I-EDU GROUP

Article

Integrated approach in teaching the subject "EARTH'S MAGNETIC FIELD"

Dilfuza A.Begmatova [1], Bonu A.Yakubova [1*]

[1] Faculty of Physics, National University of Uzbekistan named after Mirzo Ulugbek, Tashkent, 100174, Uzbekistan
difuzafizic@mail.ru (D.B.), p21008472@gmail.com (B.Y.)
* Correspondence: p21008472@gmail.com; Tel.: +998 90 0388584 (B.Y.)

Abstract: Integration of educational subjects in the educational process is a requirement of the present time. Because the integration of educational subjects is important for the integration of education and upbringing, for the development of students as a person who is patriotic, kind to nature and the environment, and embodies spiritual and moral qualities. In our opinion, in this regard, the training conducted on the basis of interdisciplinary integration classes will have a very good effect. Because the basis of the process of integrating sciences and scientific knowledge is the unity of the material world, i.e. nature, society and the mutual coherence of its determination. In this article, we describe the method of conducting an integrated conference lesson on the topic "Earth's magnetic field" using integrative sciences: physics-geography-biology. Through this lesson, students can develop ideas about the causes of geomagnetism and the geomagnetic field.

Keyword: integration, earth's magnetic field, geomagnetism, geomagnetic field, integrative sciences, polar precipitation, compass, solar flare, magnetic poles.

Introduction

Integration of natural sciences - the ideas, concepts, laws, and phenomena related to nature studied by the sciences of physics, chemistry, biology, geography, astronomy into a whole (whole) and generalized to the student (students) into a single (whole) knowledge is the process of imparting knowledge. This aspect is done in the following steps. In the first stage, the integration of physics with other sciences will consist of:

- expansion of internal relations of physics;
- study physics in connection with the basics of science;
- attracting physical laws and evidence to master the basic concepts of other sciences;
- improvement of relations between physics and the foundations of science.

In the second stage, complex problems will be covered. Complex problems mean integrating academic subjects, focusing on a single goal, and correctly determining the place of each academic subject in it.

The lesson explaining the topic based on integration will be more interesting and effective if it is conducted mainly in the question-and-answer method. We need to prove that the Earth is a big magnet. We take the most important thing with us - a compass, and travel to the poles in our imagination. The word "compass" originated from the ancient English word meaning "circle" in the 13th 14th centuries (Fig. 1).

The mysterious forces of nature have attracted the inquisitive mind of man since ancient times. One such force makes the magnetic needle stubbornly return to the north-south direction. Using integrative science, we prove that the Earth is a big magnet.

Quoting: Dilfuza A.Begmatova, Bonu A.Yakubova. Integrated approach in teaching the subject "EARTH'S MAGNETIC FIELD". **2024**, 1, 1, 5. https://doi.org/

Received: 10.11.2024
Corrected: 18.11.2024
Accepted: 25.11.2024
Published: 30.11.2024

Figure 1. Compasses

Materials and Methods

Earth is a big magnet.

In 1600, the English scientist W. Gilbert used the work of his predecessors and his own experimental method in his treatise "On the Magnet". Gilbert described an experiment with a sphere made of magnetic ore and a small magnetic arrow. He came to the conclusion that the Earth is a big magnet. People have long believed that the magnetic arrow is attracted by the Pole Star. In 1759, the Russian scientist M.V. Lomonosov recommended the establishment of observatories for the study of the earth's magnetism and continuous magnetic observations. Russia is still the leading country in this field. In 1785, the French physicist Sh. Kulon laid the foundations for a complete study of the Earth's magnetic field, that is, he began to determine not only the magnetic direction, but also the quantitative indicators of the geomagnetic field forces. Until the beginning of the 20th century, the question about the causes of the earth's magnetism was answered as follows: the Earth is a big magnet. It seems that a very strong magnet is hidden in the depths of the earth. It controls the direction of the compass needle, forcing it to follow the magnetic field that surrounds the globe and creates the Earth's magnetic field.

Results

Let's look at the physical aspects of the subject.

