Journal of Vasyl Stefanyk Precarpathian National University
http://journals.pnu.edu.ua
Vol. 9, No. 1 (2022), 16-26

UDC 374.1
doi: 10.15330/jpnu.9.1.16-26

HOW TO COMBINE STUDENT SCIENCE EDUCATION WITH MODERN ENVIRONMENTAL EDUCATION?

ANDRII CHEPOK, NATALIA YEVTUSHENKO

Abstract. This work is devoted to current problems of modern education: the formation and development of scientific thinking of the individual from the school age and the improvement of environmental education of students both of high school and older ones, since the authors do believe that these issues are interrelated. In this paper, some issues of students' scientific education are considered from the standpoint of strengthening the science intensity of the proposed educational content. The authors, being in the systems of secondary and higher schools and based on their own professional experience, found their way to improve the level of scientific education of students by involving them in educational environmental/bionic research works in the form of IT projects. The students' work on such a project implies the main stages of modern researching – from mathematical modeling of a selected natural phenomenon to mathematical processing of the corresponding computer experiment results and their interpretation. The organization of training-and-research activities of high school students and working on such researches have several positive outcomes, one of which is not only the improvement of knowledge in the Natural sciences, but also other positive aspects related to certain types of human thinking – critical, algorithmic, logical and creative ones. The authors believe that significant success in conducting student research can be achieved by working with "ordinary-and-average" but motivated students. The authors prove with their practical experience that it is possible to identify and educate young people with qualities (maybe with talents!) of researchers in time. The paper also points an important question about the contents of modern education at the secondary school and higher levels.

Keywords: natural science, scientific education, environmental education, non-formal education, student's motivation, motivation for educational achievements, student-and-teacher interaction.

1. INTRODUCTION

In December 2019, the results of the international PISA survey were published (known that Ukraine took part the PISA survey for the first time in 2018 [1]): these results confirmed the rather low educational level of Ukrainian schoolchildren in the field of "exact" disciplines and Natural sciences. Surely, it is very sad to realize the mentioned fact, especially it given that these figures are not the so-called "that historically lowest point which was reached in 2018", but it is a clear trend that continues currently, in 2021 [8, 10, 12]. The certain level of final knowledge in Mathematic

and Natural sciences is very important not only as an abstract statistical indicator, it is rather a kind of dual indicator – and it is not so much for a certain or current date, but for the future.

Any "good education" (or "quality education") is always thorough education, and it is that basis which can guarantee of well-being and progress – both individual and social ones [8, 10, 12, 14, 20]. Quality education does allow incomparably better understanding of Nature, i.e. the Natural processes, as well as their relationship and mutual impact on the Reality that surrounds us [9, 11, 16].

Education with a significant share of the Natural science components is that basis that allows anyone to get fully and accurately understanding the Laws of Nature, and at the same time mentioned education helps to find quickly the shortest ways to reveal yourself positively as a scientist, or a researcher, or an engineer etc. [2]. And one cannot disagree with V. Lamanauskas and J. Holbrook that the Natural science education has always been a very important one for the existence and development of a civilized society [10, 14].

Sketchy and/or fragmentary knowledge, or banal "knowing through a smartphone", unfortunately, prevails now, or even simply dominates. As one can see, this infamous ability to obtain instantly any available information without a formed basis as well shortage of critical thinking allows you to use the information obtained abstractedly, primarily without the slightest idea of what it is and how to use it. So, this peculiarity is not evidence of quality education. Surely, deep knowledge has always been associated with the ability to self-improvement, maintaining intellectual and professional competitiveness throughout one's life.

In the past two decades high-level scientists and researchers have said a lot and unequivocally on the close connection and strong correlation between "knowledge-intensive education" and "technological complexity", on the one hand, and personal and social well-being, on the other hand [12, 18, 20]. That is, the guidelines for educational practice should be modern standards of teaching quality, which provide for strengthening the scientific component of education, and the acquisition of certain practical competencies by students [10, 19, 23].

The authors have been working for many years at the crossroads of two levels of "habitual" education – the secondary vocational and higher ones, and all these working years they teach their students mathematics, physics, computer science and programming. For more than 20 years of teaching, the authors note a notable decrease in students' interest in traditionally "difficult disciplines" that belong to the natural-and-mathematical cycle. And afterwards the certain share of graduates of specialized classes of secondary schools goes to universities as usual. And then the next stage is expected: there will be the second act of the same play, but it will be more difficult and more significant act because one will see insufficient preparation of former schoolchildren plus their reluctance to master some higher school science-intensive disciplines: now they are university students of early academic years.

