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The monograph provides a concise overview of modern strategies for preparing highly qualified specialists in conditions of globalization, digitalization, and technological change. It highlights competence-oriented learning as the core approach to professional training, emphasizing the integration of innovative technologies into the educational process. The volume unites research on intercultural communicative competence, forensic expert education, cybersecurity, artificial intelligence, and vocational psychological and pedagogical training. The monograph examines modern strategies, methods, and tools for preparing competent specialists in a rapidly changing world. The research combines theoretical frameworks with practical applications, providing models for curriculum modernization and competence-oriented learning.
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ABSTRACT

The collective monograph presents a comprehensive examination of modern approaches to the preparation of specialists in the context of globalization, digital transformation, and Ukraine's integration into the European and global educational spaces. It addresses the challenges of aligning higher education with rapidly changing labor market requirements and demonstrates how new technologies, when systematically integrated into curricula, can serve as powerful tools for enhancing competence, employability, and resilience.

The central focus of the monograph is the intentional use of innovation – ranging from digital platforms and cyber polygons to artificial intelligence and intercultural communication models – in the formation of professional competences. Rather than treating technology as an isolated component, the authors conceptualize it as a structural driver of pedagogical change, reshaping what is taught, how it is taught, and how professional identity is cultivated. The volume situates professional education within the broader framework of Industry 5.0, which emphasizes human-centric development, ethical responsibility, and the capacity to adapt in volatile conditions.

Each chapter provides a specific contribution to this overarching vision. The first chapter highlights the development of intercultural communicative competence (ICC) among IT and computer science students, recognizing it as a prerequisite for effective participation in multicultural teams and international projects. The authors present the innovative course project Navigating Cultural Diversity, which blends theoretical instruction with practical activities, such as case studies, simulations, and role-playing. The outcomes confirm that ICC is not an optional skill but a core professional competence in the global digital economy.

The second chapter examines the harmonization of forensic expert training with international standards. By analyzing models from leading countries and comparing them with Ukrainian practice, the authors identify gaps and propose reforms, emphasizing the integration of digital forensics, artificial intelligence, and blockchain technologies. This chapter underscores the importance of interdisciplinary approaches and international cooperation, positioning forensic science education as both a national priority and a globally oriented field.

The third chapter explores the cyber polygon as a pedagogical tool for cybersecurity training. It demonstrates how immersive simulations enable students to master offensive and defensive techniques, from vulnerability scanning to ethical hacking and incident response. The cyber polygon provides authentic contexts, in which students build practical competencies while developing teamwork, critical thinking, and ethical responsibility. This hands-on approach ensures that graduates are ready to respond to the escalating complexity of cyber threats.

The fourth chapter extends the discussion to methodology, presenting a combined approach that unites theoretical generalization, biographical analysis, and survey methods to study openness to innovation. This contribution situates professional education as a process that not only imparts

knowledge but also cultivates creativity, adaptability, and receptivity to new ideas—qualities essential for professionals in dynamic environments. The authors argue that competence formation must include dispositions toward innovation, ensuring long-term professional growth.

Artificial intelligence (AI) is the central theme of the fifth chapter, which examines its integration into the digital transformation of higher education. Drawing on both theoretical frameworks and empirical data from Lviv Polytechnic National University, the authors analyze how AI can be harnessed to personalize learning, optimize assessment, and support instructors while simultaneously addressing ethical challenges and ensuring equitable access. The models, presented in this chapter, highlight AI literacy as a critical competence for both students and educators in technical universities.

The final chapter provides a philosophical and methodological perspective on vocational psychological and pedagogical training in technology and design. It emphasizes human-centered values, ethical responsibility, and the imperative of nation-building in conditions of war and reconstruction. By situating education within a value-oriented framework, this contribution reinforces the idea that professional training must not only deliver technical expertise but also form reflective, responsible, and socially engaged individuals.

Taken together, the chapters illustrate how professional education can be transformed through the purposeful integration of technology and innovation. The monograph demonstrates that competence-oriented learning, when grounded in digital tools and human-centered values, is the key to preparing specialists who are adaptable, creative, and capable of leading in global and national contexts. It offers a roadmap for aligning Ukrainian higher education with international standards, while simultaneously responding to local challenges of resilience, workforce shortages, and socio-economic transformation.

The volume is intended for researchers, educators, postgraduate and doctoral students, and policymakers who are engaged in the modernization of professional education. It may also serve as a reference for practitioners in fields, such as information technology, forensic science, and cybersecurity, providing insights into effective training models and innovative pedagogical practices. Ultimately, this monograph positions professional education not as a static system but as a dynamic process of transformation – driven by new technologies, guided by human values, and oriented toward building a resilient and competitive society.