1. It is known that magnetic arrows are magnetic field indicators. 99% of the Earth's magnetic field is caused by hidden causes deep within the planet. What are the causes of geomagnetism? At the beginning of the 19th century, the French physicist Andre Ampere made an interesting comment. He knew that an electric current can affect a magnetic arrow (this was proved by the Danish physicist Oersted in 1820). Ampere was the first to realize that if an electric current flows from east to west in the Earth's depths, a magnetic field is created around the Earth. It was possible to theoretically prove that 99% of the causes of the Earth's magnetic field are caused by hidden forces in the depths of the planet. Physicists tried to save the hypothesis of self-magnetization of the Earth, using new information about the atomic structure. Knowing the rotation speed of our planet and the approximate distribution of magnetic materials on Earth, it was possible to calculate the intensity of magnetization. It turned out to be a billion times smaller than the real one. Thus another hypothesis failed.

In 1939, the American physicist Elsasser proposed a new theory. According to it, the Earth is magnetized by thermoelectric currents flowing in the liquid earth core mixed with various metals. Although the core is liquid, there is always contact between two metals. Thus, the core of the Earth has all the conditions for holding thermocurrents: the mutual contact of different metals and temperature changes. In fact, it is impossible to accurately calculate the complex movement of the Earth's core substance and the thermocurrents circulating in it.

2. Hypotheses failed one after another. What are the modern ideas about geomagnetism? Frenkel's theory (1947): Earth's core is a kind of natural turbo-heater, in which heat currents play the role of a turbine. The method of lines of force helps to clearly visualize the Earth's magnetic field. The landscape of the geomagnetic field can be visualized using closed lines of force emanating from the North Magnetic Pole and absorbing into the South Magnetic Pole (Figure 2).

3. Earth's magnetic field has been proven. How can you imagine it? What affects him? The landscape of the geomagnetic field can be visualized using closed lines of force extending from the north magnetic pole to the south pole. The solar wind has a significant effect on the geomagnetic field. Solar wind particles (mainly electrons and protons) entering the Earth's atmosphere are directed by the magnetic field (they are affected by the Lorentz force) and they are focused in a certain way.

Figure 2. Earth's magnetic field

It collides with atoms and molecules in atmospheric air, ionizes and excites electrons and protons, resulting in radiation called aurora (Fig 3).

Figure 3. Polar rain

The physics of polar precipitation is complex. The appearance of charged particles at certain heights in certain regions of the atmosphere is the result of the interaction of the solar wind with the Earth's magnetic field.

4. Physics lessons will be more interesting if we also remember literature.

What a joke this north makes!
It lights up over my head.
Different colors of the rainbow
In the waves of the ice crown!
The cold flame of beauty
Maybe from his nature.
Magnetic storm effort
He buried it in beautiful colors!

A magnetic storm is remembered in the poem. What is it?

The solar wind gets stronger when a big explosion occurs on the Sun (Figure 4). This causes the excitation of the earth's magnetic field and causes a magnetic storm. A magnetic storm affects various electrical equipment.

From the point of view of geography:

1. If the Earth is a big magnet, how many poles does it have? The Earth has 4 poles: 2 geographic poles and 2 magnetic poles. Magnetic lines of force create the Earth's magnetic field, and along these lines the compass needle disappears. These are magnetic meridians, which do not correspond to geographic (true) meridians. In 1831, British polar explorer John Ross, a participant in one of the Arctic expeditions to find a sea route from the Atlantic Ocean to the Pacific Ocean along the coast of North America, discovered the north magnetic pole in the Canadian archipelago at 700 50 170 north latitude and 96 46 45 west longitude.

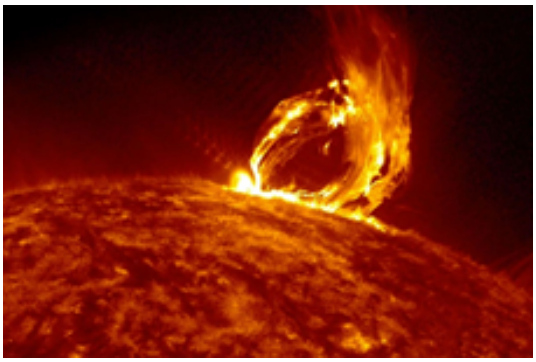

Figure 4. An explosion in the sun

In 1841, James Ross (J. Ross's nephew) reached the second pole of the Earth located in the Arctic.