On the other hand, the authors note with concern that this trend does not contribute to the process of research personnel reproduction, and the preparation and training of such people are extremely important for the development of any country.

Let's make a right away reservation: in this paper we will focus on the out-of-school education as an additional one. But, as for the authors, the problems raised and the related issues are characteristic ones of the secondary and higher school system as a whole.

At the beginning of the authors' joint work (2012), the main their goal was finding some ways to harmonize the contents of training in secondary school specialized classes and the university requirements. And in order to realize this idea we used an extracurricular "learning platform" since out-of-school education makes it possible to more optimally build an individual learning path for each student.

Working at the "junction" of middle and high schools, the authors tried to solve the most important task for each of their students – how to teach the pupil to think. It is regarding one's ability to think creatively, critically and independently. And one knows that these kinds of thinking will not be possible without one's ability to analyze, compare, and evaluate. For the authors, a successful way to solve this particular problem was to involve students in educational research activity.

Naturally, the authors undertook a search for those topics and directions to implement student's educational researches that could attract students in research works in the fields of Natural sciences. It turned out that it was precisely the environmental and bionic topics that became a strong motivating factor for the students.

So, we can say that since 2012 a small pedagogical experiment has been launched with the main goal of educating a new generation of research-and-engineering personnel. The mentioned work is being carried out up to the present.

2. THEORETICAL BACKGROUND

Within the framework of the Ukrainian national education system, the authors have long and quite acutely felt the need to increase the share or degree of scientific character (another words – the science intensity) in training, and also against the background of growing environmental problems of our Planet do understand the need to improve the ecological education of students.

As for the importance and necessity of mass environmental education, this fact has long been beyond doubt. The UNESCO-UNEP Conference on the Necessity of Environmental Education was held in 1975 [22], but these pressing ideas concerning the mass environmental education should become a compulsory part of the school curriculum, and these ideas were only the first step along the overall positive direction [3, 7, 8, 9, 11].

The authors of this work, daily practicing the rules and requirements of their national educational system, and based on their experience as well, share the following standpoints that the modern problems of education quality and certain difficulties of environmental education are closely linked and it is probably due to the following reasons:

1) If the content of educational disciplines of the Natural cycle is reduced to a greater extent to informing students (or to the level of awareness) students (or to the level of awareness), i.e. without the sufficient scientific basis for the content of educational material, these contents are evidently insufficient and become unattractive for well-informed and attentive students. It is true, in the modern secondary school it is increasingly possible to detect a low level of scientific intensity of the acquired knowledge [17, 3, 13], which inevitably affects not only the general educational level, but also the environmental educational level of the students [13].

2) Many students, if not most of them, do not fully understand the causal links between different natural phenomena and their scientific explanations (there are many current technical and environmental problems and their possible solutions among them). This failure can be remedied by a sufficient level of scientific knowledge in the field of Natural sciences, which, unfortunately, is not often provided in high school [1]. Similar problems [2, 3, 8, 11, 13] occur here as well, in Ukraine [15, 24].

2.1 PURPOSE OF THE WORK AND HYPOTHESES

The authors of this work have been working in a creative tandem for more than 8 years, involving their students in training research activities. Since there is a significant correlation between the level of natural education of students and the level of acquired knowledge about

Nature/Environment [7, 16, 17], the authors strive to interest more of their students in scientific knowledge about the Nature that surrounds them, and make them want to gain more in-depth knowledge in this area. Working as teachers, the authors seek to instill in their students the need and ability to think logically, critically, and algorithmically as well.

The authors consider some ways in order to improve the Natural Education of their students by solving two key problems:

(i) Improving the quality of knowledge in natural and mathematical disciplines for a wide range of students. This idea can be realized by involving so-called "average" students, but motivated to study and researches. We believe that among such students it makes sense to look for those ones who can do research.

(ii) Formation of critical thinking skills in high school students. We believe that increasing the level of critical and logical thinking of students will help to overcome their fear of so called "difficult subjects" due to their incomplete understanding.