CIRCLE OF READERS AND SCOPE OF APPLICATION

The monograph is intended for researchers, educators, postgraduate and doctoral students, and policymakers who are engaged in the modernization of professional education. It may also serve as a reference for practitioners in fields, such as information technology, forensic science, and cybersecurity, providing insights into effective training models and innovative pedagogical practices. Ultimately, this monograph presents professional education not as a static system but as a dynamic process of transformation, driven by new technologies, guided by human values, and aimed at building a resilient and competitive society.

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INTRODUCTION

The 21st century has made the technological dimension a primary driver of educational change. Professional education is no longer defined solely by the transfer of domain knowledge; it is increasingly measured by the ability of institutions to cultivate technology-enabled competencies that ensure graduates' effectiveness in complex, data-rich, and multicultural environments. For Ukraine, pursuing accelerated European integration while simultaneously rebuilding national capacity, this shift is not optional. It is strategic. The central idea of this monograph is therefore clear: cutting-edge technologies must be purposefully embedded in professional training to connect theory with authentic practice, raise the quality of human capital, and align higher education with principles of human-centricity, resilience, and sustainability.

This unifying perspective reframes curriculum design around competence-oriented learning, where technologies are not supplementary but transformative. Digital platforms, cyber ranges, AI-assisted learning environments, data-driven assessment, and simulation act as catalysts of key educational shifts. They move learning from content recall to applied performance in authentic tasks, shift training from individual to collaborative formats that mirror real workplaces, and extend education beyond the classroom through continuous feedback, analytics, and blended delivery. The resulting ecosystem is one, in which technologies amplify, rather than replace, the human factors of professionalism: judgment, ethics, intercultural awareness, communication, and the capacity for lifelong learning.

Against this backdrop, the formation of intercultural communicative competence emerges as a fundamental condition for technology-intensive fields. Globalized software development, distributed engineering, and digital entrepreneurship all demand graduates who can coordinate across cultures with clarity and empathy. Effective participation in international teams depends on communication that is not only technically precise but also culturally aware, avoiding misunderstandings and fostering collaboration.

Equally important is the harmonization of specialized training with international standards in areas where technology, law, and public trust intersect. The growing role of digital forensics, artificial intelligence, and big data analytics in professional practice requires programs to bridge the gap between theoretical foundations and real-world applications. Without curricular modernization, technological modernity only widens the competence gap. Program coherence, authentic practicum, and continuous upskilling become indispensable conditions for quality training.

Another dimension of technological transformation lies in practice-based digital environments, where students engage in realistic simulations that train both technical mastery and social responsibility. Cybersecurity education provides an illustrative example: cyber polygons allow learners to model attack and defense scenarios, develop incident response skills, and coordinate in high-stakes situations. Such platforms show how technologies themselves can become the curriculum, enabling safe experimentation and professional growth.

At the same time, innovation is not limited to tools; it is equally a matter of mindset and method. Professional education must foster openness to change, curiosity, cognitive flexibility, and reflective practice – qualities that make technological learning sustainable over time. Without cultivated receptivity to the new, even the most advanced technological initiatives remain fragile and short-lived.

Artificial intelligence brings many of these issues into sharp focus. It functions simultaneously as an object of study, as a learning tool, and as an organizational enabler of transformation. Intelligent systems personalize learning, optimize assessment, and automate processes, but they also pose challenges related to ethics, access, and the digital readiness of instructors. Embedding AI into education requires clear strategies, scaffolded literacy, and governance frameworks that ensure equitable and responsible use.

Finally, professional education must remain grounded in values. In times of uncertainty, war, and reconstruction, the human dimension of education is decisive. Training must protect dignity, cultivate agency, and foster resilience. Technology should be viewed not as an end but as a means of forming reflective, ethical, and competent professionals capable of serving both the economy and society.

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CHAPTER 1

ADVANCING INTERCULTURAL COMMUNICATIVE COMPETENCE IN FUTURE SPECIALISTS IN IT AND COMPUTER SCIENCE: DEVELOPMENT AND IMPLEMENTATION OF THE "NAVIGATING CULTURAL DIVERSITY" COURSE PROJECT

ABSTRACT

This chapter examines the critical importance of advancing intercultural communicative competence (ICC) among future specialists in IT and computer science, addressing the challenges posed by increasing globalization and Ukraine's integration into the European economic and cultural landscape. Intercultural communicative competence is conceptualized as a dynamic interplay of knowledge, skills, attitudes, and behaviors that enable effective, respectful communication and collaboration across diverse cultural settings. It represents a fundamental prerequisite for professionals engaged in international teams, navigating cross-cultural business environments, and contributing to the global digital economy.

The relevance of ICC for Ukrainian students, particularly in technical fields, is underscored by the context of Ukraine's integration into the European Union and the demands of the multicultural workplace. A comprehensive needs analysis conducted with 136 1st- and 2nd-year students from Lviv Polytechnic National University revealed significant gaps in their confidence and preparedness for cross-cultural communication, thereby highlighting the necessity for targeted educational interventions.