Observations have shown that the Earth's magnetic poles change. For example, in 1952, the North Pole was located at 740 north latitude and 1000 west longitude. Currently, its coordinates are 750 N latitude and 990 W longitude (Butia Peninsula in the north of Canada). The magnetic pole is about 2100 km away from the geographic pole, the South Magnetic Pole is located on the meridian of the island of Tasmania at 66.50 south latitude and 1400 north longitude.

2. These poles are not mutually compatible. What causes polar mismatch? Magnetic and true meridians do not correspond to each other. The angle between the magnetic and geographic meridians is called the magnetic declination. The deviation of the magnetic arrow from the horizontal plane under the influence of the magnetic field is called magnetic deviation. To explain more fully, the magnetic and geographic poles are not compatible with each other. Magnetic and true meridians are also incompatible. The angle between the magnetic and geographic meridians is called the magnetic declination, and H. Columbus discovered that the magnetic declination is not constant, and that the declination changes with the change of geographic coordinates. If the compass needle deviates from the geographic meridian to the west, it is called a westerly (negative) deviation, and if it deviates to the east, it is called an easterly (positive) deviation. Columbus's discovery prompted a new study of the Earth's magnetic field - information about it was needed by sailors. Knowing the deviation of the magnetic arrow in a certain place, the direction of the true meridian can be easily determined. If the latitude is also known, then the geographic coordinates are also determined.

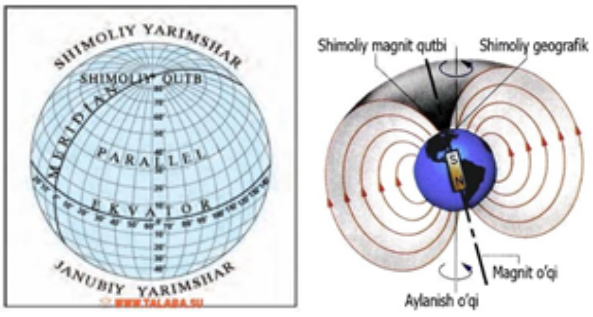

Figure 5. Earth's magnetic poles

Thus, the Earth's magnetic poles do not correspond to its geographic poles. For this reason, the direction of the magnetic arrow does not correspond to the direction of the geographic meridian (Fig. 5). Therefore, the compass arrow shows approximately north.

If we look at it from the point of view of biology.

1. But this problem is of interest not only to economists, but also to ecologists, biologists, and medical professionals. There is now a large body of evidence that climate change, particularly magnetic storms, affects people's well-being.

2. Scientists have identified 3 types of interaction of electromagnetic waves with living organisms. First, the interaction of electromagnetic fields with living organisms. Secondly, various

electrical connections in the organism itself. Thirdly, electromagnetic connections between living organisms.

Interaction of electromagnetic fields with living organisms. Examples.

1. 86% of fish thrown into an unfamiliar water body move along the magnetic meridian.

2. Already in the middle of the last century, scientists expressed the opinion that migratory birds must have a special magnetic sense that points the way to the South in the fall and to the North in the spring, like a compass arrow.

3. In one of the laboratories, a cage with birds was placed side by side with an aquarium with fish. A source of accurate coordination of the electric field was placed at a distance of 15 cm. When the wire is attached, the birds and fish look in the same direction as if given a command.

Electromagnetic biology does not deny the existence of a certain electromagnetic connection between organisms. If living organisms have a complex system of bio currents, why can't there be an electromagnetic connection between organisms?

Examples:

Electromagnetic signals allow animals to find each other even over long distances. This is why male insects find their way to female insects, and birds mark the place where the nest is built. Some sea predators also recognize their victims by electromagnetic fields. An example of this is the flat fish scat, whose eyes are located in the upper part of the body, and the mouth is located in the lower part. He does not see his victim! It receives signals from the electromagnetic field that the victim radiates.

So, an integrated lesson

Anticipation-Reaction Guide (ARG) is used to reinforce this topic

The purpose of this method is to:

- Clarify the purpose of reading, listening and watching videos.
- Remembering previous knowledge.
- To help the student to understand the need to compare his points of view.

A video on the subject is shown to the student and the conclusions obtained from the lecture and video are analyzed. Through this, the subjects are well mastered by the students.

