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Electric vehicles and energy-saving technologies – master's degree program under the Erasmus project Cybphys

Hnatov A.[1], Arhun Shch.[1]

[1]Kharkiv National Automobile and Highway University, Ukraine

Annotation. Problem. *The quality of higher education is achieved by compliance with the conditions for the implementation of educational activities and learning outcomes with the requirements of legislation and higher education standards, professional and international standards, as well as the needs of stakeholders and society. Obviously, the requirements, recommendations and opinions of stakeholders play one of the main roles in the process of ensuring the quality of higher education. It should be noted that without ensuring and improving the quality of higher education, it is impossible to obtain accreditation of an educational program (EP) in the relevant specialty.* ***Goal****. Analysis and processing of feedback received from employers and representatives of the academic community who have experience in working and teaching in the 141 specialty "Electric Power Engineering, Electrical Engineering and Electromechanics" to improve the quality of education under the master's EP "Electric vehicles and energy-saving technologies".* ***Methodology****. The method of questioning consists in obtaining information by means of written answers of respondents to a system of standardized questions. Methods of information processing and synthesis method - the study of an object in its integrity, in the unity and interconnection of its parts.* ***Results****. An analytical review of decisions on EP and publications on the introduction of innovative teaching methods and methods of maintaining the quality of the educational process into the educational process was carried out. In a number of educational components, the list of literature will be expanded due to the technical documentation of automakers and references to modern research by foreign authors. It is proposed to improve the existing and develop new laboratory and practical work on modern equipment purchased through the «CybPhys» project and on the equipment of interested employers. It is proposed to expand the practice of the educational components of the EP related to the cycle of professional training disciplines. It is proposed to add the topic "Alternative power sources" to the cycle of disciplines of the applicant's free choice (professional training section).* ***Originality****. It is proposed to conduct practical and laboratory classes and conduct research on the topic of the thesis directly in production and in the daily work of service stations and car service.* ***Practical value****. Based on the results of the feedback received from stakeholders, appropriate changes will be made to the courses that will improve the quality of education and make the master's EP "Electric vehicles and energy-saving technologies" even more relevant and actual for the labor market in the field of electric power, electrical engineering and electromechanics, in particular, with regard to the industry electric vehicles and energy saving technologies.*

Key words: *energy-efficient technologies, master's program, educational program, energy-saving technologies, grant project, electrical engineering and electromechanics, quality of higher education, stakeholder.*

Introduction

According to Art. 29, 32 of the Law of Ukraine "On Higher Education" dated 01.07.2014 under No. 1556-VII, the issue of rational organization and planning of the educational process belongs to the competence of higher education institutions (HEIs) and is a component of their academic autonomy. Based on the provisions of this Law of Ukraine, HEI develops and implements educational programs in the relevant

specialties into the educational process. At the same time, great attention is paid to the quality of educational services of higher education. By definition, the quality of higher education is achieved by complying with the conditions of conducting educational activities and learning outcomes in accordance with the requirements of legislation and standards of higher education, professional and/or international standards (if available), as well as the needs of interested parties (stakeholders) and society, which is ensured by implementing procedures of internal and external quality assurance [1]. Therefore, the requirements, recommendations, as well as the opinions of stakeholders play one of the main roles in the process of ensuring the quality of higher education. Also, it should be noted that without ensuring and improving the quality of higher education, it is impossible to obtain accreditation of the educational program (EP) in the relevant specialty. That is, the position of stakeholders, in fact, determines the vector of education for EP. Therefore, feedback from stakeholders, both regarding the educational program as a whole and its educational components, is very important for higher education institutions and graduation departments that take care of specific educational programs (they develop, modernize and monitor labor market trends). Receiving this feedback can take place in several ways. The main ones are surveys of stakeholders, conducting seminars, symposia, conferences with them, involving them in the discussion of educational programs and their educational components, sending educational programs to stakeholders in order to receive feedback, reviews and recommendations, involving employers in conducting educational activities (lectures, seminars, laboratory and practical classes, joint lectures, etc.). After receiving such feedback and conducting its analysis, it becomes clear how to improve and strengthen educational components and, as a result, the quality of higher education according to a specific educational program [2-5].

This work is aimed at this. It presents stakeholders, both from the academic environment and from the side of employers, disclosed information about the educational components of the master's program «Electric vehicles and energy-saving technologies» («EV and EST»), which is studied at the Kharkiv National Automobile and Road University (KhNAHU). The results of stakeholder surveys with their analysis regarding the improvement and strengthening of the educational process (quality of education according to this EP) are given.

