Original Article

The Comparative Analysis of Components of Pharmacy Education Programs in Universities of EU Countries and Ukraine

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Abstract

The research aimed to conduct a comparative analysis of the academic components of Pharmacy education programs of higher education institutions in Ukraine and EU countries and to study their development experience. The research objects were the Pharmacy education programs presented at the official websites of higher education institutions of Ukraine, Poland, Italy, Sweden, and Germany. Analytical-comparative, content, systematic, meta-analysis, logical, decomposition, and modeling research methods were used. There were established similar and different academic elements relevant to the title, structure, content, and workload hours in higher education institutions of Ukraine and EU countries. It determined the criteria of the originality and specific direction of the Pharmacy education programs, which indicates the peculiarities of specialists' training of a certain degree level and qualification. The importance of the vector of European integration processes in higher education institutions in Ukraine concerning the modeling and development of students' learning process by the Pharmacy specialty has been proven. The research results can be a guide for making changes and annexes to the structure and content of the Pharmacy education programs in higher education institutions of Ukraine for maximal convergence and harmonization of the education system with the EU countries within the framework of the Bologna Agreement, intending to create a single European area of higher education.

Keywords: Pharmacy education, Curriculum, Education programs, Academic component, Learning process, Higher education institution

Introduction

In European (EU) countries, 28 unique pharmaceutical systems exist that differ significantly not only in practice but also at the level of legislation regulating the functioning of the pharmaceutical industry [1-5]. So, for example, in the Netherlands, pharmaceutical practice is a system with liberal regulation, which is a unique phenomenon [6]. In Ukraine, on the contrary, pharmaceutical practice is strictly regulated. The precedent of the Arab Republic of Egypt is also well-known, where the counterfeiting of medicines is strictly prohibited (the death penalty is possible). It is controlled at the state level; therefore, counterfeiting is not allowed, leading to the adoption of stricter draft laws, which also spread in other countries [7]. Such a different approach to forming the legislative framework for regulating pharmaceutical practice in other countries conditioned the importance of studying and evaluating the specialists training for the pharmaceutical industry in higher education institutions (HEIs).

The research aims to compare the academic components (AC) of Pharmacy education programs (EPs) of HEIs in Ukraine and EU countries and to study their development experience.

Some problems regarding specialists' training process for the pharmaceutical industry exist in Ukraine. The learning takes place in HEIs of different subordination, namely the Ministry of Health of Ukraine (MH) and the Ministry of Education and Science of Ukraine (MES), for the single direction (specialty) 226 Pharmacy, industrial pharmacy. As a result, the systems of higher education levels and forms of certification of future specialists in the pharmacy industry are significantly varied in the HEIs of different subordinates. However, all prerequisites for solving this issue were created in 2021-2022 at the legislative level [8-12]. Unfortunately, the war on the

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territory of Ukraine postponed the planned progressive processes regarding creating an integrated system of specialist training for the pharmaceutical industry.

Comparative analysis of EPs in different countries aimed to study the possibility of students learning and pharmacists improving qualifications in foreign universities, integrating pharmacy specialists into the European pharmaceutical systems considering the migration processes of the population of Ukraine, first of all, to EU countries caused by the Russian-Ukrainian war.

Materials and Methods

The research objects were Pharmacy study programs presented at the official websites of HEIs of Ukraine, Poland, Italy, Sweden, and Germany. As a result, the following educational programs: Lviv Polytechnic National University, Ukraine (HEI-1); Danylo Halytsky Lviv National Medical University, Ukraine (HEI-2); the University of Opole, Poland (HEI-3); University of Pavia, Italy (HEI-4) have been selected as objects for comparative analysis. The first two HEIs were chosen since their comparative analysis allows seeing the differences in the components of EPs for specialty 226 Pharmacy, industrial pharmacy in HEIs subordinated for the MES and MH of Ukraine. The foreign universities were selected based on the similarity of the fundamental principles of EPs compared to the Ukrainian HEIs. Analytical-comparative, content, systematic, meta-analysis, logical, decomposition, and modeling research methods were used.