In response to these findings, the course "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" was developed to address these specific gaps. This innovative program combines theoretical foundations with practical applications, aiming to enhance students' cultural awareness, multilingual capabilities, and intercultural communication skills. The curriculum features lectures, workshops, educational quests, and round-table discussions, employing interactive and experiential learning methodologies. Practical components such as case studies, role-playing exercises, and simulations equip students to effectively manage real-world multicultural scenarios.

Preliminary outcomes indicate measurable improvements in students' cultural sensitivity, adaptability, and confidence in professional intercultural communication. By bridging the divide between technical expertise and intercultural competence, the course provides students with essential tools for thriving in international teams and collaborative projects.

This chapter concludes by emphasizing the imperative of embedding ICC into higher education curricula, particularly for technical disciplines such as IT and computer science. It advocates for ongoing refinement and broader implementation of such courses to align with the evolving demands of the global economy.

KEYWORDS

Intercultural communicative competence, cultural diversity, cross-cultural communication, cultural awareness, English for Specific Purposes, professional adaptability, multilingualism, global workforce, curriculum development.

The integration of Ukraine into the European Union and the broader processes of globalization have highlighted the necessity of preparing future specialists, particularly in IT and computer science, for effective communication within the multicultural European economic landscape. As Ukraine strives for greater international integration and its students seek to become competitive in the global labor market, enhancing intercultural communicative competence (ICC) has become an essential part of their education. This competence is critical not only in mastering technical and professional knowledge but also in the ability to interact effectively with peers, colleagues, and clients from diverse cultural backgrounds. The development of this competence has thus become a key priority in higher education, especially for future specialists in IT and computer science, who will be increasingly called upon to work in international teams and deal with cross-cultural challenges.

Globalization has transformed the nature of communication, making intercultural interactions indispensable in professional settings. The rise of international business relations, coupled with the increased mobility of professionals across borders, requires specialists not only to be linguistically competent but also culturally aware. Intercultural communication studies emphasize the importance of understanding cultural differences and the strategies needed to bridge gaps between individuals from diverse cultural backgrounds. In this context, effective communication is no longer solely about fluency in a foreign language but also about the ability to navigate cultural nuances, avoid misunderstandings, and foster mutually beneficial relationships.

1.1 THE RELEVANCE OF RESEARCH ON ADVANCING INTERCULTURAL COMMUNICATIVE COMPETENCE AND THE DEVELOPMENT OF THE "NAVIGATING CULTURAL DIVERSITY" COURSE

The growing need for intercultural communicative competence in the global workplace underscores the importance of integrating such skills into the curriculum of higher education institutions, particularly for students in fields like IT and computer science. Traditionally, education in

these fields has been focused on technical expertise, with little emphasis on the development of soft skills such as communication. However, as the global job market becomes more interconnected, the ability to communicate effectively in multicultural environments has become just as crucial as technical skills.

The research has shown that students in non-linguistic fields, including those at Lviv Polytechnic National University (LPNU), face a significant gap in their ability to interact with colleagues from diverse cultural backgrounds. A survey of 136 students across disciplines such as computer science, engineering, and economics revealed that 87% of respondents felt uncomfortable communicating with colleagues from different cultural contexts.

This gap in intercultural communicative competence highlights the urgent need for specialized courses, such as the "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course, which the authors of this article have developed specifically to address these needs and equip students with the necessary intercultural communication skills.

The significance of such courses lies in their ability to equip students with the knowledge, skills, and attitudes necessary for successful intercultural communication. This is particularly relevant in the context of English for Specific Purposes (ESP) courses, where the focus has traditionally been on language proficiency in specific professional contexts. While ESP courses for IT and computer science students have focused primarily on technical language skills, they must evolve to include intercultural communication strategies. As Byram suggests, learners must not only understand a foreign culture from an external perspective but also experience it from within [1]. This holistic approach enables students to develop the necessary cultural awareness to interact effectively in a globalized work environment.

The course "Navigating Cultural Diversity" aims to address this need by providing students with the tools to understand cultural differences, adapt their communication styles, and build stronger professional relationships in the European and global economic landscape. By integrating intercultural communication into ESP instruction, the course not only enhances language proficiency but also prepares students to succeed in an increasingly multicultural and interconnected job market. This project represents a crucial step in enhancing the professional competencies of future specialists in IT and computer science, ensuring that they are not only technically proficient but also culturally adept in their professional interactions.

Therefore, the integration of intercultural communicative competence into the education of future specialists in IT and computer science is no longer optional but a necessity. As the professional world becomes more globalized and interconnected, the ability to navigate cultural diversity is a critical skill.

By developing and implementing specialized courses like "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape", we can ensure that students are not only equipped with the technical skills needed for success but also the cultural awareness required to thrive in a diverse, international environment.