Analysis of publications

In the work [6], the authors gave an example of the introduction of EP double diplomas into the educational process of higher education institutions. We are talking about the master's level EP «EV and EST», which is implemented within the framework of the Erasmus + grant project «CybPhys» between KhNAHU and Riga Technical University (RTU). The authors described the stages of implementation of EP double degrees between partner universities. The algorithm of actions when starting the program in the educational process and the conditions for its implementation are indicated. One of the main issues is compliance with the quality of the provision of educational services under this EP. For this, it is planned to conduct a survey of both representatives of the academic community, students of higher education, and representatives of employers interested in these specialists.

The work [7] revealed the theoretical foundations of the study of the features of "double degree" programs as one of the components of solving the problems of the Bologna Process. The relevance of the work [7], as its authors claim, is due to the need to study the experience of modern innovative approaches to the development of academic mobility of students during the creation of a single space of higher education in Europe. The purpose of the paper [7] is to analyze the significance of "double diploma" programs in the implementation of the tasks of the Bologna process and the essential features of this phenomenon. Of course, one of the priority tasks of the Bologna Process is to maintain the quality of education. Accordingly, one of the mechanisms for its implementation is receiving feedback from stakeholders.

In the article [8], the authors defined the peculiarities of the organization and conduct of student surveys within the international consortium "Student experience in the research university" and considered the prospects of using online survey tools in the quality control system of higher education. According to the results of the analysis of the world experience regarding the participation of students in the assessment of higher education institutions' provision of the quality of educational activities and the quality of higher education in general,

the possibility of including students in expert groups for monitoring the quality of higher education is substantiated. The paper [8] describes the advantages and disadvantages of online student surveys as a tool for monitoring the quality of higher education. The authors emphasize the feasibility of using online student surveys in the system of quality assurance of higher education, both at the university and state levels. In work [8], practical recommendations are given for using the tools of student questionnaires within the framework of its quality control mechanisms.

In work [9], the issue of improving the quality of higher education services with the help of gamification is considered, the experience of using game technologies in conducting classes in higher educational institutions is analyzed, a comparison of the traditional approach to education and gamification is made, advantages and disadvantages are established, and the rules for creating a game mechanism are substantiated. According to the authors of the article, the introduction of game technologies into the educational process leads to an increase in the quality of higher education services.

The issue of the two-level model of improving the quality of higher education in Ukraine is considered in the publication [10]. The researchers proposed a conceptual approach and technological directions for improving the quality of labor potential by means of professional education. This is realized thanks to the training of such graduates of higher education institutions who would meet the requirements of the labor market not only today and in the near future, but also over a long period of time in the future.

In the article [11], the authors revealed the issue of capacity building as a tool of institutional reform. The main focus is on improving the quality of higher education through academic audits in Great Britain, New Zealand, Sweden and Hong Kong. The experience of using «Academic Audit» - an accountability tool for capacity building for the universities of the specified countries - is considered. The proposed audit changed the incentives in behavior among teachers to improve student learning.

The authors of the article [12] emphasize that improving the quality of education in higher education institutions can be supported thanks to a survey of students regarding satisfaction with the educational environment. Students, after passing the appropriate course, give evaluations to the teacher, so-called Student evaluations of teaching. This approach is widely used in North America and Great Britain as a means of improving the quality of teaching.

The publication [13] is devoted to the issue of relations with stakeholders in the field of higher education. As the goal of the research, the authors of the work [10] considered the development of a map of interested parties for their description and the development of the process of relations with them in higher education. Stakeholder maps are important for quality assurance, as HEIs need to identify the most important stakeholders in order to collect feedback from them and improve their educational processes.

The article [14] is devoted to the evaluation of the quality of education from the point of view of stakeholders on the example of higher educational institutions of Armenia. In the work [14], the authors focus on the fact that employees of education management structures, teachers, students and stakeholders perceive the concept of education quality in different ways. Thus, employees of education management structures assess the quality of education as compliance with state education standards. Students talk about the quality of education as meeting the requirements of the labor market. For teachers, the effectiveness of the educational process is a guarantee of the quality of education. For employers, the quality of education is the speed and efficiency of completing tasks or work requirements. Therefore, when assessing the quality of education, the vision of all stakeholders of the educational process should be taken into account.

So, from the given analysis of publications, it becomes obvious that maintaining the quality of the educational process is one of the most important tasks for higher education institutions and, accordingly, for departments that ensure the implementation of specific EPs. At the same time, work with stakeholders takes the main positions. Therefore, issues related to the procedure for receiving feedback from stakeholders and summarizing the obtained results (recommendations, comments, wishes, etc.) are very important.

Purpose and Tasks

The main purpose of this study is Analysis and processing of feedback received from employers

and representatives of the academic community who have experience in working and teaching in the 141 specialty "Electric Power Engineering, Electrical Engineering and Electromechanics" to improve the quality of education under the master's EP " EV and EST ".

