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ACADEMIC RESEARCH ACTIVITY OF THE SMALL ACADEMY OF SCIENCES OF UKRAINE MEMBERS AS ONE OF THE DIRECTIONS OF IMPLEMENTATION OF STEM-EDUCATION


DZIAŁALNOŚĆ BADAWCZA CZŁONKÓW MAŁEJ AKADEMII NAUK UKRAINY JAKO JEDEN Z KIERUNKÓW REALIZACJI STEM EDUKACJI

Abstract

The article describes the research process of student members of the Kharkov Small Academy of Sciences of Ukraine using differential equations in the study of natural phenomena. The studied issue was the dependence of the wind speed on the path it traveled into the thick of the forest. Mathematical problem was formulated practical and theoretical calculations were carried out. The work corresponds to certain areas and ap-

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proaches to building training within the framework of STEM-education, which at the present stage of education development in Ukraine is actively discussed and is gradually being introduced into the learning process.

Keywords: *STEM-education, scientifically-research activity, differential equalizations*

Streszczenie

W artykule opisano proces badawczy studentów z Charkowskiej Małej Akademii Nauk Ukrainy, wykorzystujących równania różniczkowe w badaniach zjawisk naturalnych. Badanym zagadnieniem była zależność prędkości wiatru od drogi, którą pokonywał on wędrując w głąb gęstego lasu. Sformulowano problem matematyczny i przeprowadzono obliczenia teoretyczne. Praca odpowiada określonym obszarom i podejściom STEM-edukacji, które na obecnym etapie rozwoju edukacji na Ukrainie są aktywnie dyskutowane i są stopniowo wprowadzane w proces nauczania.

Słowa kluczowe: *STEM-edukacja, naukowo-badawcza działalność, równania różniczkowe*

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Statement of the problem in general outlook and its connection with important scientific and practical tasks.

There is a deficit of specialists well-informed in the field of scientific, able to participate in innovating processes and provide stable development of society in the future in Ukraine. Passing to innovative education envisages the preparation of specialists of a new generation, apt at social mobility and mastering of front-rank technologies. At modern terms in Ukraine highly sought must become: IT- specialists, programmers, engineers, professionals highly technological productions, specialists of bio- and nanotechnologies. The receipt of modern professions needs all-round preparation and acquisition of knowledge from the different educational areas of natural sciences, engineering, technologies and programming, directions that are embraced by STEM-education. Ukraine, after materials of Institute of modernization of maintenance of education, for itself STEM defined

education (Science, Technology, Engineering, Mathematics) as a category that determines the corresponding pedagogical process (technology) of forming and development of mentally-cognitive and creative qualities.

STEM-education is based on interdisciplinary approaches to the construction of curricula of different levels, individual didactic elements, to the study of phenomena and processes of the surrounding world, solving problem-oriented tasks (Instytut modernizatsii zmistu osvity, 2017). One of the effective means of realization of the indicated direction of development of education can be considered a scientifically-research activity of students-members of the Small Academy of Sciences of Ukraine on the example of writing their own research works.

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Analysis of latest research where the solution of the problem was initiated.

The last researches devoted STEM education are sufficiently diverse, viz.: a key notion and conceptual principles of development, theoretical aspects, different forms of realization, educational practices, uses of elements of STEM of education, are investigated at the teaching of base disciplines for students and students, pre-condition and

prospect. In the context of our article will distinguish researchers that engage in the application of STEM education in experimental and research activity of students I. Vasylyashko (Vasylyashko I., 2017), N. Vesela (Vesela N., 2017), I. Savchenko (Savchenko I., 2017).

Aims of paper. Methods

The aim of the article consists in description of student's experience of 11 class of Kharkiv specialized school of I - III of degrees № 80 Alona Lemekhova within the framework of All-Ukrainian competition-defense of scientifically-research works of students-members of the Small Academy of Sciences of Ukraine that investigated mathematical methods the dependence of wind speed on the distance which it passed in a

thicket. To the basic methods undertaken a study will take a capture and comprehension of scientific literature after a theme, methods of design and optimization, synthesis, comparison and analysis of data, practical activity from the realization of measuring of the speed of wind and decision of tasks by means of stowage of differential equalizations.