1.2 LITERATURE REVIEW AND DEFINITIONS OF KEY CONCEPTS

A primary objective of national education reform is the adoption of a competence-based approach and the cultivation of professional foreign language communicative competence (PFLCC) in the training of higher education professionals. Achieving this objective and its associated tasks necessitates multidisciplinary integration and the active involvement of employers. Employers can work collaboratively with universities to define explicit criteria for educational outcomes, ensuring that graduates are well-equipped for the professional arena.

Foreign language communicative competence (FLCC) enables enhanced interaction, professional communication, and collaboration at various levels with specialists from different countries. This exchange of experiences fosters professional and scientific self-development and self-realization, particularly in the context of globalization and especially within the business sector.

We posit that the role of a foreign language as a tool for developing future specialists' professional communication competence can be effectively harnessed at higher education institutions. This can be accomplished through the institution's oversight of the entire educational process, curriculum content, and a clear professional focus. Additionally, the methods for delivering this information, types of teacher-student interactions, and student engagement in the educational process are critical. Concurrently, attaining a long-term strategic goal, such as a specialist's professional advancement, is facilitated by achieving short-term tactical goals, such as mastering a foreign language.

The scholarly exploration of intercultural communication began with the publication of E. Hall and G. Trager's book "The Analysis of Culture" in 1953, marking the onset of this field as an academic discipline [2]. E. Hall and G. Trager were the first to introduce the term "intercultural communication", framing it as a distinct area of interpersonal relationships. This concept was further developed in E. Hall's influential work "The Silent Language", where he provided a comprehensive definition of intercultural communication [3]. Hall and his colleagues at the Foreign Service Institute in the early 1950s are widely regarded as the pioneers of intercultural communication, establishing the foundational framework for this area of study. Hall emphasized the challenges in intercultural communication, pointing out that "difficulties in intercultural communication are rarely seen for what they are". He suggested that when individuals from different cultures fail to understand one another, they tend to blame it on "those foreigners" or attribute it to incompetence, deception, or irrationality. He encouraged readers to "take seriously the cultures of others" in order to better understand themselves and their own cultural biases [3].

In 1990, K. Knapp and A. Knapp-Potthoff defined intercultural competence as a "complex of analytical and strategic abilities that expand the interpretative spectrum of an individual in the process of interpersonal interaction with representatives of other cultures" [4]. This notion underscores the importance of developing a multifaceted skill set that enhances an individual's capacity to engage effectively with people from different cultural backgrounds. C. Sinicrope, J. Norris, and Yu. Watanabe further emphasized that intercultural competence enables individuals to engage in effective communication with interlocutors from other cultures [5].

M. Bennett expanded on this concept by exploring the internal progression of students as they move from ethnocentrism to ethnorelativism, which represents a shift from viewing other cultures through the lens of one's own to a more open and comparative approach to understanding diverse cultural contexts. Such shifts are crucial for developing intercultural competence, as they enable individuals to recognize and appreciate cultural differences [6].

Researchers such as N. Vovchasta, I. Kozlovska, M. Opachko, M. Paikush, and O. Stechkevych argue that the training of competent specialists should be based on an activity approach. This approach involves simulating real-world functional tasks and professional scenarios, allowing students to apply their knowledge and experience in context. According to these scholars, competence is not merely theoretical knowledge but the ability to apply that knowledge effectively in various situations [7].

The concept of intercultural communication has been further explored by scholars such as T. Antroshchenko and D. Kovrei [8], Z. Bakum, O. Palchykova and S. Kostiuk [9], L. Maksymchuk [10], who focus on the challenges of communication between different cultural groups. O. Nezhiva highlights that intercultural communication occurs when individuals interact in contexts that differ significantly from their own cultural norms, emphasizing its importance in determining the success or failure of a communication event [11]. As O. Nezhiva suggests, the primary objective of intercultural communication is the development of both intercultural and communicative competencies, essential for bridging cultural divides in professional settings [11].

One of the most influential models of intercultural communicative competence comes from M. Byram and M. Wagner, who proposed a multidimensional framework that integrates knowledge, values, and skills as key components of effective intercultural interaction [12]. According to M. Byram, the five essential components of intercultural communicative competence are:

1. **Attitudes**: for example, curiosity and open-mindedness towards other cultures.

2. **Knowledge**: understanding social groups, historical backgrounds, and contextual knowledge related to communication.

3. **Skills of interpreting and relating**: the ability to understand and interpret documents and symbols from other cultures.

4. **Skills of discovering and interacting**: the capacity to acquire new knowledge about other cultures and adapt accordingly.

5. **Critical cultural awareness**: the ability to critically assess one's own and foreign cultures, understanding their influence on communication practices [1, 12].