Results and Discussion

A meta-analysis of the information regarding the availability of EPs for the pharmaceutical industry presented at the official websites of Ukrainian and several EU HEIs (Uppsala University, Sweden [13], Heinrich Heine University Düsseldorf, Germany [14], Lviv Polytechnic National University, Ukraine [15, 16], Danylo Halytsky Lviv National Medical University, Ukraine [17], University of Opole, Poland [18], University of Pavia, Italy [19]) was conducted.

University of Opole (Poland) offers a 5.5-year Master of Pharmacy degree program. During the first two years, students learn the primary fundamental disciplines: general, inorganic, organic, analytical, and physical chemistry, mathematics and statistics, biophysics and informatics, biology and genetics, botany, physiology, and anatomy, and biochemistry. Studying these subjects provides a foundation for further practically oriented learning and research, including medicinal chemistry, pharmaceutical technology, pharmacology, toxicology, pharmacognosy, pharmacokinetics and pharmacodynamics, biopharmacy, and pharmaceutical biotechnology. In addition, Latin, foreign language, history of pharmacy, professional ethics, qualified first aid, and humanities are mandatory subjects of this Master's program, which are learned in university-wide courses. The monthly practices in community and hospital pharmacies occur during the holidays, after the third and fourth years of study. In addition, students can improve their pharmaceutical and chemical sciences knowledge in the optional courses offered during the second, third, fourth, and fifth years of study. After defending the Master's thesis, the EP provides a six-month internship in pharmacies (33 ECTS), which is required to obtain permission for a pharmacist's practical activity.

The University of Pavia (Italy) offers a master's course in "Chemistry and Pharmaceutical Technology", similar in content and structure to other analyzed programs. It is a single-cycle Master's Degree program, like at Danylo Halytsky Lviv National Medical University (Ukraine) and the University of Opole (Poland). The Master's Degree program in "Chemistry and Pharmaceutical Technology" aims to provide students with knowledge and skills applicable to the activity in all sectors directly or indirectly related to the design, development, production, and quality control in the pharmaceutical, food, and cosmetic industry, as well as public and private research institutions and analysis laboratories. The training path is multidisciplinary and structured to build a background suitable for acquiring, consolidating, and developing qualified theoretical and operational skills in specific disciplines through solid theoretical knowledge in primary fields. Concerning basic subjects, the students gain the physical, mathematical, computer, and statistical skills necessary to acquire and consolidate a valid chemical background and adequate biological culture. Also, basic disciplines confer – beyond the essential specific knowledge required – working methods and approaches to problem-solving capable of combining fundamental sciences and know-how, transforming the potential energy of knowledge into practical work to solve issues of pharmaceutical interest. The training path includes the experimental thesis (30 ECTS), added to the compulsory professional internships (6 months, 30 ECTS) at a public or a hospital pharmacy. Thanks to such an educational experience, the student can be fully aware of the problems that trace the path leading from the primitive idea of the pharmacologically active molecule to drug identification, their marketing way, and, finally, the drug dispensing to the patient.

All HEIs included in the research run full-time education processes and conform to the guidelines from the Bologna Process in European higher education. Learning processes are conducted at the level of first-cycle studies (Bachelor's Degree program), second-degree studies (Master's Degree program), and long-cycle studies (single-cycle Master's Degree program). The first two levels are offered at HEI-1 (Lviv Polytechnic National University, Ukraine), and the last is at all other analyzed HEIs (Danylo Halytsky Lviv National Medical University, Ukraine; the University of Opole, Poland; University of Pavia, Italy). The Pharmacy (Industrial pharmacy) Bachelor's Degree is a higher education level offered only at the Lviv Polytechnic National University (Ukraine), among the considered HEIs. At the same time, the EP of the University in Pavia (Italy) is the most related and similar to the training of specialists for the pharmaceutical

industry at the Lviv Polytechnic National University (Ukraine) regarding the profile and direction of learning.

According to the study curriculums, one year of studies corresponds to 60 ECTS credits and one semester – to 30 ECTS credits in HEI-1, HEI-2, and HEI-3. At the same time, one year of full-time study in HEI-4 ranges from 54 ECTS to 66 ECTS credits, and one semester – from 24 ECTS to 36 ECTS. A 4-year bachelor's degree program in HEI-1 has eight semesters and equals 240 ECTS credits. A 1.5-year master's degree program at the same HEI provides learning for three semesters and amounts to 90 ECTS credits. Long-cycle studies in HEI-2, HEI-3, and HEI-4 (5 years which consists of 10 semesters) lead to the professional title of master (magister) of Pharmacy degree. The program duration is 300 ECTS credits. Such single long-cycle studying is based on an integrated EP containing fundamental studies and in-depth specialization.