To achieve the specified goal, the following tasks must be solved in the work:

– conduct an analytical review of decisions regarding educational programs and publications regarding the introduction of innovative teaching methods into the educational process and methods of maintaining the quality of the educational process;

– to reveal the features of the developed/modernized educational components of the educational program «EV and EST» and the contingent of stakeholders who took part in the survey on this program;

– to analyze the results of the survey of both scientific and pedagogical staff and representatives of employers. Consider the possibility of incorporating recommendations received from stakeholders into the educational components of the master's program «EV and EST».

Master program «Electric Vehicles and Energy-Saving Technologies»

A survey of representatives of the Scientific, academic staff, as well as representatives of potential employers, was conducted in August 2022. The selection of stakeholders for the course evaluation was carried out taking into account basic education, work experience and professional competences.

7 Scientific, academic staff and 9 representatives of employers, who are potentially interested in MA graduates from EP «EV and EST», Table 1, took part in the survey.

The list of Scientific, academic staff and employers who took part in the survey in the specialty «Electric Power Engineering, Electrical Engineering and Electromechanics» for the master's EP «EV and EST» is given in Table 1.

Table 1. List of Scientific, academic staff and employers who took part in the survey in the specialty «Electric Power Engineering, Electrical Engineering and Electromechanics» under the master program «EV and EST»

No.	Company	Industry	Position
Scientific and academic staff			
1	KhNAHU	Education	Professor
2	Kharkiv State Polytechnic College	Education	Lecturer
3	KhNAHU	Education	Docent
4	KhNAHU	Education	Docent
5	KhNAHU	Education	Professor
6	KhNAHU	Education	Docent
~~7~~	KhNAHU	Education	Professor
Employers			
1	Alfa Diamant LLC	Transport	Deputy Director of Alfa Diamant LLC
2	NMU "ELECTROPIVDENMONTAJ" LLC	Electric power industry	Head of NMU "ELECTROPIVDENMONTAJ" LLC
3	SUZUKI "Technician-Center" car showroom	Transport	Director of the SUZUKI "Technician-Center" car showroom
4	LIMITED LIABILITY COMPANY AKRIS LOGISTICS (AKRIS LOGISTICS)	Transport	Head of Akris Logistics LLC
5	LIMITED COMPANY PAPER CUPS (PAPER CUPS)	Trading	PC operator "Paper Kaps" LLC
6	"Avtodom Kharkiv" LLC	Transport	Standardization and quality engineer of "Avtodom Kharkiv" LLC
~~7~~	Individual entrepreneur Saraev O.V	Transport	Individual entrepreneur Saraev O.V
8	Elcars	Transport	Owner of the company "Elcars"
9	Beetroot	IT	HR-manager

For the survey, 5 Educational Components (EC) EP «EV and EST» were selected, Table 2. These ECs were developed/modernized within the framework of the Erasmus+ KA2 project «Development of practically-oriented student-centred education in the field of modelling of Cyber-Physical Systems», acronym «CybPhys», Official number: 609557-EPP-1-2019-1-LV-EPPKA2-CBHE-JP [4–6,15]. The project started in 2019 and is scheduled to be completed on May 14 2023. Its main goal is the introduction of cyber-physical systems into the educational process. The development of electronic systems, components and software that interact with physical systems and their environment, providing opportunities for detection, monitoring, analysis and control of devices, components and processes in various application areas. Cyber-physical systems can provide specialist solutions with reduced time to market, bringing significant economic results and growth in sectors critical to the economy and competition Europe's prosperity, and stimulate innovation to cope with the "new digital transformation" of Europe [5,6,16].

Table 2 lists the developed/modernized ECs and presents detailed information that characterizes and gives a general idea about them. Links are also provided to the developed distance courses of EC data, which are developed in the Moodle environment on the Educational Site of the KhNAHU.

Table 2. Study courses that were evaluated by representatives of employers

Course/Lab title	Updated or totally new	Level	ECTS credit points	The teaching/training methodologies developed/adopted	The link to the university webpage	Date of accre-ditation
Energy-saving technologies in transport	New	Master	8,5	Lecture, practical, lab practical	https://dl2022.khadi-kh.com/course/view.php?id=2452	autumn-winter 2022
The structure of hybrid and electric vehicles	New	Master	4	Lecture, lab practical	https://dl2022.khadi-kh.com/course/view.php?id=2453	
Electric systems of environmentally friendly vehicles	Updated	Master	4	Lecture, lab practical	https://dl2022.khadi-kh.com/course/view.php?id=3517	
Methods of planning scientific research on vehicles	Updated	Master	5,5	Lecture, practical, lab practical	https://dl2022.khadi-kh.com/course/view.php?id=3518	
Mathematical modelling and methods of optimization	Updated	Master	3	Lecture, lab practical	https://dl2022.khadi-kh.com/enrol/index.php?id=1733	
Intelligent information technologies and systems in transport	Updated	Master	8,5	Lecture, practical, lab practical	https://dl2022.khadi-kh.com/enrol/index.php?id=3519	

These ECs are selected for the survey because they form the basis of special (professional) competences under the EP «EV and EST». Also, within the framework of the KhNAHU project, together with RTU, developed and introduced into the educational process a joint innovative master's program of double diplomas «EV and EST» in the specialty 141 «Electric Power Engineering, Electrical Engineering and Electromechanics», where the listed ECs represent the backbone of this program [4–6,16].