Conclusions

Analyzing the content of this teaching, first of all, it is necessary to pay attention to the motivation of students' educational activity, which is the most important problem of education. At this stage of the lesson, students form the topic of the lesson independently. Students are given the goal of mastering the learning material. During the explanation of the topic on the basis of an integrated approach, the high level of student activity is maintained with the exchange of types of educational activities in addition to interesting content. At the end of the integrated lesson, the unity of the material world and the interdependence of events will be demonstrated. Students will understand that physics, geography, biology are the links of a single chain of knowledge about nature and help to understand the world as a whole.

In addition, to students:

- Earth's magnetic field, the causes of geomagnetism, geomagnetic field, magnetic field excitation, and the effect of magnetic storms not only on objects, but also on living organisms were explained.
- Students' worldviews about knowing the world were formed, the effect of electromagnetic fields on living organisms was explained.
- They were taught how to distinguish the necessity of the studied materials, how to continue all education and apply it to life by comparing events.

Authors' contribution.

Conceptualization, methodology, software, D.B.; formal analysis, research, writing and editing, B.Y.; supervision, D.B. All authors have read and agree with the published version of the manuscript.

Funding source.

This research received no external funding.

Ethics approval.

This study did not require ethical approval.

Consent for publication

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The information presented in this article is the product of the authors' work, and those interested can contact the above-mentioned e-mail addresses regarding the information on the topic.

Acknowledgments

We express our gratitude to Dr. Rbrt G. Brwn for his assistance in preparing the article.

Conflict of interest

The authors declare no conflicts of interest.

Abbreviations

ARG Anticipation-Reaction Guide

References

[1] Begmatova D.A., Nortojiyev A.M., Integration of physics lessons in higher education institutions in construction, EPRA International Journal of Multidisciplinary Research, 2021, 7, 05, 520–523.
[2] Brown Robert G., Introductory Physics I, Duke University Physics Department, Durham, 2013.
[3] Isabelle Aaron D., Zinn Gilbert A., STEPS to STEM – Student Science Notebook, Sense Publishers, Boston, Rotterdam, 2017, 224.
[4] Dori Yehudit Judy, Mevarech Zemira R., Baker Dale R., Cognition, Metacognition and Culture in STEM Education, Springer International Publishing, AG, 2018, 386.
[5] Sanders M., STEM, STEM education, The Technology Teacher, 2009, 68, 20–26.
[6] Capraro Robert M., Capraro Mary Margaret, Morgan James R., STEM Project-Based Learning, Sense Publishers, Rotterdam, Boston, Taipei, 2013, 197.
[7] Sangirova Z.B., STEM education in teaching the subject "Natural Sciences", Science and Innovation, 2022, 4, 343–349, UIF-2022: 8.2, ISSN: 2181-3337 (Impact Factor: 8.2), Uzbekistan.
[8] Sangirova Z.B., STEAM as a means of developing students' inquisitiveness, Uzluksiz ta'lim, 2020, 6, 54–57, Tashkent: Uzbek, Sangirova Z.B. STEAM o'quvchilarda izlanish qobiliyatini rivojlantirishda vosita sifatida. Uzluksiz ta'lim, Toshkent., 2020, №6. .54-57.
[9] Qurbonov M., Uzoqova G.S., Tursunov K.Sh., Theoretical Foundations of Physics Teaching, "Ozbekiston", , 2008, Uzbek: Qurbonov M., Uzoqova G.S., Tursunov K.Sh. "Fizika oqitishning nazariy asoslari". T.: "Ozbekiston", 2008.
[10] Jo'rayev M.D., Methods of Teaching Physics (General Issues), TDPU, , 2015, Uzbek: M.D. Jo'rayev. "Fizika o'qitish metodikasi (umumiy masalalar)". T.: TDPU, 2015.
[11] Azizxojaeva N.N., Pedagogical Technologies and Pedagogical Skills, , 2006, Uzbek: Azizxojaeva N.N. Pedagogik texnologiyalar va pedagogik mahorat. T., 2006.
[12] Po'latov A.A., Murodov K., The Importance of Integrated Lessons in Teaching Physics (Study Guide), 2015, Uzbek: A.A.Po'latov, K.Murodov. Fizika fanini o'qitishda integratsiyalashgan darslarning ahamiyati (O'quv qo'llanma). N., 2015 y.
[13] Abdullayev N.Q., Method of system analysis in solving physical problems, Journal of Critical Reviews (JCR), 2020, 7, 3344–3351, 10.31838.07.14.613, Scopus IF 0.67.