divides and reconstructs the object until it finds the necessary "electronic information", which predicts the result of creation. In other words, it creates things and events that did not exist before [5].

Imagination not only helps a person to acquire new knowledge using existing knowledge, but also to transfer knowledge from one field to another and use its conclusions to solve new problems. The elements of imaginative thinking and imaginative thinking complete each other [6].

According to A. Eienstein, imagination is more important than knowledge. Knowledge is limited, and 'imagination' encompasses the whole universe, creating development.

There is a strong connection between 'creative thinking' and 'imagination'. Therefore, in order to improve "creative thinking", it is recommended to practice painting, visualize the process being studied and draw.

It is also possible to use the method of training the sensory channels to develop "imagination". Because in order to perceive the image, we need information from the sensory channels of sight, hearing, smell, taste, and touch. In particular, the scent has the property of reviving the imagination. This is due to the fact that smelling signals are analyzed in the part of the brain that forms emotions and motivation [7].

The most powerful human trait is the ability to "compare". He is constantly learning new information by comparing it with the information in his brain. The new information is recorded in the brain as consistent with the previous one, and the new information is taken as additional. This means that all the information that comes to the brain is analyzed first. Compared to existing ones.

It gave human another divine opportunity, the ability to apply knowledge in one field to another[5,6]. This ability is one of the most powerful tools for full thinking. Analogy and metaphor are important for comparison.

Analogy – in Greek conformity, similarity. When we study an object or process, we compare it with the information (template) that already exists in our brain.

Typical comparisons are based on the following characteristics:

- comparison of uniformity (conformity to the template);
- "direct" comparison - one or two common elements;
- detailing an object or comparing parts of an object as a whole;
- Indirect comparison, not indirectly.

This shows the similarities and differences between the comparisons. The comparison can be made in the following cases:

- the existence of a comparable "thing";
- the existence of a comparator, a "template";
- the presence of "comparison marks" with the comparator of the comparable. So analogy helps us learn new things using what we already know. In the words of Sterenberg, it underlies most of our scientific achievements [4]. The analogy mechanism is actuated by the phrase "if so ...". For example, if different things, events, and processes are compatible with some of their characteristics, then their other characteristics may also be compatible.

Metaphor (in Greek - copy). U. Gordon saw the possibilities of searching for analogies and developing 'creative thinking' as metaphors[4].

Metaphor is a universal phenomenon in language. It has existed in all ages, in all languages.

Metaphor exists not only in poetry and rhetoric, but also in our speech, thinking, and even our actions in our daily lives. It is based on the idea that it is cold, high, deep, hot, and so on.

Metaphors are unique models in which the laws of nature are described and studied. We can describe the unknown by comparing it with the familiar.

Not only does man discover similarities, he also creates them.

1. Comparing incomparable things. The main mechanism for creating metaphors is to establish similarities between different realities. The result is a model for comparing a system that needs to be studied with a system that is easy to study in another field, the element that needs to be studied. For example, "planetary model of the atom", "sandwich model of membrane structure".

2. **Impossible opportunity.** In Aristotle's words, metaphor is not a way of describing "what happened," but a way of describing "what could happen" if necessary. It is formed in the context of "if it were". In this way, the metaphor creates an opportunity to overcome an "impossible" obstacle, to bring the distant closer, to make the extraordinary ordinary, to present the news in an unusual way.

3. **Adapting the inconsistencies.** Metaphor consists of different objects. One of them is the basis of the metaphor. The other is an assistant. It is this that evokes in the mind the symbolic-association harmony.

If the basis of the metaphor defines the author's purpose and idea, then the "as if" hypothesis allows the choice of auxiliary object.

As a result, a metaphor that combines two different concepts leads to a complex meaning that has many associations. In other words, a new meaning is created.

To develop students' 'imagination' and 'creative thinking' skills in teaching physics.

Most subjects in the natural sciences, including physics, require students to rely on their "imagination." Because they can only be studied indirectly, that is, by results or by some means. Indirect knowledge is knowledge gained by enhancing or facilitating the observation of human senses. Examples of this are knowledge gained through experimentation or modeling, and analogies and metaphors are widely used. At the same time, to analyze this knowledge, human is endowed with the ability to “think” and reason.

These same abilities do not make a person feel physiologically limited, and with their help a person was able to look at the depths of the nucleus, the size of which is 10-15m from a distant space. To obtain indirect knowledge, a person uses many methods. These are:

idealization-creates an ideal object with some limitations and with the help of it, the properties of the real object are studied. For example, the concepts of an ideal gas, an absolute solid.

