

Problems that have arisen in universities in connection with COVID-19 on the example of the Double Degree Master's Program "Electric Vehicles and Energy-Saving Technologies"

Shchasiana Arhun, Ph.D., professor
Automobile Faculty,
Vehicle Electronics Department, Kharkiv
National Automobile and Highway
University
Kharkiv, Ukraine
shasyana@gmail.com

Andrii Hnatov, Dr.Sc., professor
Automobile Faculty,
Vehicle Electronics Department, Kharkiv
National Automobile and Highway
University
Kharkiv, Ukraine
kalifus76@gmail.com

Hanna Hnatova, student
Automobile Faculty,
Vehicle Electronics Department, Kharkiv
National Automobile and Highway
University
Kharkiv, Ukraine
annagnatova22@gmail.com

Antons Patlins, Dr.sc.ing., Leading Researcher
Faculty of Electrical and Environmental Engineering,
Institute of Industrial Electronics and Electrical
Engineering
Riga Technical University
Riga, Latvia
Antons.Patlins@rtu.lv

Nadezhda Kunicina, Dr.sc.ing., professor
Faculty of Electrical and Environmental Engineering,
Institute of Industrial Electronics and Electrical
Engineering
Riga Technical University
Riga, Latvia
Kunicina@latnet.lv

Abstract— The paper analyzes the problems that have arisen in universities in connection with the COVID-19 pandemic using the example of the international educational master's program of double degrees "Electric Vehicles and Energy-Saving Technologies" (EV&EST). Riga Technical University and Kharkiv National Automobile and Highway University are participating in the development of the EV&EST program. A brief description of the EV&EST program and the priority tasks that were set for its implementation are given. Problems that hinder the timely completion of some tasks are identified. A brief description of the distance course, which was developed within the framework of the EV&EST program in the Moodle educational environment, is given. A complex for laboratory and practical exercises based on a solar charging station for electric vehicles, which was developed under conditions of adaptive quarantine, is described. Laboratory and practical exercises have been developed at this complex.

Keywords—*Transportation; Vehicles; Energy efficiency; .Solar energy; Electric Vehicles; Distance Learning; Laboratories; Education Courses.*

I. INTRODUCTION

The Law of Ukraine "On Education" No. 2145-VIII says [1]: "The purpose of education is all-round development of the person as personality and the highest value of society, her talents, mental, creative and physical abilities, forming of values and necessary for successful self-realization of competence, education of the responsible citizens capable to the conscious public choice and the direction of the activities of advantage for other people and society, enrichment on this

basis of intellectual, economic, creative, cultural potential of the people, increase in educational level of citizens for ensuring sustainable development of Ukraine and its European choice."

It is difficult to overestimate the importance of this goal. In connection with world globalization, not only the well-being of the country depends on the level of development of each citizen, but also, we are not afraid to say, of the world as a whole. This is confirmed by the COVID-19 pandemic, which originated in China and in just a few months swept the whole world. Scientists of our planet are busy looking for a vaccine. And today's scientists are yesterday's students. The more knowledge they have been able to acquire in the learning process, the more benefit they can bring to society.

But, in addition, the need for social distance caused by the COVID-19 pandemic showed us the imperfection of the education system in Ukraine, like in many other countries [2], [3]. And now, in order to achieve the goals set in the Law of Ukraine "On Education", it is necessary to revise and add new teaching methods, taking into account the new conditions. On the one hand, the task is facilitated by the fact that many teachers share their experience in conducting distance learning [4] – [7]. On the other hand, not all disciplines can be studied remotely [8]. Undeniably, theory without practice is dead. This is especially true for practical exercises and laboratory work. It is with this problem that the majority of universities in Ukraine, and especially technical ones, have faced.

The reform of the higher education system in Ukraine has not yet been completed. It provides for close cooperation with

leading European and American modern educational institutions. The most effective means of reforming higher education is the introduction of modern foreign teaching methods and practices into the educational process. This is achieved through the development and implementation of new innovative joint training programs [9].