According to B. McSweeney, researchers such as A. Trompenaars, G. Hofstede, and T. Hall further explored the structure of culture, differentiating between visible, external aspects such as language, rituals, and traditions, and the hidden dimensions of culture, which include values, norms, and life attitudes. Intercultural communication, they argue, involves the exchange of messages guided by both visible and invisible cultural elements [13].

O. Topchiy discusses the linguistic code as a crucial component of culture, noting its role in shaping a person's worldview and mentality. O. Topchiy also highlights the importance of

understanding cultural typologies to prevent misunderstandings during communication. For instance, low-context communication, common in English-speaking nations, focuses on the explicitness of language, while high-context communication, prevalent in Eastern Europe, Asia, and the East, places a greater emphasis on emotionality and collective awareness [14].

O. Topchiy also identifies five models of intercultural communication in the process of cultural inculturation: **integration**, **assimilation**, **separatism**, and **marginalization**. These models describe the ways in which individuals or groups interact with and adapt to different cultures, ranging from full assimilation to the rejection of cultural exchange [14].

T. Branitska argues that intercultural competence is crucial for enhancing professional competitiveness, harmonizing relationships between different cultural groups, and fostering social cohesion in multicultural environments. She identifies three key components of intercultural competence: **value-cognitive**, **motivational**, and **action** components [15]. This perspective aligns with the broader view that intercultural competence is a complex process involving knowledge, skills, and attitudes.

According to O.-A. Illie (2019), intercultural competence is built through knowledge of cultural values and norms, as well as skills in observing, analyzing, and interpreting behaviors and attitudes in intercultural contexts. Attitudes such as respect, openness, and curiosity are essential to navigating intercultural interactions effectively [16]. This holistic approach to competence emphasizes the need for individuals to not only understand different cultures but also to engage with them empathetically and constructively.

M. Byram's approach to foreign language learning reinforces this idea, arguing that learning a language is not just about mastering grammar and vocabulary but also about understanding and integrating cultural knowledge. He suggests that students must learn to live and work in two cultures, acting as mediators between them and utilizing the intercultural skills they develop [12].

In the context of professional training for future specialists in fields like IT and computer science, intercultural communicative competence is essential for success in the global workforce. It is a quality formed through education, socialization, and direct communication with people from other cultures. Competence in intercultural communication enables individuals to recognize and adapt to cultural differences, avoid misunderstandings, and build effective communication strategies in diverse professional environments.

Finally, in the domain of "English for Specific Purposes" (ESP), the importance of intercultural communicative competence is increasingly recognized. ESP courses, particularly those related to IT and computer science, focus on equipping students with the language skills necessary for professional success in their respective fields. T. Hutchinson et al. define ESP as an approach to language teaching that is directly tied to the learners' specific goals, emphasizing practical language skills over general language proficiency [17].

However, as T. Dudley-Evans points out, ESP also requires a nuanced understanding of the cultural and communicative contexts in which the language will be used [18]. This recognition has led to the integration of intercultural communicative competence into ESP curricula, particularly

in courses like "Navigating Cultural Diversity", which aim to prepare students for the multicultural demands of the global job market.

In conclusion, we assert that intercultural communicative competence is an essential and multifaceted skill set, vital not only for professionals across various fields but especially for those specializing in IT and computer science. In my view, it involves more than just an understanding of cultural differences – it requires the ability to communicate effectively across cultural boundaries. This skill is indispensable for future specialists who aim to succeed in the globalized, multicultural professional landscape that characterizes today's interconnected world.

As part of this research, the study draws on the work of O. Nagachevska, and B. Kushka, titled "Intercultural Communication and Intercultural Communicative Competence of Undergraduates Learning Business English" [19]. Their findings were instrumental in shaping the curriculum for the course "Navigating Cultural Diversity", ensuring that it not only addresses language proficiency in a professional environment but also fosters the development of intercultural communicative competence among students. This inclusion of intercultural communication elements is key to equipping students with the necessary competencies to navigate cultural differences in their future professional careers.

The development of intercultural communicative competence for students in IT and computer science is, in my opinion, a critical aspect of their preparation for the global workforce. Scholars like M. Byram, T. Hall, and M. Bennett have consistently highlighted that intercultural competence includes not only the knowledge and skills needed to navigate cultural differences but also the attitudes and behaviors that facilitate effective cross-cultural communication. It is the ability to understand, adapt to, and engage with cultural nuances that makes this competence particularly important for IT and computer science professionals. Therefore, we believe that fostering such skills is essential for students in these fields to thrive in international settings, where respect for diverse perspectives and effective communication strategies are paramount.

The course "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" directly addresses this need by equipping students with the necessary skills and knowledge to communicate competently in multicultural European business environments. In my perspective, the course's dual focus on both theoretical understanding and practical application within the context of IT and computer science creates a comprehensive framework for developing students' intercultural competence. This aligns with broader educational objectives, particularly the aim of fostering responsible, ethical global citizens who can effectively navigate the cultural complexities of the European Union and beyond.