- modelling is a method based on analogy. In this, the object, which is difficult to learn, is replaced by another object, which is similar to it, but convenient to learn. The knowledge gained from the study of the model is applied to the initial object. This method is used to study objects that are difficult to learn directly. For example, micro and macro space, which is difficult to see.

experiment (scientific experiment) – a method of studying an object that is difficult to know directly. In this, tools are used that stimulate or facilitate the observation of human sensory organs. This method has made human from the observer of nature to the researcher of it. For example, the experience of Reserford, conducted with the purpose of determining the structure of an atom. In the educational process, it is important for students to visualize the processes in the teaching of natural sciences, including physics.

Because visual information is recognized faster and restored faster. The human brain analyzes visual information sixty thousand times faster than verbal information. Even when people were shown more than two and a half thousand images for 10 seconds, the familiar display of their images was not less than 90 percent. After a year, this figure was 63 percent [7]. If the information is given orally 72 hours later, people will remember 10 percent of their cases. If the text is given in the form of an image, then this figure increases to 65 percent.

The color, position, size and movement of the image attract attention well. Therefore, it is worthwhile to use animations in training. So it is worthwhile to use information technology to increase the productivity of education [8,12].

One of the most effective ways to develop data visualization and "full thinking" skills in the educational process is the "mind map", which is widely used in education today. Teaching topics in all disciplines with the help of "mind maps", will help students independently study the topics, develop their "full thinking" skills. The use of "mind maps" in the lessons activates the right hemisphere of children's brains and learns to work in the process of "full thinking" [12,13].

Also "Mind Map":

- clarifies the problem;
- regulates the information to be provided to students;
- helps to fully describe and "imagine" the problem;
- becomes a means of storing all the necessary information;
- encourages unusual solutions.

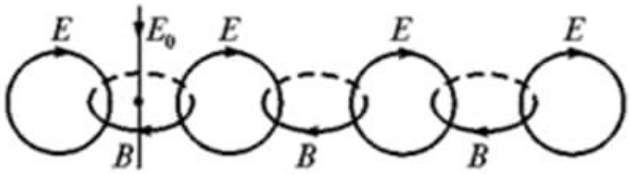
Results

To develop students' "imagination" and "full thinking" skills in the transition to the topic of "electromagnetic wave scale".

Here are some suggestions on how to look or get an appointment for 11th grade high school students. It should be noted that the information under consideration is not a single topic, but contains a lot of information.

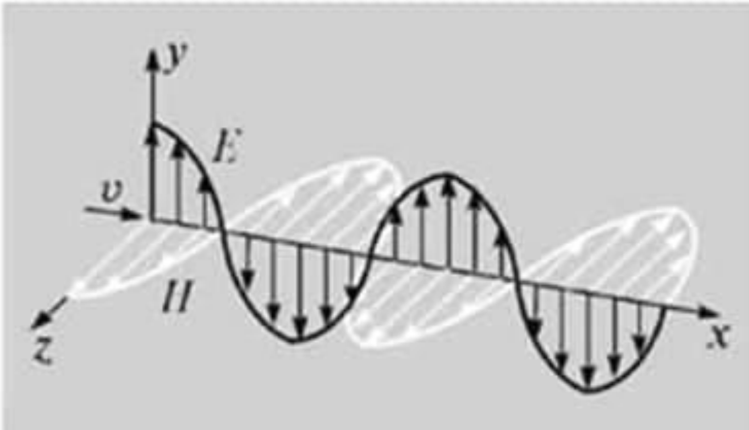
J. Maxwell, who analyzed the phenomenon of electromagnetic induction by M. Faraday: any change in the magnetic field creates a rotating electric field in the surrounding space. He concluded that any change in the rotating electric field would in turn create a rotating magnetic field in the surrounding space.

Thus, according to Maxwell's theory, the alternating magnetic field is always closely related to the self-generating electric field, and the alternating electric field is closely related to the self-generating magnetic field, and together they form a single electromagnetic field. The propagation of this alternating electromagnetic field in space is called electromagnetic waves[14-18].



Picture 1. (Fig. 348)

According to Maxwell's theory, electromagnetic waves are transverse waves, and the vectors $\underset{E}{\rightarrow}$ *and* $\underset{B}{\rightarrow}$ are perpendicular to each other and the velocity of the wave is perpendicular to $\vec{\vartheta}$.