For several years together, the authors have been trying to find proper confirmation of the following *working hypotheses* in their academic work:

– the Hypothesis №1: Involving students in environmental or Natural sciences research in the form of an IT project will certainly help to increase the general level of education of a younger generation, improve their residual knowledge and develop sustainable useful skills in order to solve certain practical problems. We believe that it is necessary and true in the context of competencies which are gained.

– the Hypothesis №2 can be formulated as follows: the student's giftedness is not the necessary condition for achieving significant learning success.

3. RESEARCH OBJECTIVE, METHODOLOGY AND DATA

3.1 THE PARTICIPANTS AND PROCEDURES (MATERIALS AND METHODS)

As it has already been mentioned, the authors work together and they put their efforts into educating of students of ordinary secondary schools, and this work with high school students is carried out as extracurricular educational activity. Such teaching activity in extracurricular time allows practicing flexible organization of students' education: it concerns the maintenance, methods and forms of the training. In the course of joint work, certain positive experience was accumulated and our own methods of extracurricular learning of students and their involvement in educational research projects were developed, mainly in form of IT-projects in the field of ecology [4, 5]. The experience gained in above activity is included in the official Curriculum of extracurricular education of the authors called "Bionics and IT", and this educational Program is designed for three years of study [6].

The authors offer their own vision of ways to overcome the problems of "research" education of high school students. The proposed method is not unique, but it is effective and successfully practiced by the authors for many years in their own professional activities.

The implementation of educational environmental research by a student usually requires his desire to learn. But for successful termination of this type of training it is necessary to have a systematically educated leader. Surely, it was and is the good old Idea: any student must have a good leader for this stage of his life – his Teacher.

The authors do not select their students at the beginning of their work: we accept everyone, whoever wishes, because we believe that the research skills acquired by a wider range of "ordinary" students will help to improve the quality and level of education in society as a whole.

As general rule, all interested students aged 12-15 come to us. The first period lasting 3-4

months, and sometimes longer – about 5 months, is not only the period of study, it is also the period of mutual adaptation. During these first months our students demonstrate their ability and desire to improve their level in Natural disciplines. It is necessary and, perhaps, it is not suitable for everyone. Therefore, a certain number of students usually leave our "team". Usually, it is no more than 20% of the number of people recruited to study.

We are convinced that this is a very important and natural process. The same students who continue their studies are gradually immersed in further educational and research work in accordance with their own priorities and interests. We believe that working on a student research IT-project is a really complex process in which the teacher-supervisor performs many specific functions – teaching, education, leadership, support and control, etc.

Our method of organizing extracurricular research activities of students is based on the common principles of continuity and systematization, and this activity is knowledge-based and accessible one as well. Working as extracurricular educator allows better implementing the principle of students' individual learning trajectory. Thus, the principles of our work can be summarized in a few sentences as follow:

1) We usually work with "middle" high school students (i.e., ordinary ones), but they are motivated to learn.

2) Among the topics of educational research works offered to our students there were mostly technological and socially significant topics [4, 5, 21], but in the last 5-6 years the most popular are environmental and biophysical spheres (including Bionics). Our experience proves that these are mostly attractive topics for student researches.

3) In our educational activities, we focused on student's (read: educational) research IT projects of environmental and/or bionic orientation. Of course, such projects require a certain level of knowledge in Natural sciences (especially Physics and Biology), Mathematics, as well as Computer science and Programming.

4) Working on the mentioned research IT projects, we follow a well-known logical sequence: *phenomenon (problem) → mathematical modeling → programming → computer (numerical) experiment → data obtained processing and interpretation of results*.

5) To maintain a certain level of knowledge of our students and foster their competitiveness, we regularly participate in high-level intellectual competitions [21]. According to the authors, such competitions – mostly National IT championships – are important elements of additional motivation for students. In addition, a sufficient level of stress resistance of students is formed.

6) Within this activity, our powerful partners are the Parents of our students: we do know that the parents of our students are not indifferent to the achievements of their children. They are our Great Helpers.

7) And finally, on the usual "dropout" of students – it is a normal, common process, and it has always taken place and it takes place currently anywhere.

3.2 WHY DO WE OFFER NAMELY THE ENVIRONMENTAL AND BIONIC TOPICS FOR STUDENT RESEARCHES?

The experience of recent years of our working has shown great need and interest in the environmental and biophysical/bionic researches. In addition, the environmental problems in general "almost do not cause any phobias and allergies" amongst modern youth: from an early age they are accustomed to the fact that the environmental issues are very important topics from many viewpoints. Finally, the environmental issues are often really interesting to them! Therefore, the authors do believe that environmental problems are *a priori* attractive to significant part of modern students.