The research results showed that each academic year has a structured EP to guide students to achieve the intended learning outcomes. The curriculums are divided into modules (courses, academic disciplines, or components) that allow students to acquire the essential knowledge, skills, attitudes, and values to be influential members of practical pharmacy. The curriculums of analyzed HEIs are designed to represent an innovative approach that takes advantage of each HEI. As a result, the number and content of disciplines offered by HEIs differ and range from 3 to 19 components per semester **(Table 1)**. At the same time, the total number of academic subjects remains almost the same. The only exception is HEI-4, which offers 36 academic disciplines for the whole learning period.

Table 1. Quantitative ratios of AC in Pharmacy EPs in HEIs of Ukraine and EU countries

Study year	HEI-1*	HEI-2*	HEI-3*	HEI-4*
1st year	12	19	17	10
2nd year	12	15	15	7
3rd year	14	13	11	7
4th year	16	11	12	9
5th year	14	15	16	3
6th year	3			
Totally	71	69**	71	36
Average (per year)	14.2	14.5	14.2	7.2

* HEI-1 – Lviv Polytechnic National University, Ukraine (4-year Bachelor's Degree programs and 2-year Master's Degree programs); HEI-2 – Danylo Halytsky Lviv National Medical University, Ukraine; HEI-3 – University of Opole, Poland; HEI-4 – University of Pavia, Italy.
** The total sum of courses does not correspond to the arithmetic sum because some are studied during several semesters.

The components of the four EPs of the mentioned HEIs were compared regarding the similarity of particular subjects, the duration, and the mandatory of their learning. The AC was ranked by the level of similarity in the three groups: high level of similitude **(Table 2)**, average level of similarity **(Table 3)**, and original AC that qualitatively distinguishes one program from another **(Table 4)**.

Table 2. The AC (ECTS) in Pharmacy EPs in HEIs of Ukraine and EU countries

HEI-1	HEI-2	HEI-3	HEI-4
Disciplines of chemical direction			
Chemistry 1 (general and inorganic chemistry) (5 ECTS)	General and inorganic chemistry (9 ECTS)	General and inorganic chemistry (12 ECTS)	General and inorganic chemistry (9 ECTS)
Chemistry 2 (organic chemistry) (9 ECTS)	Organic chemistry (8 ECTS)	Organic chemistry (15 ECTS)	Organic chemistry (19 ECTS)
Pharmaceutical chemistry (7 ECTS)	Pharmaceutical chemistry (14 ECTS)	Pharmaceutical chemistry (17 ECTS)	Pharmaceutical Chemistry (18 ECTS) Applied pharmaceutical chemistry (9 ECTS)
Toxicological chemistry (4 ECTS)	Toxicological and forensic chemistry (5.6 ECTS)	Toxicology (6 ECTS)	Toxicology (6 ECTS)
Physical and colloid chemistry (7 ECTS)	Physical and colloid chemistry (5 ECTS)	Physical chemistry (8 ECTS)	Physical chemistry (9 ECTS)
Chemical methods of substances analysis (4 ECTS) Physical and chemical methods of analysis of substances (4 ECTS)	Analytical Chemistry (8 ECTS)	Analytical Chemistry (13 ECTS)	Analytical Chemistry (6 ECTS)
Biological chemistry and molecular biology (8 ECTS)	Biological Chemistry (6 ECTS)	Biochemistry (9 ECTS)	General Biochemistry (12 ECTS)