Innovations related to electric vehicles – cars that use a traction electric motor instead of a ICE (internal combustion engine) [10] – [12], are especially popular and relevant. It should be noted that this relevance is immediately dictated by a complex of factors – these are environmental, economic, social and medical (the impact of exhaust gases on humans). The growing number of such energy efficient and environmentally friendly vehicles requires a completely new approach to the development of infrastructure for their operation, maintenance and repair. The components of this infrastructure should be charging stations and various power generating devices [13] – [18].

Riga Technical University (RTU) have a great experience in study program development and motivation of students in electrical engineering education [19] – [23].

In this regard, a joint educational double degree master's program "Electric Vehicles and Energy-Saving Technologies" (EV&EST) was developed. Universities of Latvia and Ukraine took part in this development, namely, Riga Technical University and Kharkiv National Automobile and Highway University (Grant Agreement 2019 - 1956/001 - 001, within

the framework of project No. 609557-EPP-1-2019-1-LV-EPPKA2-CBHE-JP "Development of practically-oriented student-centered education in the field of modeling of Cyber-Physical Systems").

Therefore, the purpose of this article is to analyze the problems that have arisen in these universities in connection with the COVID-19 pandemic using the example of the joint educational master's program of double diplomas "Electric vehicles and energy-saving technologies".

II. JOINT EDUCATIONAL MASTER PROGRAM OF DOUBLE DIPLOMAS EV&EST

The EV&EST program is designed to solve problems in the road transport sector by:

- growth of innovative energy-saving technologies;
- increasing the competitiveness of graduates in employment;
- productive cooperation between universities;
- reducing energy consumption and replacing traditional energy sources with alternative "green" sources.

In addition, EV&EST indirectly assists in solving a number of problems associated with the development of these technologies, their implementation, operation and maintenance.

Fig. 1 presents the main components of the EV&EST master's program.