There is one, as for the authors, but extremely important detail: the environmental and bionic

spheres, if anybody looks at them from a realistic viewpoint, are scientific-intensive ones, and they are multidisciplinary ones as well. We also believe that the current state of the environmental education is due to the insufficient level of science training of students. Thus, the Ecological education of modern students should be no less knowledge-intensive [7, 11], otherwise it will only be the level of informing of youth about abstract "fashionable and status" topics.

The authors practice a certain combination of formally different but related disciplines – Mathematics, Physics, Computer Science and Programming, as well as some topics of Biology, Chemistry and Geography. There are many facts and data from the disciplines of Natural sciences which one can organically combine with the help of "interesting-and-high-quality" educational IT-projects. Such a job is usually results in the formation of many key competencies which are presently needed.

Also, according to the authors, the formation of students' ability to overcome complex and multidisciplinary research problems depends largely on the personal qualities of their mentor (i.e., their teacher or supervisor), who is associated not only with one's inspiration for such work, but also with new knowledge and skills, including his ability to notice and to analyze many related factors.

4. RESULTS AND DISCUSSION

4.1 RESULTS

So, now about the eternal, and sometimes sensitive and signaling as well and nevertheless very important question: how to evaluate own work and achievements? Of course, this can be assessed after comparison to some corresponding results.

To do testing of their students' achievements (as well as their own achievements) more objective and reliable, the authors always tried to choose serious "external" contests in Computer Science or Programming, and sometimes in Physics. The Ukrainian national IT-championship "Ecosoft" (Kyiv City, Ukraine) and the Belarusian conference of students-researchers (Minsk City, Belarus) one can consider as good examples of such competitions. It should be noted that the "Ecosoft" IT Championship is the official national stage of the famous International competition of Computer Projects "INFOMATRIX" by name (Bucharest City, Romania).

If one looks at the results of joint work of authors and their pupils, one can see the next coming list of their students' research IT projects (in the different areas of science and technology): the list presented shows the research topics that high school students have worked on under the guidance of the authors in recent years (*see Table 1*).

IT-project topics	Contest/Year/City	Diploma degree
1. Automatic calculation of the electric power supply of a computer by its components or constituent parts	National competition of inventors and innovators, 2015, Kyiv	2nd deg.
2. New generation of Digital-to-Analog Converter with elements of visual comparison of the output signal	XX Belarusian conference of student researchers, 2016, Minsk	3rd deg.
3. The Program "Test_Det" as a stylistic content analyzer of various texts	National contest, "Ecosoft-2017", Kyiv	3rd deg.
4. A bionic model of the fruit tree flower Thermodynamics	XXI Belarusian conference of student researchers, 2017, Minsk	3rd deg.
5. Automatic creation of electronic documents according to the e-Health system	National contest, "Ecosoft-2018", Kyiv	3rd deg.

6. Computer modeling of the flower pistil Thermoregulation	National contest, "Ecosoft-2018", Kyiv	3rd deg.
7. Computer modeling of the flower pistil Thermoregulation	XXII Belarusian conference of student researchers, 2018, Minsk	3rd deg.
8. Modeling of certain stages of the feeding behavior of pollinating insects	2nd regional Hackathon of student youth "X Reality Ecological Hack 2019"	1st deg.
9. Smart technologies in agricultural production works	National contest, Youth Hackathon, 2019, Kherson	1st deg.
10. Beekeeping and some environmental problems	National contest, Youth Hackathon, 2019, Kherson	3rd deg.
11. Modeling of the process of soil colonization by annual Plants	National contest, "Ecosoft-2020", Kyiv	2nd deg.
12. Environmentally friendly Energy generation according to the bionic principle of Dual Power Supply and its delivery to miscellaneous buildings: modeling and calculations	National contest, "Ecosoft-2020", Kyiv	3rd deg.
13. Computer modeling of the scout bees' foraging behavior while intensive honey harvesting	National contest, "Ecosoft-2021", Kyiv	3rd deg.

Tab. 1. The topics of students' educational research IT-project which were conducted within 2014-2021 academic years (chronological listing) (compiled by the authors based on the results of their work)

4.2 DISCUSSION

After several years now we are convinced that the combination of IT-education, Natural science and environmental research can attract more students to research activities through the popularity, socio-economic importance and prospective of topics in these fields: so, as our practice says, the bionic and environmental IT-projects are powerful and sustainable motivation drivers for those students which are ready to be taught and be trained properly.