Exposition of main material of research with complete substantiation of obtained scientific results. Discussion.

Convincing and striking are lines from work of prominent teacher-physicist XIX to the century of J. Veinberg the "Forest appears to the poetic mind as something mysterious, existing separated, indifferently to all living. Winds rock the tops of giants, but powerless to rock them; to the Midwood, the rays of sun get poorly, winds and rains are small felt there". The wind is the motion of the air masses, is the consequence of the uneven heating of earth surface by sunbeams and, in this connection, changes of atmospheric pressure, air density. Presumably, many of us are known this mysterious feeling, when overcoming high wind we, deepening in midwoods, suddenly appear

among a boundless calmness that muffles us. The surprising feeling is exactly given and became a push for further research.

The role of wind in the life of the forest is many-sided, and depending on speed can be positive and negative. At speed of wind a to 2-3 m/of sec, the efficiency of photosynthesis rises, and at the abundant supply of moisture assimilation of carbon increases in 4-5 times. In wintertime wind releases the crowns of trees from snow, promoting their wind resistance. Wind sets about pollen of arboreal plants (pine-trees, fir-trees, larches, silver firs, aspens, alders, birches and etc.), due to what it takes place them cross-pollination, assists distribution of

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seed. The negative role of wind begins to appear at his speed a more than 5 m/of sec. High wind increases the intensity of transpiration leaves and pine-needle, water from the soil does not have time to come trees to the tops, that can cause the death of assimilatory vehicle and formation of top drying.

Force and speed of wind relax in-field, the influence of the forest affects the direction of the wind, on moving of currents of air. The local influence of the forest on the wind began to be studied in the second half of XIX of the century. The first experimental researches are on the study of the influence of the forest on the wind, that became classic, was conducted by N. Nesterov in 1904-1906 under Moscow. He defined the change of speed of wind before the forest, in-field and after the forest.

He set the formation of air surf nearby the forest during the motion of wind from open place to the forest and air fall nearby the leeward of the forest. N. Nesterov was shown, that if the speed of wind on an open place to take for 100, then the speed of him at approaching to the forest will change as follows: in the distance, 110 m are a 100%, 76 m – 84%, 30 m – 68%. The part of the air masses goes up, the part is included in the forest. At included in the forest wind weakens force.

On the opposite, leeward, with removal from the forest speed gradually increases and, from data of N. Nesterov, in the distance a 50-multiple height tree stand wind acquires the same force that he had before the forest.

On occasion, this distance increases to the 60-100-multiple height (Bordiv, 1937). After researches N. Vysockiy, the most effective peacemaking influence of the forest is stretched out on distance equal to the 10-

20-multiple height of the forest. Further researches allow naming the 30-40-multiple height of forest stripe.

The distance the protective action of the forest can show up on that depends not only on the height of planting, and also from force and speed of the wind, character of the forest, extend on length, the spatial location of forest stripes and their structure.

Forest stripes influence not only on the wind mode and turbulent exchange but through them and on the whole on the microclimate of interband space. Influencing on the motion of air, they determine the laying of snow-cover, and, and soaking of soil. Considerable role of the system of protective forest stripes in the complex of measures on a fight against wind erosion of soils during dust born storms. The wind mode and transference of pit-run fines related to him depend on wind pervasion of forest stripes, the distance between the mand degree of roughness of the field surface between stripes.

Taking into account these indexes some principles of calculation of maximally possible distances are worked out between protective forest stripes on earth apt to wind erosion.

As far as the forest influences on the wind in the scale of large territories, enough complete experimental materials a bit. However, there are grounds to deny such influence. Many parties of influence of the forest on a climate, including on wind and turbulent exchange, in a global cut it is yet required to find out to science, using possibilities that were opened in connection with the mastering of space and newest technologies.

The behavior of wind in-field depends on pedigree composition, his heights, and structures. Into the forest of the tree stand from durable breeds with their long and wide crowns more considerable reduce the

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speed of the wind, than a tree stands from heliophilous breeds with their narrow and high-lifted crowns in default of understories.