			Applied Biochemistry (6 ECTS)
Methods of organic synthesis (6 ECTS)		Synthesis and technology of biologically active compounds (6 ECTS)	Synthesis of drugs (6 ECTS)
Disciplines of pharmaceutical direction			
Introduction to the profession and the basics of professional hygiene (4 ECTS)	Hygiene in pharmacy and ecology (3 ECTS)		
	Ethics and deontology in pharmacy (2 ECTS) Bioethics (0.5 ECTS)	Professional ethics (2 ECTS)	
Medical Botany (6 ECTS)	Pharmaceutical Botany (5 ECTS)	Botany (7 ECTS)	Pharmaceutics biology (5 ECTS)
Pharmacognosy (5 ECTS)	Pharmacognosy (9 ECTS)	Pharmacognosy (9 ECTS)	
Drugs technology in pharmacy (6 ECTS)	Technology of drugs (13 ECTS)	The technology of drugs 1 (24 ECTS)	Pharmaceutical technology and legislation (9 ECTS) Pharmaceutical technology (9 ECTS) Industrial manufacturing of medicinal products (9 ECTS)
Basic of clinical pharmacy (4 ECTS)	Clinical pharmacy and pharmaceutical care (9 ECTS)	Clinical Pharmacy (3 ECTS) Applied pharmacy with pharmaceutical care (6 ECTS)	
Regulatory support of pharmaceutical industries (3 ECTS)	Law and legislation in pharmacy (2 ECTS)	Pharmaceutical legislation (3 ECTS)	
	Pharmaceutical Biotechnology (3 ECTS)	Pharmaceutical Biotechnology (2 ECTS)	
	Biopharmacy (3 ECTS)	Biopharmacy (3 ECTS)	
Disciplines of linguistic direction			
Foreign language (professional-oriented) (9 ECTS)	Foreign language (professional-oriented) (5 ECTS)	Foreign language (7 ECTS) Foreign language electorate (2 ECTS) New foreign language course (2 ECTS)	English language and translation (3 ECTS)
Latin (3 ECTS)	Latin (3 ECTS)	Latin (4 ECTS)	
Disciplines of mathematic direction			
Higher mathematics (12 ECTS)	Higher mathematics and statistics (4 ECTS)	Mathematics (3 ECTS) Statistics (2 ECTS)	Mathematical analysis (6 ECTS)
Informatics (3 ECTS)	Information technologies in pharmacy (4 ECTS)	Information technologies (2 ECTS)	
Physics (7 ECTS)	Biological physics and physical methods of analysis (4.5 ECTS)	Biophysics (3 ECTS)	Experimental physics (6 ECTS)

Disciplines of biological direction			
Microbiology (7 ECTS)	Microbiology and essential immunology (5 ECTS)	Immunology (2 ECTS) Microbiology (6 ECTS)	Microbiology and clinical microbiology (8 ECTS)
Biology and physiology with fundamentals of anatomy (7 ECTS)	Physiology (4 ECTS) Human Anatomy (3 ECTS) Biology with essential genetics (3 ECTS) Pathological physiology (5 ECTS)	Human physiology (4 ECTS) Human Anatomy (2 ECTS) Biology and genetics (4 ECTS) Pathological physiology (5 ECTS)	Physiology (6 ECTS) Human Anatomy (6 ECTS) General pathology (5 ECTS)
Disciplines of clinical direction			
Basic of pharmacotherapy (4 ECTS) Pharmacokinetics (3 ECTS)	Pharmacotherapy with pharmacokinetic (3 ECTS)	Pharmacotherapy and scientific information on drugs (3 ECTS) Pharmacokinetics (3 ECTS)	Pharmacotherapy (6 ECTS)
Basic of pharmacology (4 ECTS)	Pharmacology (9 ECTS)	Pharmacology and pharmacodynamics (15 ECTS)	Pharmacology (5 ECTS) Experimental pharmacology (12 ECTS)
Basics of emergency medical care (3,5 ECTS)	First preliminary aid with the introductory medical practice 3 ECTS) First aid in emergencies (2 ECTS)	Qualified first aid (2 ECTS)	
Disciplines of humanitarian direction			
Philosophy (3 ECTS)	Philosophy (3 ECTS)	History of Philosophy (1 ECTS)	
History of statehood and culture of Ukraine (3 ECTS)	History of Ukraine and Ukrainian culture (3 ECTS)		
Disciplines of scientific-professional direction			
	Methodology of scientific investigations based on the subject of Master's degree project (15 ECTS)	Methodologies of investigations (10 ECTS)	
Disciplines of economic direction			
Organization and economics in pharmacy (3 ECTS)	Organization and economics in pharmacy (7 ECTS)		
Management, marketing, and pharmaceutical commodity science (4 ECTS)	Management and marketing in pharmacy (9 ECTS)		