We are determined that students' participation in the described research IT-projects can help achieve the following:

- raising the level of science teaching – it really leads to deepening students' knowledge and improving their skills as well their thinking level;
- the level of residual knowledge of students increases due to the general practice of their application to solve specific practical problems.

According to the results of students' training activities, we believe that research IT-projects in the field of Natural and environmental orientations, as a rule, have a long-term positive result. The authors in their practice adhere to the positions like these:

1. The Science-and-Technological education as well the Ecological/Environmental education are multidisciplinary ones, as they involve mastering the Natural sciences along with Mathematics, Computer science and even Programming, and this fact automatically means increase students' interest in high-tech and in scientific-intensive knowledge as well, which may lead to improved education in general;

2. The combination of Computer science and modern high-tech content in Education can attract much more motivated students to their study, so due to certain research topics, real students' interest is a powerful locomotive in any educational activity;

3. There is a notable increase in the level of knowledge and skills, as well as students' ability to demonstrate them in intellectual competitions of the highest level;

4. Working on research IT-projects provides a guaranteed development of algorithmic thinking

of students and, in our opinion, gives a significant impetus to the development of critical human thinking.

Active teaching methods can encourage students to their intensive mental and practical activities in the process of acquiring new knowledge. Educational and research activities of our students are carried out either on an individual trajectory or as part of "micro-teams" of 2-4 people. But the success of such students depends largely on the support of their parents and the Institution administration. By the way, about the role of parents of our students: they are a powerful driving force of their children on this fruitful but difficult path to a better education of students.

Once again about the role of Informatics (and programming too) in the modern education:

The authors can not ignore the role of informatics and programming in the modern educational process. It is true, Computer science and Programming are very attractive to the younger generation, because they are symbols of the ubiquitous and "omnipotent" Information Technology (IT), besides we consider it as the powerful ancillary tool to make construction of modern education.

5. CONCLUSIONS

In their educational activities, the authors combined the two important sides of modern education: on the one hand, students' interest in information technology plus their desire to try themselves as researchers while working on vital and important problems in the field of ecology and bionics/biophysics, and on the other hand, with Natural science systematic mastering for modern students' and their environmental education as well.

The main features of our methodology during extracurricular activities are:

1) individual learning trajectory;

2) increasing the scientific intensity of training and deepening the acquired knowledge of Natural science;

3) encouraging student motivation to study;

4) formation of teamwork skills;

5) formation of programming skills;

6) formation of the digital literacy.

The authors do believe that students' systematic working for mastering scientific research methods, such as observation, modeling, numerical experiment, interpretation of the obtained data, of course, greatly contributes to the development of critical, logical, creative thinking of a young researcher.

Let the authors permit now for little lyrical digression:

Our students are not geniuses at all, but they are persistent persons. They learn to conduct their first real researches with the help of a supervisor. As a result, they can gain new knowledge and skills on how to conduct relevant researches as well how to apply their knowledge. Sometimes they become winners of intellectual competitions (*see the Tab. 1*). In other words, our students are ordinary, average, but motivated to learn and make other good and worthy achievements, and they are hardworking, – and in this way they are supported by their parents. We believe that the formation of a thorough educating level of students requires at least two conditions: the presence of a properly educated Teacher, and a Student who is eager and able to study hardly. All this, in our opinion, will clearly reveal the potential of the student – intellectual, creative ones and other his abilities.

Acknowledgements

The authors are grateful to some people who made their positive contribution to the overall course of this work. So, we give special thanks to the Parents of our students, who have taken many steps with us across the difficulties of a truly complex Science: for the upbringing of their children, that are full of desire to study carefully for the sake of their future.

We would like to thank Professor Volodymyr Verbitsky – the Director of Ukrainian National Center of Ecology-and-Nature – for his all-round supporting of research students of Ukraine in the field of Ecology and Natural sciences. Our thanks are also to Mrs Halyna Nadezhko – the Principal of Secondary School #49 of Odesa City – for her seeking to improve the quality of education of students in specialized classes of the mentioned school as well as for her moral support of the authors for all these years since 2012.