In-field force and speed of wind are different on different levels above the surface of the soil. The character of motion of air in-field other, then on an open even surface. In-field anymore the expressed force of friction: overhead part the declivous shows a soba a very unequal surface as a result of different height of trees, different width and closeness of crowns; a bit below crowns close up densely; space busy at the barrels of trees and free intervals appears yet below.

All of it separately and in totality complicates and modifies the motion of air in-field. Most sharply speed of wind goes down in the zone of understories of the forest, near the surface of the soil, where she can go down to the speed of wind on an open place.

The positive operating of the forest on the decline of the speed of the wind is widely used in a rural and forest economy in the forest-steppe and steppe districts of Ukraine. Here the protective forest stripes of different constructions are created since olden times. In protective afforestation most effective at increase speeds of wind are stripes with blowing out and delicate structure, that provides the most distance of wind-proof action. Dense stripes on a leeward sharply weaken speed of the wind, but only in the direct closeness of stripe.

The dense structure of stripes is effective at protecting of roads from the snow and sandy skidding.

Harmful influences of wind on the forest can be monastic by the increase of wind resistance of breeds by creation of wind-resistant glades, growing of the many-tier planting with participation of wind-resistant breeds, timely realization of deck-

houses, supervision upon the forest with an abandonment on the root of optimal amount of trees on unit of area, correct choice of direction of cutting area and deck-houses.

The influence of forest stripes on agricultural lands, first of all, shows up in their influence on the speed of wind near a terrene. A wind stream, meeting a forest stripe, collapses. Part of him crosses through a stripe, the other part passes through in lightening in a forest bell, forming on leaving from her system of shallow whirlwinds that cast aside a mass of air forward, that crossed through a forest bell.

The forest bells of different constructions differently influence on a wind stream. The forest bell of unpurging construction gives the most resistance to wind. An original air pillow appears from her weather-side, where the speed of wind the minimum (goes down on 75 %).


The forest bell of delicate construction operates on a wind stream on the principle of the aerodynamic grate. Part of the current of air leaks through in lightening in a stripe, the other part rounds a forest bell from above. The zone of turbulence after a delicate forest bell has a greater width than after a dense stripe.

Reduction to the speed of wind especially strongly shows up at the presence of the system of forest bells. In this case of reduction to the speed of the wind will consist of the influence of all forest bells, so as a wind stream, flowing around each of them, loses part of kinetic energy. If the distance between forest bells less 30-multiple height of stripe, speed of wind at going near each of stripes does not have time to recommence and as a result goes down yet stronger than under act of single or far located one from other stripes.

The wind is an important factor that influences on the distribution of natural fires.

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Because of the transference of blazing material and hot air of fire quickly spread in the direction of motion of wind. By means of determination of the speed of wind in a certain moment in a certain locality, it is possible to correct actions in protective afforestation, at extinguishing of fires in-field and other industries of forestry.

Consider a necessity the dates of determination to the next concepts. The forest is the totality of earth, vegetation trees and bushes prevail in that, animals, microorganisms and other natural components that in the development interconnected biologically, influence on each other and on an environment. The wind is the air that moves mainly in a horizontal direction. Wind actively influences on climate formation and causes the row of geological processes.

Yes, in districts with a droughty climate wind is the main reason of erosion, he is able to carry plenties of dust and sand and make in layers them in new districts. Prevailing winds that blow above oceans cause ocean flows that substantially influence on the climate of adherent districts. Also, the wind is an important factor of the transference of seed, spores, pollen, playing an important role distribution of plants. Windstorm is the common name for the powerful atmospheric phenomena, very high wind, hurricane, storm, fall trees, wind-fallen trees, hurricane.

Windstorm is a wind of destructive capacity and protracted in time speed of that an over 30 m/of sec.

By means of mathematical methods, it is possible to give answers for not simple questions, for example, how the speed of wind changes in-field. Clear that passing through the forest, wind stands resistance of

trees and speed of him diminishes, but as far as quickly there is this process, or it is possible to distinguish here some conformities to law or to find the law of process? To lean only against experimental data, in our view, is not rational.