We believe that this course goes beyond the traditional scope of English for Specific Purposes (ESP) courses, which typically focus on language proficiency. By integrating essential elements of intercultural communication, the course offers a more holistic approach to preparing students for the demands of today's global economy. It helps students understand European values, communication styles, and cultural differences, which in turn shapes their business practices. For future IT and computer science professionals, this preparation is indispensable. As these professionals

increasingly work in international teams, collaborate with colleagues from diverse cultural backgrounds, and engage with clients and partners from various cultural contexts, the ability to communicate across cultures becomes crucial for their success.

Through this project, we aim to bridge the gap between technical expertise and cultural competence. My goal is to ensure that future specialists in IT and computer science are not only proficient in their technical fields but are also equipped with the intercultural communication skills necessary for success in the multicultural and interconnected European economic landscape. This course is designed to enhance students' critical thinking, empathy, and adaptability – key qualities that will empower them to navigate the challenges of cross-cultural communication and contribute meaningfully to the global digital economy.

1.3 OBJECTIVES AND FOCUS OF THE RESEARCH

The primary goal of this research is to explore the critical role of advancing intercultural communicative competence (ICC) in future specialists in IT and computer science. Specifically, the research investigates the process by which undergraduates acquire intercultural communicative competence and the constituent skills required for effective professional activity in globalized environments. A central focus is placed on the development and implementation of the course "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape", designed to meet the growing demand for intercultural communication skills in the European job market.

The subject matter of this study is the integration of intercultural communication into the curriculum for IT and computer science students, particularly through ESP (English for Specific Purposes) courses. These courses are intended to equip students with the skills necessary to communicate effectively in diverse European business environments, emphasizing the importance of intercultural sensitivity and understanding.

The research involves both theoretical and methodological components of designing and implementing a course that incorporates intercultural communication into the context of IT and computer science education.

The objectives of the "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course are as follows:

1. General objectives:

– to empower students to bridge cultural divides and communicate effectively in diverse European business settings;

– to cultivate a profound understanding of core European values, emphasizing respect for cultural nuances, tolerance, and ethical conduct;

– to prepare students for thriving careers in the globalized European economy, where intercultural communication is a pivotal skill.

2. Specific objectives:

– to expand LPNU students' awareness of cultural distinctions relevant to European business communication;

– to nurture students' critical thinking abilities by analyzing diverse perspectives and communication styles;

– to elevate students' understanding of how cultural values shape business practices and ethical considerations;

– to foster students' intercultural sensitivity and cultivate empathy for various cultural backgrounds;

– to promote tolerance and respect for cultural diversity within the professional environment;

– to inspire students to become responsible and ethical global citizens;

– to refine students' ability to adapt their communication style to different audiences and situations;

– to equip students with impactful verbal and nonverbal communication skills for cross-cultural interactions.

3. Assessment objectives:

– to evaluate students' grasp of key concepts in intercultural communication and European values;

– to analyze students' ability to discern and interpret cultural nuances in communication;

– to measure students' progress in developing effective cross-cultural communication skills;

– to assess the course's impact on students' attitudes towards cultural diversity and ethical business practices.

4. Dissemination objectives:

– to disseminate the knowledge and best practices acquired in the course to the broader academic community and business professionals;

– to heighten awareness of the critical role of intercultural communication in the European economic landscape;

– to showcase the Erasmus+ program's impact on international education and understanding.

The project of the course "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" is designed as a comprehensive initiative to foster multicultural business communication skills among Ukrainian students and graduates, particularly those pursuing technical, computer science, and engineering specialties at Lviv Polytechnic National University. This project extends its scope beyond academia, targeting high school students, teachers, and professionals from various sectors, including enterprises, organizations, civil society, and the general public.

Spanning one year, the course offers 180 hours of instruction over three years, with students from diverse academic backgrounds, including IT, computer science, and engineering, participating in specialized modules. The flagship course provides participants with essential skills to navigate the cultural intricacies of the European Union, emphasizing the importance of intercultural communication for successful business interactions in the European economic landscape.

The anticipated outcomes of this research and course project include the publication of two scientific articles, the development of a comprehensive textbook, and the organization of three research events and six activities. This initiative, EuCDBizCom, aims to bridge the gap between European values and the multicultural business communication skills essential for Ukrainian professionals seeking career opportunities in the European job market or aiming to collaborate with EU companies. EuCDBizCom aspires to shape a generation of professionals ready to thrive in the diverse and dynamic European economic landscape through a strategic blend of academic instruction, research initiatives, and public engagement.

This research, alongside the development and implementation of the "Navigating Cultural Diversity" course, is crucial in preparing future IT and computer science professionals to succeed in the globalized and multicultural business environment that defines today's European economy.