The notice in Memory of our Colleague

The authors take this opportunity to honor the blessed memory of Prof. Ivan Vasyliovych Trotsyshin (1959-2019) – our Colleague and Friend who did a lot for training and scientific educating of young residents of Odesa City.

REFERENCES

[1] Avvisati F., Echazarra A., Givord P., Schwabe M. *Ukraine–Country Note–PISA 2018 Results,* OECD, Paris, 2019. Available at: https://www.oecd.org/pisa/publications/PISA2018_CN_UKR.pdf

[2] Barrows C., Murphy-Mariscal M., Hernandez R. At a crossroads: the nature of natural history in the twenty-first century. *BioScience*, **66** (7) (2016), 592-599. doi:10.1093/biosci/biw043

[3] Blumstein D., Saylan C. The failure of environmental education (and how we can fix it). *PLoS Biology*, **5** (5):e120 (2007). doi: 10.1371/journal.pbio.0050120

[4] Chepok A., Yevtushenko N. Computer science as the master key for transdisciplinary education: from one's practical teaching experience. *Measuring and computing devices in technological processes*, **57** (1) (2017), 210-214. Available at: http://nbuv.gov.ua/UJRN/vott_2017_1_38 (in Ukrainian)

[5] Chepok A., Yevtushenko N. Through IT-education to the future. *Measuring and computing devices in technological processes*, **60** (4) (2017), 164-170. Available at: http://nbuv.gov.ua/UJRN/vott_2017_4_25 (in Ukrainian).

[6] Chepok A., Yevtushenko N. *Curriculum for extracurricular education in environmental sciences "Bionics and IT"*. Odesa, 2019. Available at: https://nenc.gov.ua/wp-content/uploads/2020/03/2019_%D0%BF%D1%80%D0%BE%D0%B3%D1%80%D0%B0%D0%BC%D0%B0-%D0%91%D0%86%D0%9E%D0%9D%D0%86%D0%9A%D0%90-%D1%82%D0%B0-%D0%86%D0%A2.pdf (in Ukrainian)

[7] Collado, S., Rosa, C. D., & Corraliza, J. A. The Effect of a Nature-Based Environmental Education Program on Children's Environmental Attitudes and Behaviors: A Randomized Experiment with Primary Schools. *Sustainability*, **12** (17) (2020), 6817. doi: 10.3390/su12176817

[8] Directorate-General for Research and Innovation Science with and for Society. *Science Education for Responsible Citizenship* (Report to the European Commission of the Expert Group on Science Education, EUR 26893 EN). (2015). doi: 10.2777/13004

[9] Hautecoeur J.-P. *Ecological education in everyday life: ALPHA 2000*. Canada: National Commission for UNESCO. (2002). Available at: https://uil.unesco.org/ecological-education-everyday-life-alpha-2000

[10] Holbrook J. Education through science as a motivational innovation for science education for all. *Science Education International*, **21** (2), (2010), 80-91. Available at: https://files.eric.ed.gov/fulltext/EJ890663.pdf

[11] Hudson S. Challenges for environmental education: issues and ideas for the 21st century. *BioScience*, **51** (4) (2001), 283-288. doi:10.1641/0006-3568(2001)051[0283:CFEEIA]2.0.CO;2

[12] Karpov A. Formation of the Modern Concept of Research Education: From New Age to a Knowledge Society. *Procedia – Social and Behavioral Sciences*, (214) (2015), 439-447. doi: 10.1016/j.sbspro.2015.11.718

[13] Lateh H., Muniandy P. Environmental education (EE): current situational and the challenges among trainee teachers at teachers training institute in Malaysia. *Procedia – Social and Behavioral Sciences*, **2** (2) (2010), 1896-1900. doi: 10.1016/j.sbspro.2010.03.1005

[14] Lamanauskas V. Natural Science Education at basic school: some didactic aspects. *Journal of Baltic Science Education*, 1 (2002), 25-35. Available at: http://www.scientiasocialis.lt/jbse/?q=node/37

[15] Ministry of Education and Science of Ukraine. *New Ukrainian School*. MES of Ukraine, Kyiv, 2016. Available at: https://mon.gov.ua/storage/app/media/zagalna%20serednya/Book-ENG.pdf (in Ukrainian)

[16] Ntanos S., Kyriakopoulos G., Arabatzis G., Palios V., Chalikias M. Environmental Behavior of Secondary Education Students: A Case Study at Central Greece. *Sustainability*, **10** (5) (2018), 1663. doi: 10.3390/su10051663