Results of the survey

The report on the conducted survey of representatives of scientific and pedagogical staff, as well as representatives of potential employers, can be found at the link (Stakeholder survey) [17]. Below is only an analysis of the survey results.

A total of 7 Scientific and academic staff questionnaires were processed (Table 1). The results of this processing are summarized in Table 3 and Table 5.

A total of 9 Employers' questionnaires were processed (Table 1). The results of this processing are summarized in Table 4 and Table 6.

Table 3. The results of processing scientific and academic staff questionnaires, Part 1

N	*Question*	Yes	No	*Justification and notes*
1.	*What is your area of professional activity?* ☒ science – **28,6%** ☒ education – **100%** ☐ other			Energy-saving technologies in transport
2.	*Have you had any previous or current experience in training specialists in the area of Cyber-Physical Systems (such as Automation, Computer Sciences, Cybernetics, IoT, AI, etc.)?*	**85,7%**	**14,3%**	There is experience in teaching disciplines in the field of intellectual information and technical systems. I have experience in teaching disciplines in the field of automation and automatic control systems. I have experience in teaching disciplines in the field of automation, cybernetics and teleautomation. I have experience in teaching disciplines in the field of automation, computer science and automatic control systems.
3.	Have you had any previous or current work experience in the area of Cyber-Physical Systems (Automation, Computer Sciences, Cybernetics, IoT, AI, etc.)?	**14,3%**	**85,7%**	I have experience in maintenance and adjustment of automatic systems of electrical systems of autonomous objects.

To get an idea of the experience of the scientific and academic staff who took part in the survey, these data are presented below (as a percentage of the total number of respondents).

Teaching experience: 3-7 year; 7-15 year (42,9%); 15-20 year (14,2%); more than 20 years (42,9%).

Experience of scientific activity: 3-7 year (28,6%); 7-15 year (14,3%); 15-20 year (14,3%); more than 20 years (42,9%).

Experience of production activity: 3-7 year; 7-15 year (14,3%); 15-20 year; more than 20 years.

Table 4. The results of processing employers' questionnaires, Part 1

N	*Question*	Yes	No
4.	*What is your area of professional activity?* ☐ industrial enterprise **– 22,2%** ☐ production of high-tech (IT) products **– 11,1%** ☐ IT-services **– 11,1%** ☒ transport **– 66,7%** ☐ non-government organization **– 11,1%** ☐ other		
5.	*Have you had any previous or current experience in training specialists in the area of Cyber-Physical Systems (such as Automation, Computer Sciences, Cybernetics, IoT, AI, etc.)?*	**-**	**100%**
6.	Have you had any previous or current work experience in the area of Cyber-Physical Systems (Automation, Computer Sciences, Cybernetics, IoT, AI, etc.)?	**11,1%**	**88,9%**

To form an idea about the experience of employers who took part in the survey, these data are presented below. Experience of scientific activity: 3-7 year (11,1%); 7-15 year; 15-20 year; more than 20 years. Experience of production activity: 3-7 year (11,1%); 7-15 year (66,7%); 15-20 year (11,1%); more than 20 years (11,1%). The second part of the questionnaire reveals questions about the EC program «EV and EST». The summarized survey results are given in Table 5 for scientific and academic staff and Table 6 for employers.

Table 5. The results of processing scientific and academic staff questionnaires, Part 2

	Question	Yes	No
1	*Do you agree with the content of the training material in the program of this discipline or laboratory work (If your answer is "no" - specify which sections of the course need amendments or additions)?*		
	Energy-saving technologies in transport	**28,6%**	**71,4%**
	The structure of hybrid and electric vehicles	**57,1%**	**42,9%**
	Electric systems of environmentally friendly vehicles	**42,9%**	**57,1%**
	Methods of planning scientific research on vehicles	**85,7%**	**14,3%**
	Mathematical modelling and methods of optimization	**85,7%**	**14,3%**
	Intelligent information technologies and systems in transport	**100 %**	**-**
2	*Do you have any suggestions for further improvement of this discipline?*		
	Energy-saving technologies in transport	**42,9%**	**57,1%**
	The structure of hybrid and electric vehicles	**42,9%**	**57,1%**
	Electric systems of environmentally friendly vehicles	**14,3%**	**85,7%**
	Methods of planning scientific research on vehicles	**14,3%**	**85,7%**
	Mathematical modelling and methods of optimization	**71,4%**	**28,6%**
	Intelligent information technologies and systems in transport	**-**	**100%**