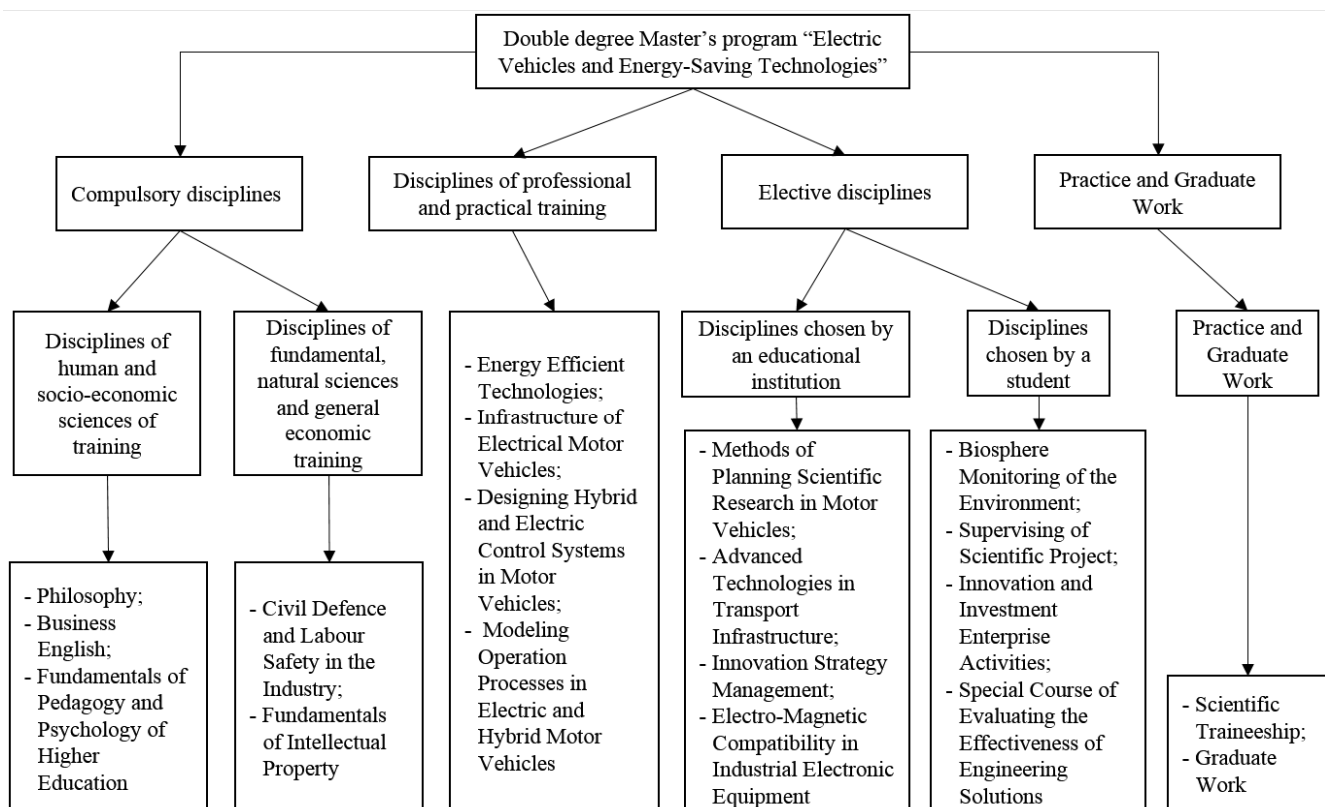


Fig. 1. Main Components of the EV&EST Master's Program

The implementation of this program includes:

- retraining of the teaching staff of universities participating in the program;
- equipping educational and laboratory classrooms;
- development and publication of educational materials.

The EV&EST program consists of two parts, which include the study of infrastructure and transport [9].

In turn, the infrastructure is divided into:

- service stations;
- charging stations and recharging points;
- alternative systems for generating electrical energy.

The full implementation cycle of this program is 3 years. A list of short-term and long-term impact indicators has been developed. These impact indicators are discussed in more detail in [9].

Fig. 2 presents different level short-term impact indicators that corresponds:

1. Short term impact;
2. Quantitative indicators;
3. Qualitative indicators;
4. Target groups/potential beneficiaries.

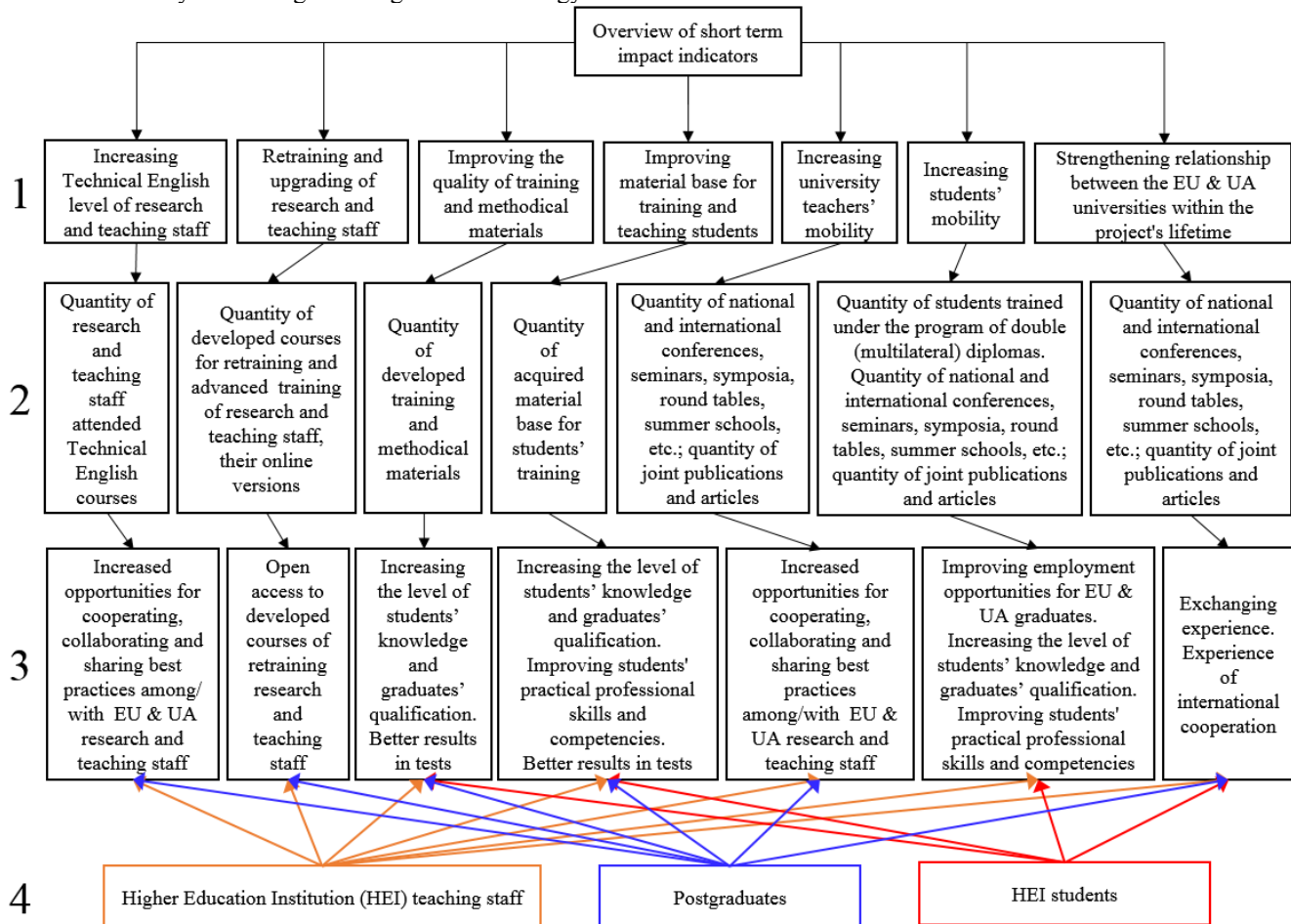


Fig. 2. Short term impact indicators

In connection with the COVID-19 pandemic, a number of problems have arisen that impede the timely implementation of this program. To clarify these problems, consider the short term impact indicators, which are presented in Fig. 2.

The implementation of the EV&EST master's program was launched in September 2019 and later in January 2021. But already at the beginning of March, quarantine was declared in Ukraine in connection with the COVID-19 spreading around the world. Therefore, when performing the primary tasks associated with improving the level of technical English of the research and teaching staff, with retraining and advanced

training of scientific and pedagogical personnel, with increasing the mobility of teachers and students, etc. there were problems. Almost everything that was planned (Fig. 2) has been postponed indefinitely.

Separately, it should be noted, that COVID-19 has completely changed the way of life of people around the world. So, today people cannot make clear plans even for the near future. In this regard, the world community should constantly revise the usual protocols of action and, depending on the epidemiological situation, make appropriate adjustments in a timely manner.

For example, in June 2020, a trip of the teaching staff of EV&EST participants to the Belgian city of Bruges was to take place. The purpose of the trip was to improve the level of technical English. Due to COVID-19, this trip has been postponed to September 2020. But now no one knows whether this event will take place or will be postponed again, or canceled altogether. Perhaps the format of this event should be changed, replacing the full-time form with a remote one.

However, despite the problems that arose, no one canceled the task, and the team working on the EV&EST master's program began to solve those tasks that can be carried out remotely or on site at the university. The work did not stop even under conditions of strict quarantine, and even more so now under conditions of adaptive quarantine.

III. DEVELOPMENT OF DISTANCE-LEARNING COURSES UNDER HARD QUARANTINE

Within the frame of the EV&EST program, training courses are developed in the Moodle educational environment. An example of one of such courses developed by Dr.Sc., professor Andrii Hnatov "Progressive technologies in road transport" is shown in Fig. 3.