[17] Osborne J., Simon S., Collins S. Attitudes toward science: A review of the literature and its implications. *International Journal of Science Education*, **25** (9) (2003), 1049-1079. doi: 10.1080/0950069032000032199

[18] Potvin P., Hasni A. Analysis of the Decline in Interest Towards School Science and Technology from Grades 5 Through 11. *Journal of Science Education and Technology*, **23** (2014), 784-802. doi: 10.1007/s10956-014-9512-x

[19] Shah A., Jehangir S. Teaching for quality education in environmental education: Challenges and possibilities. In: *Quality in education: Teaching and leadership in challenging times*, *2*, 565-579. Aga Khan Univ., Karachi, 2006. Available at: http://ecommons.aku.edu/book_chapters/94

[20] Sjøberg S. *Science and technology education: Current challenges and possible solutions*. Innovations in science and technology education. UNESCO, 2002.

[21] The Educational project "IT docentes Futurum" (ITDF). *Home* [https://www.facebook.com/ITDF.ua/?ref=page_internal]. Facebook. Retrieved September 14, 2021, from https://www.facebook.com/ITDF.ua/

[22] UNESCO-UNEP (1975). International workshop on environmental education. The Belgrade Charter: a framework for environmental education. Belgrade, Yugoslavia, 13-22 October 1975. Available at: https:// https://www.gdrc.org/uem/ee/belgrade.html

[23] Veselinovska S.S., Osogovska T.L. Engagement of students in environmental activities in school. *Procedia – Social and Behavioral Sciences*, **46** (2012), 5015-5020. doi: 10.1016/j.sbspro.2012.06.378

[24] Voloshanska A. Decline in the knowledge intensity of manufacturing, and deindustrialization processes in Ukraine. *Periodyk Naukowy Akademii Polonijnej*, **26** (1) (2018), 82-85. doi: 10.23856/2609

Address: Andrii Chepok, State University of Intellectual Technology and Telecommunications (SUITT), SE Dept., 1 Kuznechna Str., Odesa 65029, Ukraine.
Natalia Yevtushenko, Secondary School № 49 of Odesa, 12 David Oistrakh Str., Odesa 65000, Ukraine.
E-mail: chepok.andrii@yahoo.com; n.i.yevtushenko@gmail.com.
Received: 11.10.2021; **revised:** 04.01.2022

Чепок Андрій, Євтушенко Наталя. Як поєднати наукову освіту учнів із сучасною екологічною освітою? *Журнал Прикарпатського університету імені Василя Стефаника*, **9** (1) (2022), 16-26.

Стаття присвячена актуальним проблемам сучасної освіти: формуванню й розвитку наукового мислення особистості зі шкільного віку та вдосконаленню природничої освіти (зокрема, екологічної) учнів основної та профільної школи, а також студентів. У цій роботі деякі питання освіти студентів розглядаються з позицій посилення наукової інтенсивності запропонованого змісту навчання. Автори, працюючи в закладах загальної середньої та вищої освіти і спираючись на власний професійний досвід, знайшли свій шлях до підвищення рівня наукової освіти школярів та студентів

шляхом залучення їх до освітніх екологічних/біонічних дослідницьких робіт у формі ІТ-проєктів. Робота учнів / студентів над такими навчально-дослідницькими проєктами передбачає реалізацію основних етапів сучасного дослідження – від математичного моделювання обраного природного явища до належної статистичної обробки відповідних результатів комп'ютерного експерименту та їх інтерпретації. Організація навчально-дослідницької діяльності старшокласників та робота над такими дослідженнями мають низку позитивних результатів, один з яких – це не лише вдосконалення знань з природничих наук, а й інші позитивні сторони, пов'язані з певними типами людського мислення – критичного, алгоритмічного, логічного та творчого. Автори вважають, що значних успіхів у проведенні студентських досліджень можна досягти, працюючи із «звичайними», але умотивованими до наукових пошуків учнями.

Автори власним практичним досвідом доводять, що можна своєчасно виявити та виховати молодих людей з якостями (а можливо, і з талантами!) дослідників. У статті також висловлено позицію авторів щодо змісту сучасної освіти в закладах загальної середньої освіти та на вищих рівнях.

Ключові слова: природознавство, наукова освіта, екологічна освіта, мотивація учнів, мотивація навчальних досягнень, взаємодія школяра та вчителя.