Table 6. The results of processing employers' questionnaires, Part 2

1	*Do you think that the proposed list of laboratory and practical works will help to develop all practical competence, declared by the discipline program? (If your answer is "no" - specify which sections of the course need amendments or additions)?*		
	Energy-saving technologies in transport	**88,9%**	**11,1 %**
	The structure of hybrid and electric vehicles	**88,9%**	**11,1 %**
	Electric systems of environmentally friendly vehicles	**88,9%**	**11,1 %**
	Methods of planning scientific research on vehicles	**100 %**	**-**
	Mathematical modelling and methods of optimization	**66,7 %**	**33,3 %**
	Intelligent information technologies and systems in transport	**55,6 %**	**44,4 %**
2	*Do you have any suggestions for changing the list of lectures laboratory and practical works? (If your answer is " yes" - specify which sections of the course need amendments or additions)?*		
	Energy-saving technologies in transport	**33,3 %**	**66,7 %**
	The structure of hybrid and electric vehicles	**22,2 %**	**78,8 %**
	Electric systems of environmentally friendly vehicles	**22,2 %**	**78,8 %**
	Methods of planning scientific research on vehicles	**-**	**100 %**
	Mathematical modelling and methods of optimization	**-**	**100 %**
	Intelligent information technologies and systems in transport	**44,4 %**	**55,6 %**
3	*Do you have any recommendations for using specialized software for laboratory works? (If you answer is "yes" – give recommendations)*		
	Energy-saving technologies in transport	**11,1 %**	**88,9 %**
	The structure of hybrid and electric vehicles	**22,2 %**	**78,8 %**
	Electric systems of environmentally friendly vehicles	**22,2 %**	**78,8 %**
	Methods of planning scientific research on vehicles	**11,1 %**	**88,9 %**
	Mathematical modelling and methods of optimization	**33,3 %**	**66,7 %**
	Intelligent information technologies and systems in transport	**55,6 %**	**44,4 %**
4	*Do you have any suggestions for further improvement of this discipline?*		
	Energy-saving technologies in transport	**22,2 %**	**78,8 %**
	The structure of hybrid and electric vehicles	**22,2 %**	**78,8 %**
	Electric systems of environmentally friendly vehicles	**22,2 %**	**78,8 %**
	Methods of planning scientific research on vehicles	**-**	**100 %**
	Mathematical modelling and methods of optimization	**33,3 %**	**66,7 %**
	Intelligent information technologies and systems in transport	**44,4 %**	**55,6 %**

It is worth noting that the respondents paid attention to the questions and offered a number of interesting, relevant and relevant recommendations.

For EC ***«Energy-saving technologies in transport»***:

– add classification of various electric vehicles except Nissan Leaf;

– add the topic "Alternative power sources";

– supplement the educational material with topics related to vehicles with ICE, as well as lighting, heating and climate control systems of vehicles;

– add the topic «Alternative power sources»;

– expand the list of practical and laboratory works;

– to add conducting some practical classes in production.

For EC ***«The structure of hybrid and electric vehicles»:***

– make a list of the chronology of the release of various types of electric vehicles;

– supplement the educational material with topics related to the study of specific technical solutions in the construction of more common cars with electric traction of various types;

– expand the list of practical and laboratory works;

– to add conducting some practical classes in production.

For EC ***«Electric systems of environmentally friendly vehicles»*:**

– add the topic «Transport on hydrogen fuel»;

– expand the list of practical and laboratory works.

For EC ***«Methods of planning scientific research on vehicles»:***

– supplement the educational material with topics related to vehicles on ICE, as well as lighting, heating, climate control systems of vehicles and sensors and executive bodies of vehicle units and systems;

– expand the list of practical and laboratory works.

For EC ***«Mathematical modelling and methods of optimization»:***

– to supplement the educational material with practical classes on subjects according to the direction of training;

– add laboratory work;

– add practical tasks;

– expand the list of practical and laboratory works;

– add laboratory work.

Employer representatives, in contrast to scientific and academic staff, offered more specific recommendations in accordance with their professional activities.

For EC ***«Energy-saving technologies in transport»***:

– expand the list of laboratory and practical work directly in the conditions of the service station;

– consider energy-saving technologies in the transport industry;

– to increase practical classes using the material and technical base.

For EC ***«Mathematical modelling and methods of optimization»***:

– add more practice on optimizing complex technical systems.

– increase the number of practical classes;

– expand the list of practical works;

– update the literature and add modern studies.