In the article N. Kepchyk (Kepchyk N., 2015) an interesting fact was found that wind at passing in-field loses n - in part of the speed, namely: for the mixed forest of $n = 59$, for very liquid high $n = 125$, where a n -parameter permanent for every type of the forest is got experimentally. The brought formula over of motion of wind in-field appeared sufficiently general and it wanted to investigate this question more in detail. Thus, we will try to investigate the dependence of the speed of wind on passing in a Midwood by mathematical methods.

Will set forth a problem specification. Passing through the forest, and feeling the resistance of trees, wind loses part of the speed. On an infinitesimal way this loss is proportional to speed at the beginning of this way and his length. Will find speed of wind that passed a 150 m in-field, knowing that to enter into the forest of him initial velocity $v = 12$ m/of sec, and after passing of way of $S = 5$ m, speed of wind diminished to the size $v = 11,03$ m/of sec (given in relation to speed of wind it was got due to the handwritten conducted measuring by means of anemometer).

Decision. Let in the distance S from the beginning of the forest speed of wind equals v , the loss of speed equals on the way of dS are $-dv$ (a process is regressive). This loss is proportional to the v and that is why the differential equation of process will look like:

$$-dv = kv dS,$$

where k is a coefficient of proportion. Will divide variables:

$$-kdS = \frac{dv}{v}$$

and integrating will get a general solution of the problem:

$$\ln v = -kS + C \vee v = e^{-kS+C},$$
$$v = e^{-kS} \cdot e^C \wedge v = e^{-kS} \cdot C_1.$$

Will find the decision of part, using an initial condition: $S = 0, v = 12$ m/of sec.

If $12 = e^{-k \cdot 0} \cdot C_1$ then $C_1 = 12$.

Got the law of process:

$$v = 12e^{-kS}.$$

For determination of coefficient of the proportion of k will use an additional condition:

$S = 5, v = 11,03$ m/of sec. From here: $11,03 = 12e^{-k \cdot 5}$ and $e^{-k} = 0,9834$.

Putting numerical values in the equation of law of process will get the sought after speed

$$v = 12 \cdot e^{-k \cdot 150} = 12 \cdot (0,9834)^{150} = 0,97 \text{ m/of sec.}$$

Thus, speed of the wind that deepened on a 150 m in the forest after the conducted calculations will make 0,97 m/of sec, that answers the experimentally got value by means of the device for measuring of the

speed of the wind to the anemometer (the got error was insignificant and her it is possible to ignore).

Conclusions.

During work after the marked theme by a student, literature was worked out in relation to the influence of wind on the forests and vice versa to influence the forest planting on the wind mode. Experimental researches on the study of the influence of the forest on wind confirmed that in-field force and speed of wind are different on different levels above the surface of the soil and at anything deep in the thicket of the forest.

With the aim of research of change of speed of wind in-field depending on the way passed by him in the thicket by mathematical methods, students it was necessary to become familiar with theoretical information about differential equations and to consider their most primary types and methods of decision, capture translating of


the set terms into the language of mathematics and learn to fold differential equations after the put problem.

On the basis of gain knowledge and skills, and own problem was made on research of dependence of the speed of wind at deepening in the forest and she is untied. Initial conditions for a problem were got as a result of the conducted measuring actions, viz. - speed of the wind was set by means of the device to the anemometer.

They got sacks give an opportunity to forecast speed of wind a many other terms: about initial velocity of wind to deepening in the forest, about the change of speed as a result of passing of certain (insignificant) way in-field, about the size of deepening of wind in the forest, and others like that, and can be useful at a grant, for example, of organizational advice in forestry activity. The

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also got results of the research can be applied in nature management, economic science and other directions.

And generally, once again the inexhaustible role of mathematics is confirmed in the achievement of all other sciences, and undertaken a study has a practical value on

leading to of it and, it is impossible not to underline, on leading to of that the similar advanced studies bring up the real researchers able to put for itself aims and to arrive at them.

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