1.4 "NAVIGATING CULTURAL DIVERSITY": DEVELOPMENT AND IMPLEMENTATION OF THE COURSE FOR ADVANCING INTERCULTURAL COMMUNICATIVE COMPETENCE IN IT AND COMPUTER SCIENCE STUDENTS

1.4.1 THE COURSE DEVELOPMENT: BACKGROUND AND RATIONALE

The rationale for creating the course "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" is rooted in the evolving demands of the global economy and the pressing need to prepare students at Lviv Polytechnic National University (LPNU) for professional activity in multicultural environments. With increasing integration into the European economic and cultural landscape, Ukrainian professionals must possess advanced intercultural communicative competence to remain competitive in the international labor market.

To assess the current level of intercultural competence among LPNU students and identify specific needs for course development, a comprehensive survey was conducted. This survey targeted 1st- and 2nd-year students from computer science, engineering, and economic specialties. Involving 136 students, the survey aimed to evaluate their confidence in cross-cultural communication, familiarity with European cultures, and understanding of multicultural communication nuances in professional settings.

The results revealed critical gaps in students' intercultural communication skills. Notably, 87% of respondents reported a lack of confidence in communicating with colleagues or peers from different cultural backgrounds. Similarly, many students demonstrated limited familiarity with European cultural norms and values, further underscoring the need for targeted educational initiatives. However, the survey also highlighted a strong interest in acquiring these competencies, with 86% of students expressing enthusiasm for a course designed to enhance their cross-cultural communication abilities. **Table 1.1** summarizes the survey questions, while **Table 1.2** outlines the key results and their implications.

● **Table 1.1** The survey questions

Section	Question	Options
1	**2**	**3**
Demographic information	1. Academic year:	[ ] 1st year [ ] 2nd year
	2. Field of study:	[ ] Computer Science [ ] Engineering [ ] Economics [ ] Other (please specify): _____
Part 1: Confidence in cross-cultural communication	3. How confident do you feel when interacting with colleagues or peers from different cultural backgrounds?	[ ] Very confident [ ] Somewhat confident [ ] Neutral [ ] Somewhat unconfident [ ] Very unconfident
	4. Have you ever participated in a multicultural team or project?	[ ] Yes [ ] No
	5. How comfortable are you with the following types of intercultural interactions? (Rate each on a scale from 1 = not comfortable to 5 = very comfortable)	Communicating in English with colleagues from different cultures [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 Understanding different cultural norms in professional settings [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 Adapting your communication style to different cultural contexts [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
Part 2: Familiarity with European cultures	6. How familiar are you with the cultures of European countries, especially in terms of business communication practices?	[ ] Very familiar [ ] Somewhat familiar [ ] Neutral [ ] Somewhat unfamiliar [ ] Not familiar at all
	7. Do you think understanding European cultural norms is important for your future career?	[ ] Yes, very important [ ] Yes, somewhat important [ ] Neutral [ ] No, not important

● **Continuation of Table 1.1**

1	2	3
	8. What aspects of European cultures would you like to learn more about? (Select all that apply)	[ ] Business etiquette and practices [ ] Social and cultural values [ ] Communication styles [ ] Ethical considerations in business [ ] Other (please specify): _____
Part 4: Interest in a course on intercultural communication	11. Would you be interested in taking a course that focuses on intercultural communication, particularly in the context of business in Europe?	[ ] Yes [ ] No [ ] Maybe
	12. What specific topics would you like to be covered in such a course? (Select all that apply)	[ ] Understanding European cultural values and communication styles [ ] Developing skills for effective communication in international teams [ ] Strategies for overcoming language barriers in business [ ] Ethical considerations in global business practices [ ] Case studies of successful cross-cultural business interactions [ ] Other (please specify): _____
	13. How would you prefer the course to be delivered?	[ ] Online lectures and resources [ ] In-person seminars and workshops [ ] A combination of online and in-person formats [ ] Other (please specify): _____
Part 5: Additional comments	14. Do you have any additional comments or suggestions regarding the development of this course?	_____ _____ _____

● **Table 1.2** Survey results for "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course

Course Survey Question	Result Summary	Implications for Course Development
1	2	3
1. Academic year	The majority of respondents were 1st-year students (62%), followed by 2nd-year students (38%)	Focus on introducing intercultural communication concepts early in the curriculum to build foundational skills for students in their initial years of study