Table 3. The AC (ECTS) in Pharmacy EPs in HEIs of Ukraine and EU countries in an average level of similarity

HEI-1	HEI-2	HEI-3	HEI-4
Quality control of medicines (3 ECTS) Physical methods of drugs analysis (4 ECTS)	Certification of medicines (3 ECTS) Quality assessment system in pharmacy (3 ECTS)		Pharmaceutical analysis (24 ECTS)
Engineering and computer graphics (4 ECTS)	Computer simulation in pharmacy (3 ECTS)		Computer science (6 ECTS)

Technology of drugs from natural raw materials and phytotherapy (5 ECTS)	The resource study of medicinal plants (3 ECTS)	Drugs of natural origin (2 ECTS)	
		Bromatology (6 ECTS)	Food Chemistry (6 ECTS)
Performing the Bachelor's degree qualification project (9 ECTS)			
Performing the Master's degree qualification project (16.5 ECTS)		Master's workshop (3 ECTS)	Final exam (30 ECTS)
Defense of the master's degree qualification project (4.5 ECTS)			

Table 4. Original disciplines for HEIs

HEIs	Directions of disciplines
HEI-1	**Disciplines of the linguistic direction:** • Ukrainian language (professional-oriented) (3 ECTS) **Disciplines of the engineering and technical direction:** • Processes and devices of pharmaceutical manufacturing (5 ECTS) • Modeling and design of chemical and pharmaceutical enterprises in the GMP system (6 ECTS) • Equipment and design of pharmaceutical industries (5 ECTS) • Industrial equipment of chemical and pharmaceutical enterprises (3 ECTS) • Industrial technology of pharmaceutical manufacturing (10 ECTS) • Scientific aspects of the ecology of chemical and pharmaceutical industries (4 ECTS) **Disciplines of the economic direction:** • Economics of chemical and pharmaceutical enterprises (4 ECTS) **Disciplines of clinical direction:** • Basic laboratory and functional diagnostics (3 ECTS) **Disciplines of pharmaceutical direction:** • Technology of biologically active substances, biomedical polymers, and nanostructures (5 ECTS) • Scientific aspects of the technology of veterinary and biomedical drugs (7 ECTS) **Disciplines of chemical direction:** • Chemistry and technology of medical compounds (7 ECTS) **Disciplines of professional direction:** • Occupational and civil safety (3 ECTS) • Fundamentals of labor protection and life safety (3 ECTS)
HEI-2	**Disciplines of linguistic direction:** • Ukrainian language (professional-oriented) (3 ECTS) **Disciplines of clinical direction:** • Basics of organization of population and military medical provision (1 ECTS) • Medicine of extreme conditions (2 ECTS) **Disciplines of pharmaceutical direction:** • The study of pharmaceutical and medical commodities (4 ECTS) • Good practices in pharmacy (3 ECTS) • Social pharmacy (3 ECTS) **Disciplines of professional direction:** Healthcare management (3 ECTS)

HEI-3	**Disciplines of humanitarian direction:** • Psychology and sociology (1 ECTS) **Disciplines of biological direction:** • Molecular biology (2 ECTS) **Disciplines of pharmaceutical direction:** • History of pharmacy (2 ECTS) • Pharmacoeconomics (3 ECTS) • Pharmacoepidemiology (3 ECTS) • Intellectual property protection (1 ECTS)

It should be noted that only 16 cases of the coincidence of educational components by content and the number of ECTS credits were discovered in all four HEIs; 13 cases were in 3 HEIs; 9 cases were in 2 HEIs. At the same time, the most significant part of coincidence is observed in HEI-3 and HEI-4, 70.42% and 83.33%, respectively. When comparing the EPs in HEIs of EU countries and Ukraine, relatively high similarities of academic components were discovered in HEI-1 and HEI-4 (28.17% and 30.98%, respectively). Interestingly, the coincidence of educational elements concerns primarily basic disciplines, such as mathematics and statistics, biophysics, and general chemistry, which are learned during the start years of study. Correspondents in the pharmaceutical and clinical disciplines occur for the technology of drugs, botany, pharmacotherapy, and pharmacology.

In subsequent years (courses) of study, the number of educational components is balanced in three HEIs, except for HEI-4, where the number of academic disciplines is significantly smaller in quantitative terms. Nevertheless, the tendency of correlation between ECTS credits and amount of subjects is not followed in subsequent years (courses) of study.