For EC ***«Intelligent information technologies and systems in transport»:***

– implement laboratory and practical work on modern cars to study their intellectual and information systems;

– add real laboratory and practical work on modern cars;

– expand the list of laboratory and practical work directly in the conditions of the service station;

– supplement the lecture material on the topic of the engine control system;

– add more modern foreign literature;

– to improve and develop new laboratory and practical work on modern equipment.

The general wish for EC ***«Electric systems of environmentally friendly vehicles»***, ***«The structure of hybrid and electric vehicles»*** is to expand the list of literature due to the technical documentation of car manufacturers.

A general recommendation for all ECs from the scientific and academic staff is to consider the possibility of adding practice in production, as well as to expand the list of practical and laboratory work on the relevant courses.

At the same time, employers offered to conduct practical and laboratory classes in production, i.e. in service station conditions. This allows students to acquire skills in working with real equipment and significantly reduces or even eliminates the time for retraining and adaptation of a specialist at the start of work. Of course, not only employers are interested in such proposals, but also scientific and academic staff of the graduate department. Also, it should be noted that this approach leads to a double win situation. One of the elements in the accreditation of an educational program is cooperation with employers, internships at employers' enterprises and conducting any types of classes by employers.

Therefore, the implementation of the specified recommendations in the educational process will contribute to the improvement of its quality. In addition, such EP becomes attractive for the labor market and, accordingly, for applicants at the stage of choosing a place of study.

Separately, it is worth noting that EP «EV and EST» developed and modernized its ECs in accordance with the Erasmus+ KA2 «CybPhys» project. Under the terms of this project, KhNAHU purchased and introduced modern equipment into the educational process:

- Complex for teaching and practical research on electric vehicles;
- Interactive kit Newline NLE-805;
- Computer classroom for 15 places.

This equipment, as well as what was already at the department of automotive electronics, became part of the developed (under the terms of the «CybPhys» project) Laboratory of energy-saving technologies in transport [15,17].

Conclusion

The feedback received from the teaching staff and employers is a very important and necessary element in ensuring the quality of the educational process in the specialty «Electric Power Engineering, Electrical Engineering and Electromechanics» under the master's program «Electric Vehicles and Energy-Saving Technologies». The received recommendations will be considered at the meeting of the department of automotive electronics, which is the graduation (main) department for this specialty. Based on the results of this review, appropriate changes will be made to the courses, which will improve the quality of education and make the master's program "Electric vehicles and energy-saving technologies" even more urgent and relevant for the labor market in the field of electric power, electrical engineering and electromechanics, in particular, regarding the field of electric vehicles and energy-saving technologies.

It is proposed to conduct practical and laboratory classes and carry out research on the topic of the thesis directly in production and in the conditions of daily work of technical service stations and car service. In a number of educational components, the list of literature will be expanded due to the technical documentation of car manufacturers and references to modern research by foreign authors. Also, improvement of existing and development of new laboratory and practical works on modern equipment purchased at the expense of the «CybPhys» project and on the equipment of interested employers is proposed. It is proposed to expand the practical component of the educational components of EP «EV and EST» (more laboratory and practical classes compared to lectures), which are related to the cycle of professional training disciplines. It is proposed to add the topic «Alternative power sources» to the cycle of subjects of the applicant's free choice (section of professional training).

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Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

1. *Про вищу освіту*. (2022). Офіційний вебпортал парламенту України. Retrieved November 23, 2022, from https://zakon.rada.gov.ua/go/1556-18. *Pro vyshchu osvitu.* [About higher education.] (2022). Офіційний вебпортал парламенту України. Retrieved November 23, 2022, from https://zakon.rada.gov.ua/go/1556-18 [in Ukrainian]
2. Hnatov, A., Arhun, Shch., & Ulyanets, O. (2018). ESTeT-new innovative specialty for Master students. *Автомобильный Транспорт*, *42*, 103–110.
3. Мигаль, В. Д., Аргун, Щ. В., Гнатов, А. В., & Жарко, Ю. Г. (2020). Постановка задачі і викладання результатів наукових досліджень в дисертаційних роботах з технічних наук. *Автомобіль і електроніка. Сучасні технології*, *18*, 6–16. Myhal, V. D., Arhun, Shch. V., Hnatov, A. V., & Zharko, Yu. H. (2020). Postanovka zadachi i vykladannia rezultativ naukovykh doslidzhen v dysertatsiinykh robotakh z tekhnichnykh nauk. [Setting the problem and teaching the results of scientific research in dissertation works on technical sciences] Avtomobil i elektronika. Suchasni tekhnolohii, 18, 6–16. [in Ukrainian]
4. Аргун, Щ., Гнатов, А., & Гнатова, Г. (2020). *Проблеми, що виникли в ЗВО у зв'язку з COVID-19 на прикладі магістерської програми подвійних дипломів.* Автомобільний транспорт. *47*, 51–57. Arhun, Shch., Hnatov, A., & Hnatova, H. (2020). Problemy, shcho vynykly v ZVO u zviazku

z COVID-19 na prykladi mahisterskoi prohramy podviinykh dyplomiv. [Problems that arose in higher education institutions in connection with COVID-19 on the example of the master's program of double degrees] Avtomobilnyi transport. 47, 51–57. [in Ukrainian]