Picture 2 (Figure 349)

The speed of propagation of electromagnetic waves according to Maxwell's theory

$$\vartheta = \frac{1}{\sqrt{\varepsilon_0 \mu_0 \varepsilon \mu}}$$

is equal to Here $\sqrt{\varepsilon\mu} = n$ is the refractive index of the medium equal to n = 1 for vacuum.

Electrostatic constant $\varepsilon_0 = 8{,}85 \cdot 10^{-12}\, {}^{F}\!/_{m,}$ magnetic constant

$\mu_0 = 4\pi \cdot 10^{-7}\, {}^{H}\!/_{m}$ is used, then $\vartheta = \frac{c}{n}$.

and in vacuum n=1, $c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}} = 3 \cdot 10^8 \frac{m}{s}$

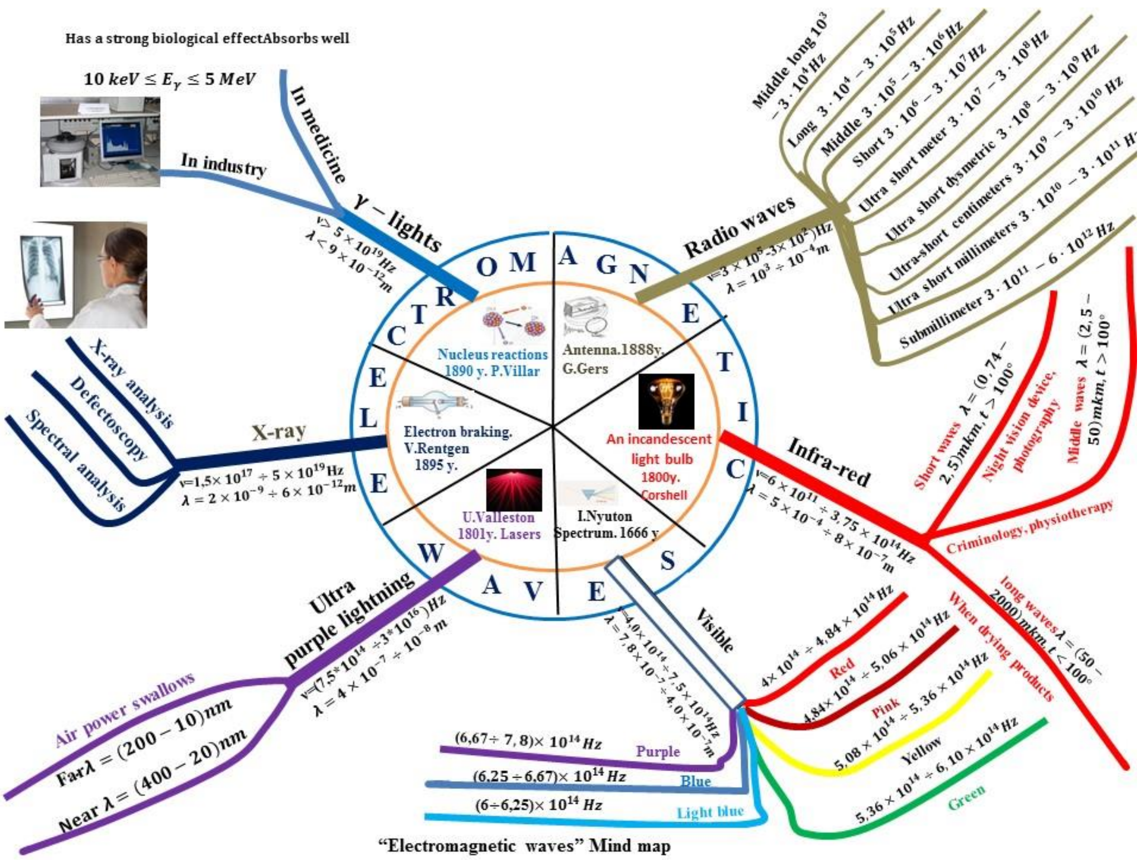
is formed. This means that the speed of propagation of electromagnetic waves in a vacuum is equal to the speed of propagation of light in a vacuum.

For simplicity, we consider our further considerations for the case of vacuum n = 1, $\vartheta = c$. Therefore, if we assume that the speed of propagation of an electromagnetic wave in a vacuum is c, the frequency and the wavelength are λ, then the relation $\lambda = \frac{c}{V}$ is reasonable.

Given that all the properties of electromagnetic waves are the same as the properties of light, it can be concluded that light is made up of electromagnetic waves.

