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THE USE OF UNMANNED AERIAL VEHICLES IN ENVIRONMENTAL EDUCATION

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Abstract. The article substantiates the urgency of the problem of ecology, environmental protection, development of environmental awareness of the world population. Environmental education is a process that should be implemented at each level of education. It is proved that public awareness of environmental protection is an important element in the process of globalization. The increasing amount of waste caused also by the COVID-19 pandemic creates many threats to the environment. The authors believe that continuous increasing of human awareness is possible by means of staff, teachers, vocational training, and the various information campaigns implementation. The use of unmanned aerial vehicles can support activities conducted by schools or other educational institutions dealing with ecological issues in Poland. Through specialized functionalities, drones can effectively show the existing threats to the natural environment. This type of activity may contribute to the visualization of pollution, fires, floods, or other dangerous environmental phenomena. It is emphasized that photos or videos data can be used in the general education system. The possibilities of primary and general secondary education in the formation of ecological knowledge and skills of children and youth are determined. The analysis of the content of the curriculum for Polish schools, including lessons in geography, biology, technology, chemistry, ethics, basics of entrepreneurship, and others, on their environmental orientation was carried out. Emphasis is placed on the necessity to improve teachers' skills, their non-formal education by means of environmental seminars, training, workshops, etc.

Keywords: unmanned aerial vehicles, environmental education, teaching, safety, ecological consciousness.

1. INTRODUCTION

Intensive human activity today leads to environmental pollution. S. Zhukauskas considers the following main reasons for the current unsatisfactory environmental situation:

- low level of environmental management in production;
- the advantage of the development of raw materials for environmentally hazardous industries;
- high level of concentration of dangerous enterprises;

- high level of resource and energy intensity of production;
- outdated technologies and depreciation of fixed assets of enterprises;
- low level of production culture and violation of design technological regimes;
- significant amounts of waste accumulated over decades, which can create dangerous environmental situations;
- low efficiency of wastewater treatment plants;
- insufficient level of ecological consciousness of society;
- financial difficulties of enterprises that limit the ability of enterprises to implement environmental measures;
- lack of budget allocations to relevant industries [23, p. 27].

To study the real environmental situation, it is necessary to focus on the scale and depth of anthropogenic impact on the environment and changes in the Earth's biosphere. After all, the change of the natural environment due to human factors leads to disruption of the structure and functioning of natural systems (landscapes), negative social, economic, and other consequences. Therefore, it is time to issue environmental education, the formation of environmental awareness and behavior of all citizens of the planet.

“The new methodological thinking is characterized by the philosophical foundation of ecological ethics (ecological consciousness, ecological thinking, ecological values, ecological activity, etc.)” [22].

The article is a short description of unmanned aerial vehicles and their functionalities that may be useful in the process of environmental education.

The anthropic principle is considered a strong argument of *theologia naturalis*. This relationship is based on a correct understanding of a human in the context of the development of understanding the values of nature [1]. The content of the curriculum concerning the world of plants and animals, problems of nature protection against devastation of humans are helpful to understanding the relationship of human beings with nature. The Curricula emphasizes the need to observe, measure, experiment, and model natural phenomena and processes [2, p. 39]. New problems are arising all the time in a complex and constantly changing society, and the old ones take on a new rank [3, p. 17]. As globalization processes develop, the number of factors that may pose a threat to the environment is increasing. Highly developed industries and a large amount of waste are a real threat to nature.

The increase of every human activity is connected with the social consent to it. This is mostly a result of the mentality of a given society. Therefore, long-term targeted educational programs should be implemented to eliminate negative social permission [4, p. 22]. The problem of the so-called „Wild dumps” or illegal waste dumping must be totally prohibited.

The amount of waste should be eliminated or limited by the waste producers and their recipients, regardless of the nuisance or threats to human life or health and the environment [5, p. 33].

The big factor is that the awareness of society has an impact on proper environmental protection. State services tasks in this area are a next-level process. The harmful factors to the environment must be constantly monitored and presented as part of the core curricula in the education system. Unmanned aerial vehicles can contribute to the protection of the environment by performing preventive, monitoring, and educational activities.