5. Arhun, S., Hnatov, A., Hnatova, H., Patlins, A., & Kunicina, N. (2020). *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."* https://doi.org/10.1109/RTUCON51174.2020.9316601
6. Hnatov, A., Arhun, S., Hnatova, H., Bagach, R., Patlins, A., & Zabasta, A. (2021). *Implementation of the double degree master's program on the example of the Erasmus project CybPhys*. 1–6. https://doi.org/10.1109/RTUCON53541.2021.9711716
7. Грицюк, Л. К., & Лякішева, А. В. (2014). *Реалізація програм" подвійний диплом" як спосіб входження вітчизняних ВНЗ до спільного європейського простору вищої освіти*. Вища школа науково-практичне видання. 5. 87-95. Hrytsiuk, L. K., & Liakisheva, A. V. (2014). Realizatsiia prohram" podviinyi dyplom" yak sposib vkhodzhennia vitchyznianykh VNZ do spilnoho yevropeiskoho prostoru vyshchoi osvity. [Implementation of "double degree" programs as a way for domestic universities to enter the common European space of higher education] Vyshcha shkola naukovo-praktychne vydannia. 5. 87-95. [in Ukrainian]
8. Мороз, В. М., Садковий, В. П., Бабаєв, В. М., & Мороз, С. А. (2018). Онлайн опитування студентів у системі забезпечення якості вищої освіти. *Інформаційні Технології і Засоби Навчання*, *68*(6), 235–250. Moroz, V. M., Sadkovyi, V. P., Babaiev, V. M., & Moroz, S. A. (2018). Onlain opytuvannia studentiv u systemi zabezpechennia yakosti vyshchoi osvity. [Online survey of students in the quality assurance system of higher education.] Informatsiini Tekhnolohii i Zasoby Navchannia, 68(6), 235–250. [in Ukrainian]
9. Захарова, О. В., & Грузд, А. В. (2017). Підвищення якості послуг вищої освіти за допомогою гейміфікації. *Наукові Праці Кіровоградського Національного Технічного Університету*, *32*, 113–122. Zakharova, O. V., & Hruzd, A. V. (2017). Pidvyshchennia yakosti posluh vyshchoi osvity za dopomohoiu heimifikatsii. [Improving the quality of higher education services with the help of gamification.] Naukovi Pratsi Kirovohradskoho Natsionalnoho Tekhnichnoho Universytetu, 32, 113–122. [in Ukrainian]
10. Дмитренко, Г. А., Мудра, С. В., & Спіцина, А. Є. (2016). Дворівнева модель підвищення якості вищої освіти в Україні. *Актуальні Проблеми Педагогіки, Психології Та Професійної Освіти*, *1*, 10–16. Dmytrenko, H. A., Mudra, S. V., & Spitsyna, A. Ye. (2016). Dvorivneva model pidvyshchennia yakosti vyshchoi osvity v Ukraini. [A two-level model of improving the quality of higher education in Ukraine.] Aktualni Problemy Pedahohiky, Psykholohii Ta Profesiinoi Osvity, 1, 10–16. [in Ukrainian]
11. Dill, D. D. (2000). Capacity building as an instrument of institutional reform: Improving the quality of higher education through academic audits in the UK, New Zealand, Sweden, and Hong Kong. *Journal of Comparative Policy Analysis: Research and Practice*, *2*(2), 211–234.
12. Hammonds, F., Mariano, G. J., Ammons, G., & Chambers, S. (2017). Student evaluations of teaching: Improving teaching quality in higher education. *Perspectives: Policy and Practice in Higher Education*, *21*(1), 26–33.
13. Kettunen, J. (2015). Stakeholder relationships in higher education. *Tertiary Education and Management*, *21*(1), 56–65.
14. Vardanyan, N. (2017). Education Quality Assessment from the Perspective of Stakeholders on the Example of Armenian Higher Education Institutions. *Business Ethics and Leadership*, *1*(3), 93–97. https://doi.org/10.21272/bel.1(3).93-97.2017
15. *Development of practically-oriented student-centred education in the field of modelling of Cyber-Physical Systems | Riga Technical University* (World). (n.d.). Https://Www.Rtu.Lv. Retrieved November 23, 2022, from https://www.rtu.lv/en/university/rtu-projects/open?project_number=4180
16. Zabasta, A., Peuteman, J., Kunicina, N., Kazymyr, V., Hvesenya, S., Hnatov, A., Paliyeva, T., & Ribickis, L. (2020). Research on cross-domain study curricula in cyber-physical systems: A case study of Belarusian and Ukrainian Universities. *Education Sciences*, *10*(10), 282.
17. *Звіти. Опитування стейкхолдерів.* (2022). ХНАДУ. Retrieved November 23, 2022. Zvity. Opytuvannia steikkholderiv. [Reports. Stakeholder survey.] (2022). KhNADU. Retrieved November 23, 2022, from https://www.khadi.kharkov.ua/erasmus/ka-2/rozvitok-praktichno-orijentovanoji-studentskoji-osviti-v-oblasti-modeljuvannja-kiber-fizichnikh-sistem-cybphys/zviti/ [in Ukrainian]