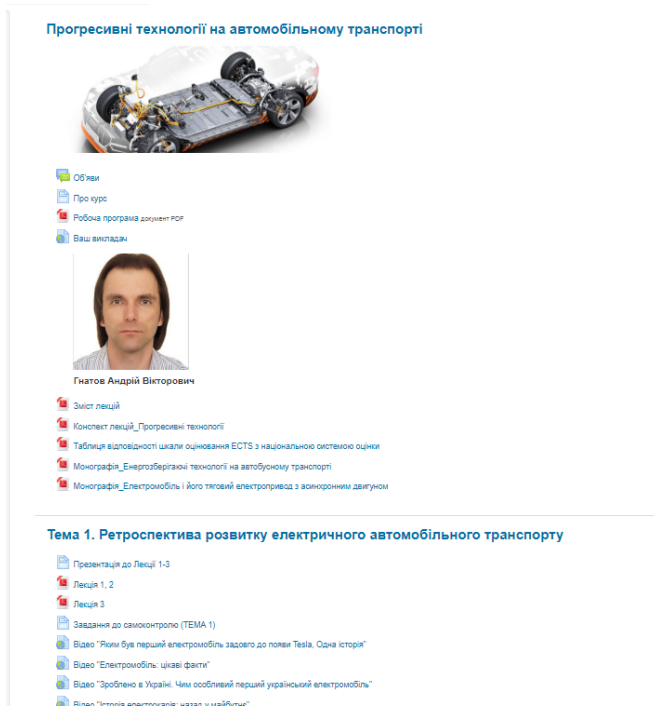


Fig. 3. The sample of distance-learning course in the educational environment Moodle

The course consists of 8 topics. For each topic, such kind of information is given:

- presentation in .pptx format;
- theoretical material in pdf format;
- tasks for self-control;
- test tasks;
- additional videos on the topic.

In addition, at the end of the course, students are tested on all the material they have passed.

So far, the weak link of the developed courses is the lack of practice. As the experience of many teachers shows, distance learning in its pure form is permissible only in the presence of force majeure circumstances, such as, for example, COVID-19. The most effective is a blended form of education, where students receive theoretical material remotely, and practical and laboratory work is carried out in existing laboratories. In this regard, the development of laboratory complexes and stands for conducting face-to-face classes with students continues.

Of course, the solution proposed in this work cannot fully suit all educational institutions. Different specialties require different approaches and teaching methods. Nevertheless, it should be noted that for the majority of technical specialties both in Ukraine and in Latvia, this approach seems to be quite effective and relevant. It lies in the fact that it is proposed to use a blended learning mechanism, where classroom lessons (lectures, practical exercises, seminars) that do not require special equipment can be conducted remotely using the Moodle platform. Those classes that cannot be conducted without special equipment are held on the territory of educational institutions in equipped educational laboratories (in compliance with all accepted sanitary and epidemiological standards).

IV. THE WORK ON PREPARING DOUBLE DEGREE MASTER'S PROGRAM EV&EST UNDER ADAPTIVE QUARANTINE CAUSED BY COVID-19

Kharkiv National Automobile and Highway University has developed a complex for laboratory and practical training based on a solar charging station for electric vehicles. The complex for conducting laboratory and practical exercises is based on a hybrid network solar power plant (SPP) of alternating current, Fig. 4.

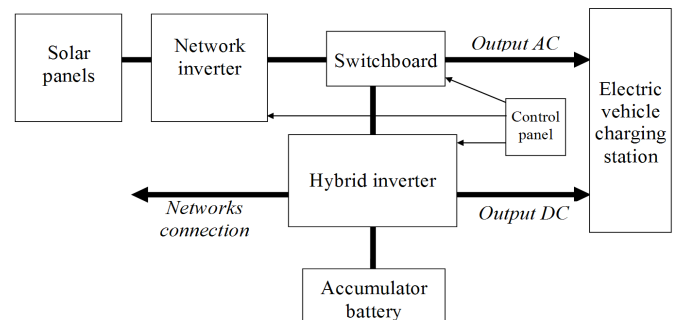


Fig. 4. Block diagram of the complex for laboratory and practical training

In this complex, solar panels are connected to a grid inverter (DC/AC). The AC network is connected to the input of the hybrid inverter (DC/AC). The batteries are also connected from the hybrid inverter. The outputs of the grid-connected solar inverter and the hybrid inverter are combined through a distribution board and provide power to the AC consumers. The output of the hybrid inverter is connected to

the electric vehicle charging station. A photo of the complex for laboratory and practical exercises is shown in Fig. 5.