It should be noted that each HEI has original components, which are not found in other universities, making EPs unique and distinctive. The EP of HEI-1 has the weightiest criterion of originality and specific direction, which indicates the peculiarities of specialists training of a certain degree and qualification **(Table 4)**.

The structure of the Pharmacy EPs in the investigated HEIs provides four main blocks of AC: 1) mandatory disciplines; 2) elective courses; 3) practice; and 4) course projects.

Mandatory, as well as optional, components are included in two cycles of disciplines – general and professional training. The optional part at HEI-1 consists of the student choosing a subject from the cycle of general training and elective professional training courses, and these ACs are included in the university-wide pool of elective disciplines. Also, the selective part of the EP contains two professional blocks; one of these blocks is chosen by the student within the specialty. These blocks are aimed at certain specializations within the framework of specialty.

Practical-oriented learning experiences, including internships and practical training, have an important role in mastering practical skills and helping students connect their education to their career aspirations. A feature of each investigated EP is that theoretical material is learned during the current classroom study of the subject, and practical skills are acquired at the workplace within industrial practices.

Today most HEIs consider the necessity of including practice in EPs for skills acquired to meet the required personal, academic, and professional demands for a future successful career.

Practice as an element of the educational process is conducted to consolidate and expand the knowledge acquired by students at the HEI, to develop the necessary practical skills for work in the production field, and to master advanced technology and work methods. In addition, practice contributes to the development of students' independence. During practice, students learn to independently select and systematize information within the framework of the assigned tasks; apply the acquired knowledge in practice; study the technology and equipment used in specific production; develop teamwork skills; and exercise self-control. In addition, one of the priority requirements of potential employers today is the employee's professional competence. Passing industrial practice allows the student to assess their competence level and determine the need for adjustment.

Nowadays, the approaches for practice organization in HEIs are different. In most HEIs, practices, according to the EPs, are evenly distributed over different years of study. Only HEI-2 and HEI-4 follow the approach for practice organization in the final year of study before the graduation exam and Master's project defense. Such an approach allows the student to assess their competence level and determine the need for adjustment, making graduates as successful as possible.

The HEI-1 proposed a specific form of the educational process - a course project, which is considered an important stage of the student's independent work on specific professional (technical, research, etc.) tasks. Course projects are completed after learning the theoretical part of the academic discipline or section that ensures the availability of knowledge sufficient for the performance of the course project.

The EP rates thus correlate strongly with indicators of demand for high-skilled workers and professionals to ever-higher levels.

Pharmacy higher education has become one of the important routes for human capital development and an individual's upward social mobility. Young people acquire advanced generic and specific skills to prosper in knowledge and flourish in society. That is why the development and availability of EPs, offering students the prospect of significant benefits in employability and earnings, is essential for HEIs of different levels.

The regrouping of educational components within academic semesters by the name of the discipline made it possible to establish elements relevant to the title, structure, content, and workload hours in four HEIs. There will be many more coincidences if such regrouping is carried out within the academic year. As a result, 16 cases of complete coincidence of educational components in all analyzed HEIs were established. At the same time, the quantity of complete coincidence decreases depending on the year of study: 1st year – 4 cases, 2nd and 3rd years – 3 instances each. Also, there are 6 cases similar in the structure and content of four HEIs, but they are learned in different years of study. A high coincidence of educational components in two or three analyzed HEIs is observed **(Table 5)**.

Table 5. Assessment of coincidence of AC in HEIs of Ukraine and EU countries

	% of coincidence regarding other HEIs (amount of AC)				% of coincidence in total by program (amount of AC)
	HEI-1	HEI-2	HEI-3	HEI-4	
HEI-1		32.39% (23)	28.17% (20)	15.49% (11)	52.11% (37)
HEI-2	33.33% (23)		37.68% (26)	21.74% (15)	62.22% (45)
HEI-3	30.98% (22)	42.25% (30)		27.17% (20)	70.42% (25)
HEI-4	33.33% (12)	55.55% (20)	61.11% (22)		83.33% (30)

At the same time, insufficient coincidences are not considered a disadvantage to the EP of the HEI. On the one hand, this is a criterion of the originality and specific direction of the EP, which indicates the peculiarities of specialists training of a certain degree and qualification. On the other hand, this is ground for making changes and annexes to the structure and content of the EPs in HEIs of Ukraine for maximal convergence and harmonization with the education systems of EU countries within the framework of the Bologna Agreement, intending to create a single EU area of higher education.