Hnatov Andrii[1], professor, Doct. of Science, Head of Vehicle Electronics Department, tel. +38 066-7438-0887, kalifus76@gmail.com, ORCID: https://orcid.org/0000-0003-0932-8849
Arhun Shchasiana[1], professor, Doct. of Science, Vehicle Electronics Department, tel. +38 099-378-0451, shasyana@gmail.com, ORCID: https://orcid.org/0000-0001-6098-8661

[1]Kharkov National Automobile and Highway University, 25, Yaroslava Mudrogo str., Kharkiv, 61002, Ukraine.

Електромобілі та енергозберігаючі технології – магістерська освітня програма за Еразмус проєктом Cybphys

Анотація. Проблема. *Якість вищої освіти досягається дотриманням умов провадження освітньої діяльності та результатів навчання вимогам законодавства та стандартам вищої освіти, професійним та міжнародним стандартам, а також потребам стейкхолдерів і суспільства. Очевидно, що, вимоги, рекомендації та думки стейкхолдерів відіграють одну з основних ролей в процесі забезпечення якості вищої освіти. Тут, слід зазначити, що без забезпечення та вдосконалення якості вищої освіти неможливо отримати акредитацію освітньої програми (ОП) за відповідною спеціальністю.* ***Мета.*** *Аналіз та обробка отриманого зворотного зв'язку від роботодавців та представників академічної спільноти, які мають досвід роботи та викладання за 141 спеціальністю «Електроенергетика електротехніка та електромеханіка» для покращення якості освіти за ОП магістрів «Електромобілі та енергозберігаючі технології».* ***Методологія****. Метод анкетування, що полягає в отриманні інформації шляхом письмових відповідей респондентів на систему стандартизованих запитань. Методи обробки інформації, та синтез метод – вивчення об'єкта в його цілісності, в єдності і взаємного зв'язку його частин.* ***Результати****. Проведено аналітичний огляд рішень, щодо ОП та публікацій стосовно впровадженню в навчальний процес інноваційних методів навчання та методів дотримання якості освітнього процесу. В ряд освітніх компонентів буде розширено перелік літератури за рахунок технічної документації автовиробників та посилань на сучасні дослідження іноземних авторів. Запропоновано вдосконалення існуючих та розробка нових лабораторних та практичних робіт на сучасному обладнанні, що придбано за рахунок проєкту «CybPhys» та на обладнанні зацікавлених роботодавців. Запропоновано розширити практичну складову освітніх компонентів ОП, що відносяться до циклу дисциплін професійної підготовки. До циклу дисциплін вільного вибору здобувача (розділ професійної підготовки), запропоновано додати тему «Альтернативні джерела живлення».* ***Оригінальність****. Запропоновано проводити практичні та лабораторні заняття та виконувати дослідження за темою дипломної роботи безпосередньо на виробництві та в умовах повсякденної роботи станцій технічного обслуговування та сервісу автомобілів.* ***Практична цінність.*** *За результатами отриманого зворотного зв'язку від стейкхолдерів будуть внесені відповідні зміни до курсів, які покращать якість навчання та зроблять магістерську ОП «Електромобілі та енергозберігаючі технології» ще більш нагальною та актуальною для ринку праці у сфері електроенергетики, електротехніки та електромеханіки, зокрема, що стосується галузі електромобілів та енергозберігаючих технологій.*

Ключові слова: *енергоефективні технології, магістерська програма, освітня програма, енергозберігаючі технології, грантовий проект, електротехніка та електромеханіка, якість вищої освіти, стейкхолдер.*

Гнатов Андрій Вікторович[1], д.т.н., проф. каф. автомобільної електроніки, тел. +38 06674380887, kalifus76@gmail.com,
ORCID: https://orcid.org/0000-0003-0932-8849
Аргун Щасяна Валіковна[1], д.т.н., проф. каф. автомобільної електроніки, тел. +38 0993780451, shasyana@gmail.com,
ORCID: https://orcid.org/0000-0001-6098-8661

[1]Харківський національний автомобільно-дорожній університет, 61002, Україна, м. Харків, вул. Ярослава Мудрого, 25.