2. RESULTS AND DISCUSSION

Ecological education

Developing effective environmental strategies and the formation of adequate environmental awareness requires a proper scientific basis, in particular the integration into a single conceptual whole of the achievements of natural science and socio-humanitarian knowledge. Anthropomorphic specifics of environmental education, where it is important not only information about the state of the environment and the need to preserve it, but also the assimilation of environmental truths by a particular individual. This makes it an extremely interesting subject of research for a wide range of professionals to highlight a new vision of the problem, especially in the pedagogical aspect. The teacher can estimate the student's potential to some extent, but only in principle and consequently, they cannot know what the student's ultimate limits are [6]. In Poland, preschool-age children acquire basic ecology education. During primary and secondary school education, students learn about environmental protection, climate changes, saving energy, water, raw materials, waste segregation, and recycling. Ecological education curriculum content is basically implemented in geography, biology, technology, and chemistry lessons. Additionally, environmental education teaching content is included in the core curricula for the following subjects: ethics, modern foreign language, basics of entrepreneurship. Considerable attention should be paid to environmental education in remote rural (mountain) schools, where students have the opportunity to learn more about the environment. After all, a mountainous region is characterized by "specific features: colorful nature contributes to the accumulation of vast experience of communication with nature, which results in preserving old traditions formed through the centuries: careful management, spirituality, and respectful attitude to the world" [20].

The Ministry of National Education in Poland conducts a lot of activities promoting environmental education, such as organization and financing of geography Olympiads or organization of ecology seminars for teachers [7]. As an auxiliary tool in the implementation of the program content of subjects or training on ecology, we can use flying cameras, commonly known as drones. With the help of drones, we can visualize risky areas. Provided ecology teachers training can be helpful to realistically show the topography, endangered species (animals, plants), or assess the degree of air pollution (water, soil). Drones are helpful for teachers and students to have current information on the environment.

The Ministry of Climate and Environment in Poland conducts social campaigns to increase the environmental awareness of the society. A good example of it is the promotion campaign „Clean air – healthy choice. Your choice!“. The above campaign's goal is to increase environmental awareness about air pollution and its consequences for human health. The purpose of that campaign is to encourage citizens to take measures to reduce the emission of harmful pollutants into the air [8]. In such projects drones could play an important role by providing real-time data on air purity in a given area. All these activities, campaigns, or programs should provide current knowledge and information on a certain topic.

UNMANNED AERIAL VEHICLES

Unmanned aerial vehicles can be used both in civil and military areas. In the specialized literature, unmanned aerial vehicles are defined as autonomous independent – remotely operated. Autonomous systems have a wide range of possibilities. They can effectively conduct observation and detect the risk of threats. This gives the necessary time to carry out preventive actions conducted by safety system components. Autonomous systems are increasing the safety of people, while at the same time are strengthening their perception possibilities [9, p. 122-123]. Ensuring the security of the state as an institution is a complicated process that depends on many external and

internal factors. Maintaining an appropriate level of state security forces inter-ministerial cooperation, including both state institutions and local government administration [10, p. 58-59].

One of the basic tasks of unmanned aerial vehicles is observation and localization. Thanks to their properties, they are perfect for patrolling large border areas as well as narrow streets in cities. In police operations, unmanned aerial vehicles are very useful during mass events or detecting dangerous tools carried by people. Flying platforms are able to detect suspicious behavior and correctly transfer this information to the police spots on the ground. Unmanned systems can be used by many different organizations. Forest or fire brigades use them to detect fires, monitor the condition of rivers, communication routes, etc. Unmanned aerial vehicles perform their tasks in the mountains during locating missing persons or they can monitor actions during an avalanche [11, p. 65].

More and more local governments and government institutions use unmanned aviation. Drones are also used to locate places where garbage or harmful materials are illegally burned. Unmanned platforms can perform measurements in various places, e.g. in residential estates or in industrial zones. Drones became an effective smog detection tool. They can be used to detect combustion sources and check their composition. The advantages of unmanned aerial vehicles are immediate action, element of surprise, and preventive effects. Thanks to effective air monitoring, it is possible to take control and preventive actions over a large area [12, p. 87-91].

The effectiveness of solving environmental problems is related to determining the most complete data on the state of the environment and assessing potential threats in the region. The use of unmanned aerial vehicles to determine and control the state of the environment depends on onboard systems and their ability to conduct environmental monitoring. At the same time, there is a need to clarify the tasks of monitoring the state of the environment. This is due to the limitation of the onboard load of unmanned aerial vehicles and the mass and size characteristics of onboard devices [21]. However, in any case, the solution to these and other issues is necessary due to the urgency of the problem of ecology and environmental protection.