Subsequent experiments have shown that not only visible light but also infrared, ultraviolet, X-ray, and gamma rays are electromagnetic waves. They differ from each other in some properties, depending on the methods of generation and recording, frequency (wavelengths) and energy. The classification of electromagnetic radiation is more conventional, and their velocities in vacuum are the same.

Below is an mind map of the Electromagnetic wave scale.



Picture 3. Mind Map of the electromagnetic waves.

Radio waves were created in 1888 by G. Gers using an open vibrational circuit. Wavelength $\lambda = 10^3 - 10^{-4}m$,, frequency $\nu = 3 \cdot 10^5 - 3 \cdot 10^2 Hz \cdot$

Infrared rays were discovered in the 1800s by W. Corshell. Its sources are tungsten incandescent lamps and various gas-filled lamps. The most powerful natural source of infrared light is the Sun. Wavelength $\lambda = 5 \cdot 10^{-4} - 8 \cdot 10^{-7}$m frequency $\nu = 6 \cdot 10^{11} - 3{,}75 \cdot 10^{14} Hz$.

Visible (white) light. Wavelength l = $\lambda = 8 \cdot 10^{-7} - 4 \cdot 10^{-7}m$, frequency $\nu = 3{,}75 \cdot 10^{14} - 7{,}5 \cdot 10^{14}$Hz In 1660, I. Newton discovered that white light consists of seven different colored lights (dispersion phenomenon).

Ultraviolet rays. Wavelength $\lambda = 4 \cdot 10^{-7} - 10^{-9}m$, frequency $\nu = 7{,}5 \cdot 10^{14} - 3 \cdot 10^{17} Hz$.

Near-ultraviolet rays $\lambda = 4 \cdot 10^{-7} - 2 \cdot 10^{-7}m$. Discovered in 1801 by the German physicist I. Ritter and the English physicist U. Walloston.

Long and vacuum ultraviolet rays $\lambda = 4 \cdot 10^{-7} - 2 \cdot 10^{-7}m$. Objects heated to 3,000 K, studied by the German physicist W. Schumann and the British physicist T. Layman, are a source of ultraviolet light.

X-rays: Wavelength $\lambda = 2 \cdot 10^{-9} - 6 \cdot 10^{-12}m$,, frequency $\nu = 1{,}5 \cdot 10^{17} - 5 \cdot 10^{19} Hz$. Discovered in 1895 by W. Rentgen. Occurs as a result of the braking of electrons in an X-ray tube. It has good absorption capacity. X-rays are widely used in structural analysis, spectroscopy, defectoscopy and other fields.

$\boldsymbol{\gamma}$ -rays. Wavelength $\lambda < 9 \cdot 10^{-12}m$, frequency $\nu > 5 \cdot 10^{19} Hz$ Hz. It was discovered in 1900 by the French physicist P. Villar. $\boldsymbol{\gamma}$ radiation is formed as a result of radioactive decay, nuclear reactions. High-energy $\boldsymbol{\gamma}$ -rays have a negative effect on living organisms. It can ionize atoms in cells and lead to various diseases. It is also used in the diagnosis and treatment of tumors.

The "Mind Map" is also of great educational value. Most people who think they can get an X-ray today are unaware that they are being harmed by the misuse of a cell phone. However, both X-rays and radio waves have the same nature, differing only in their frequency, and their energy. It is especially important to explain this to young children.

The "Mind Map" not only summarizes information about electromagnetic waves, but also helps students to develop "imagination" and "creative thinking" skills.

Conclusion

- The rapid development of science and technology creates new directions. Educational institutions are required to train specialists with "creative thinking" skills in new areas.

Teaching students to "thinking fully" begins with developing their "imagination." Because "imagination", unlike cognition, helps a person to create and the computer to awaken the information that is dormant in the brain.

- The role of the elements of "comparative learning", analogy, metaphor and fantasy in the development of students' "imagination", "creative thinking" and “full thinking” skills was discussed.

The study of physics is based on the fact that the main part of knowledge is "indirect knowledge" and therefore difficult to explain without "imagination" and "full thinking".

It is based on the importance of data visualization in the teaching of physics, and the most effective way to develop "creative thinking" skills for this purpose is the use of "Mind Map".

The most relevant topic in the article today is "Electromagnetic Wave Scale" and "Mind Map".

- This "mind map" not only encourages students to "imagine" and "creative thinking", but also to develop their "full thinking" skills.

A mind map is a collection of all the information about electromagnetic waves. In this regard, the most dangerous of the "radio waves" and radioactive rays is the fact that γ rays have the same nature, which can help students to follow the rules of use of mobile phones.

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