Fig. 5. Complex for laboratory and practical training

Three laboratory works have been developed for this installation:

1. Research of the SPP in the autonomous operation mode – 4 hours.
2. Investigation of SPP in mixed power supply mode – 4 hours.
3. Investigation of SPP in standby power supply mode – 4 hours.

10 practical lessons have been developed:

1. Setting up a hybrid inverter SPP for different operating modes.
2. Measurement of the current-voltage characteristic of a solar panel (SP) with a gradual increase and decrease in load resistance.
3. Determination of the optimal load of the SP with various schemes of their connection.
4. Measurement of the power function of the SP depending on its load at tilt angles of the panel 15° ; 30° ; 45° ; 60° ; 75° .
5. Measurement of the function of I , U and P from time to time during the discharge of the SPP battery during operation at rated load.
6. Determination of the efficiency of the SP depending on its heating.
7. Determination of the efficiency of the SP with its partial and complete blackout.
8. Construction of a load graph of the SPP when connecting a time variable load.
9. Calculation of a solar charging station for charging an electric vehicle.
10. Calculation of SPP for work on the "green tariff" for one household.
11. Calculation of a solar autonomous power plant to provide electricity to one household.

The above is a real list of laboratory and practical exercises that were developed as part of the implementation of the international educational master's program of double degrees EV & EST between Riga Technical University and Kharkiv National Automobile and Highway University.

Due to the COVID-19 pandemic, it is proposed that the above list of classes must be conducted under a blended learning program. Students remotely prepare for practical and laboratory classes, prepare reports, study theoretical material,

instructions and a description of the order of work. In the laboratory, students only conduct research in accordance with the order of work. All calculations, processing of the results obtained, construction of graphs, tables, etc., as well as the formation of conclusions about the results of the conducted research, students perform remotely (outside the laboratory). Also, remotely (through the Moodle platform), students defend the work done.

After the end of the COVID-19 pandemic, the need for blended learning will certainly decrease. However, it is possible that it will be used further, albeit to a lesser extent than in a pandemic. Everything will depend on how effective blended learning proves to be. This will be seen after a comprehensive analysis of the results of the educational process carried out during the pandemic and their comparison with the results before the pandemic. There will also be a survey of students on their attitude to distance and blended learning. This will provide a more comprehensive view of performance and help identify potential problems and resolve them.

V. CONCLUSIONS

The paper analyzes the problems that have arisen in universities in connection with the COVID-19 pandemic using the example of the international educational master's program of double degrees "Electric vehicles and energy-saving technologies" (EV&EST).

In connection with the COVID-19 pandemic, a number of problems have arisen that impede the timely implementation of this program. Namely, when performing the primary tasks associated with improving the level of technical English language of the research and teaching staff, with retraining and advanced training of scientific and pedagogical personnel, with increasing the mobility of teachers and students, etc.

Most of the planned activities have been postponed indefinitely.

A brief description of the distance course, which was developed within the framework of the EV&EST program in the Moodle educational environment, is given.

A complex for laboratory and practical exercises based on a solar charging station for electric vehicles, which was developed under conditions of adaptive quarantine, is described. Laboratory and practical exercises have been developed at this complex.

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Antons Patlins, Dr.sc.ing. He is IEEE member, the author of more than 60 scientific publications. The scientific interests are related (but not limited) to control algorithms and devices development in the field of electrical engineering; researches are connected with the improvement of electric energy effectiveness in industrial electronics and electric transport, the sustainable development of public transport system and also with sustainability and motivation in education process. More than 50 students have developed their Bachelor, Engineering and Master Thesis under the supervision of Dr. Antons Patlins. The MC member of COST Action: CA16232 – “European Energy Poverty: Agenda Co-Creation and Knowledge Innovation” (ENGAGER) and MC Member Substitute of COST Action CA15127 “Resilient communication services protecting end-user applications from disaster-based failures” (RECODIS). Address: Riga, Latvia, Azenes str. 12/1 office 503. Antons.Patlins@rtu.lv