3. CONCLUSIONS

The use of drones in science is becoming more and more popular. According to the website gorzow.tvp.pl, drones are used in extracurricular activities at the Primary School in Kłodawa. Students have 11 simulators and 2 drones for their disposal and they can learn aviation skills. An air club was created in this school where students can learn about the operation and aviation law [13]. Environmental protection areas according to the „Velvet. Five for Nature” are implemented in areas such as: „trees carrying, saving water, waste segregation, plastic consumption reduction, and greenhouse gas emissions reduction. The aim of this program is to support environmental education in schools and to activate students and educators for change for improving their surrounding environment” [14]. The role of unmanned aerial vehicles could also be educational processes related to ecology support. Drones equipped with normal and thermal cameras can realistically image a given area. Educational activities conducted with the help of video or a wide picture of a given area could be interesting for the audience. Drone-made material such as abandoned waste in the forest or the effects of fire could contribute to better understanding many topics in the ecological safety area. Many preventive programs are often introduced in schools and the main task of it is to support students and focus on learning specific attitudes and behaviors.

Educational problems should be directed to students, parents, and teachers to achieve the intended effect. The effectiveness of the preventive programs depends on the methodology of teaching [15, p. 32-33]. The use of innovative techniques and teaching methods effectively affects the education quality. Undoubtedly, unmanned platforms could increase the teaching attractiveness and at the same time provide updated materials (data) related to ecology or

environmental protection.

Unmanned systems can be used safely and responsibly. Many universities offer study programs related to unmanned aerial vehicles. The University of North Dakota began its UAV program in 2009 as a first offering to study in this field. The use of drones in nature protection brings many benefits related also to time and cost savings. Monitoring of hidden areas is an example of an amazing drones advantage [16, p. 157-164]. Ongoing industry development entails numerous consequences. The disadvantages include water consumption during production processes, environmental pollution, and the production of industrial wastewater [17, p. 9]. The goals and tools of the educational process must skillfully increase the activity of students. The above-mentioned threats to the environment must be fully understood by students. M. Chymuk describes that classes with students should be varied with the use of various didactic aids and should be conducted clearly and easily also taking place in a real environment as often as possible. The author conducted research in 1-3 primary schools about the impact of the social and natural environment subject on students. The research confirmed that this subject left a permanent mark on the mind and students' feelings [18].

Conducting ecology classes, programs or educational campaigns with the use of an unmanned aerial vehicle is a developmental and innovative idea. Conducting activities in the real environment field or in lecture halls with the use of a drone would certainly be interesting for every age group of students and teachers. Showing students the real threats to the environment directly from the air could contribute to the improvement of ecological safety and increase interest in issues related to environmental education in Poland.

The development and implementation of new technological ideas allow for the continuous development of unmanned aerial vehicles. Law regulations changes and new technologies are increasing the functionality of unmanned aerial vehicles and allowing for the task's implementation in various areas [19, p. 100-101].

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Лісник Антон, Парчевський Рафал. Використання безпілотних літальних апаратів в екологічній освіті. *Журнал Прикарпатського університету імені Василя Стефаника*, 9 (1) (2022), 37-43.

У статті обґрунтовано актуальність проблеми екології, збереження навколишнього середовища, розвитку екологічної свідомості усіх громадян Планети. Екологічна освіта – це процес, який слід реалізовувати на кожному рівні освіти. Доведено, що свідомість громадськості щодо охорони навколишнього середовища є важливим елементом процесу глобалізації.

Збільшення кількості відходів, викликаних також пандемією COVID-19, створює багато загроз для навколишнього середовища. Автори переконані, що постійне підвищення обізнаності людей можливе шляхом навчання персоналу, викладачів та інженерів та проведення різноманітних інформаційних кампаній. Використання безпілотної авіації може підтримати діяльність, яку проводять школи чи інші навчальні заклади, що займаються екологічними проблемами в Польщі. Завдяки спеціалізованим функціям дрони можуть ефективно показувати наявні загрози природному середовищу. Цей вид діяльності може сприяти візуалізації забруднення, пожеж, повені чи іншого небезпечного для навколишнього середовища явища. Акцентовано, що дані фото чи відео можна використовувати в загальноосвітній системі. Визначено можливості початкової та загальної середньої освіти у формуванні екологічних знань та умінь дітей і молоді. Здійснено аналіз змісту навчальної програми для польських шкіл, зокрема уроків географії, біології, технології, хімії, етики, основ підприємництва та інших, щодо їх екологічної спрямованості. Наголошено на потребі підвищення кваліфікації вчителів, їх неформальній освіті у руслі окресленої проблеми: екологічні семінари, тренінги, воркшопи та ін.

Ключові слова: безпілотні літальні апарати, екологічна освіта, навчання, безпека, екологічна свідомість