The obtained results will be used as a foundation for determining universal (essential) lists of educational components for two separate specializations (directions) of specialty 226 "Pharmacy, Industrial Pharmacy" offered by HEIs of Ukraine – 226.01 "Pharmacy" and 226.02 "Industrial Pharmacy". Furthermore, these lists can guide the development of EPs for specialist training in HEIs.

Also, it should be noted that improving learning processes, which involves optimizing the content of EPs and minimizing the number of their components, is one of the tasks declared in the Strategic Development Plan of the Lviv Polytechnic National University (HEI-1) until 2025. Reviewing EPs and their optimization process is a part of the annual procedure for improving the educational process. Every year specific changes are made, taking into account the circumstances, suggestions of employers, and feedback from graduates and young professionals. This action occurs according to the Regulation on developing, approving, and updating EPs at the Lviv Polytechnic National University (HEI-1) [20]. Minimizing the number of components is one of the mechanisms for optimizing EPs, as stated in the Strategy. The last similar changes in all EPs occurred in 2014, after approving the new Law on Higher Education and the new List of Specialties [21].

Since 2018, the MES of Ukraine has started approving Higher Education Standards according to new criteria. Thus the necessity to review EPs once again became. In addition, the comparative analysis of EPs of HEIs of EU countries, which is periodically carried out, shows that they include significantly fewer educational components. Indeed, it improves the quality of the educational process and allows students to study subjects more thoroughly through independent work. Recommendations and requirements of all stakeholders, including employers, were also considered. Consequently, during 2019–2020, a methodical committee of Lviv Polytechnic National University (HEI-1) developed a new curriculum for first-year students for specialty 226 "Pharmacy, industrial pharmacy," introduced in 2021, in which the number of educational components in the EPs was reduced to 5-6 per semester.

Following the order of the rector of the Lviv Polytechnic National University (HEI-1), optimization (increasing) of the quota of mathematical disciplines (block of fundamental training) occurred. Specific educational components were combined. The scope of other essential academic disciplines, such as "Biological chemistry and molecular biology", "Physical and colloidal chemistry", and "Biology, physiology with the basics of anatomy", has partly decreased. Two disciplines were merged, such as "Hygiene" and

"Introduction to the profession. History of pharmacy"; as a result, the discipline "Introduction to the Profession and the basics of professional hygiene" was proposed.

Also, the methodological committee of the Department of Technology of Biologically Active Compounds, Pharmacy, and Biotechnology of Lviv Polytechnic National University (HEI-1) regularly collects feedback from students and graduates regarding studied disciplines and EPs in general. They advise how and when it is more convenient to study specific academic subjects and express their views on the practicality of the issue or the need for additional competencies or learning outcomes that are required in the labor market. The list of optional disciplines is also reviewed annually, particularly considering the students' proposals. Changes may concern the scope of academic subjects and the form of their learning.

That is why our analysis of the educational components of curriculums of four HEIs will allow us to predict the necessary changes for modeling the optimal (universal, essential) list of disciplines for specialists training by specialty “Pharmacy, industrial pharmacy” by the Bachelor's and Master's degree.

Conclusion

1. A meta-analysis of EPs of HEIs of Ukraine and EU countries for learning specialists for the pharmacy branch was conducted.
2. It was established that the fundamental educational components of the EPs of the four HEIs are similar and do not differ by name; however, they can be learned in different semesters of one year or separate academic years (courses). At the same time, each HEI has original components not found in other universities, making EPs unique and distinctive.
3. The comparative analysis of the components of the EPs made it possible to observe their similarities and establish the possibility of continuing the education of students in foreign HEIs, as well as the integration of pharmacy specialists into foreign education systems, which became especially relevant due to the Russian-Ukrainian war and the migration processes of the population of Ukraine to EU countries.
4. The rationality of the vector of European integration processes in HEIs concerning modeling the learning process of students of specialty “Pharmacy, industrial pharmacy” in Ukraine has been proven.

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