Continuation of Table 1.2

1	2	3
2. Field of study	Respondents were primarily from computer science (50%), engineering (30%), and economics (20%)	Tailor the course to meet the specific needs of IT and engineering students, emphasizing their potential roles in multicultural teams and global projects
3. How confident do you feel when interacting with colleagues or peers from different cultural backgrounds?	87% of students expressed a lack of confidence in communicating with individuals from different cultural backgrounds	Focus on building students' confidence in cross-cultural communication through practical exercises and simulations. Emphasize real-life scenarios and encourage active participation in multicultural group projects
4. Have you ever participated in a multicultural team or project?	42% of students have had experience in multicultural teams or projects	Incorporate case studies, role-playing, and team-based activities that simulate multicultural collaboration to prepare students for the realities of international teams
5. How comfortable are you with the following types of intercultural interactions?	Communication in English: 55% of students rated themselves between «neutral» and «somewhat unconfident» in communicating in English with colleagues from different cultures	Prioritize improving English communication skills in multicultural contexts. Include training on English for Specific Purposes (ESP) related to intercultural business communication, emphasizing clarity and cultural context in language
6. How familiar are you with the cultures of European countries, especially in terms of business communication practices?	58% of students reported being only somewhat familiar or unfamiliar with European business communication practices	Introduce dedicated modules on European cultural values, business etiquette, and communication styles, focusing on key European countries and their business cultures
7. Do you think understanding European cultural norms is important for your future career?	91% of students acknowledged that understanding European cultural norms is crucial for their future careers	Reinforce the importance of cultural awareness in the course by emphasizing European business norms, ethics, and the importance of cultural sensitivity in global business environments
8. What aspects of European cultures would you like to learn more about?	Top preferences: business etiquette and practices (74%), communication styles (70%), and ethical considerations in business (68%)	Prioritize these topics in the course structure. Create modules focused on European cultural values, team communication in international settings, and strategies to overcome language barriers in business contexts
9. In your opinion, what are the main challenges of communicating in a multicultural professional environment?	Key challenges identified: language barriers (67%), misunderstandings due to cultural differences (61%), and lack of cultural awareness (54%)	Address these challenges in the course by including strategies for overcoming language barriers, understanding cultural nuances, and adapting communication styles. Use authentic materials to demonstrate real-world challenges

● **Continuation of Table 1.2**

1	2	3
10. Do you believe that acquiring intercultural communication skills will help you in your future career?	98% of students agreed that intercultural communication skills are essential for their careers	Ensure the course content is directly aligned with students' career goals by focusing on skills that help them navigate multicultural professional environments. Provide examples of successful cross-cultural business interactions
11. Would you be interested in taking a course that focuses on intercultural communication, particularly in the context of business in Europe?	86% of students expressed interest in taking a course focused on intercultural communication in European business contexts	The high level of interest supports the need for the course. Emphasize practical and culturally relevant content, such as European business practices, cross-cultural negotiation, and communication in professional settings
12. What specific topics would you like to be covered in such a course?	Top preferences: understanding European cultural values and communication styles (74%), developing communication skills in international teams (70%), and overcoming language barriers (68%)	Prioritize these topics in the course structure. Create modules focused on European cultural values, team communication in international settings, and strategies to overcome language barriers in business contexts
13. How would you prefer the course to be delivered?	52% of students preferred a combination of online and in-person formats, while 38% preferred in-person seminars and workshops	Adopt a blended learning approach that combines online lectures with interactive in-person seminars and workshops. This hybrid model will cater to different learning preferences and maximize engagement
14. Do you have any additional comments or suggestions regarding the development of this course?	Many students emphasized the need for practical case studies and real-world examples, as well as opportunities for role-playing and live discussions	Integrate hands-on activities such as case studies, simulations, and real-world problem-solving exercises into the course. Highlight real business scenarios to enhance engagement and relevance

Key takeaways for course improvement

The survey results underscore the pressing need for a targeted course that bridges gaps in students' intercultural communicative competence. The findings highlight the importance of focusing on practical skills, cultural awareness, and confidence-building strategies to prepare students for professional interactions in a multicultural and interconnected global economy.

To address these needs, the course should:

– build foundational intercultural communication skills early in students' academic journeys, particularly for 1st- and 2nd-year students;

– tailor content to the specific needs of computer science and engineering students, emphasizing real-world applications of intercultural competence in international teams and projects;

– prioritize practical and hands-on learning, including simulations, role-playing, and case studies to develop communication confidence;

– include modules on European cultural values, business etiquette, and strategies for overcoming language barriers, as these were identified as critical areas for student improvement;

– adopt a blended learning approach, combining online flexibility with in-person workshops for active engagement and skill-building.

These insights provided a clear roadmap for enhancing the "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course, ensuring that it could equip students with the essential skills to excel in their professional and intercultural endeavors. Accordingly, we have designed the course to address specific gaps in intercultural communication competence while aligning with students' career aspirations in both European and global professional contexts.

1.4.2 COURSE OBJECTIVES AND IMPLEMENTATION

The course "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" has been designed specifically to enhance the intercultural communicative competence of LPNU students in computer science and related fields. Its primary goal is to prepare students for professional collaboration in diverse, multicultural settings and to equip them with the skills necessary to thrive in the globalized European economic landscape.

General objectives:

– empower students to bridge cultural divides and communicate effectively in diverse European business environments;

– cultivate an understanding of European values, emphasizing respect for cultural nuances, tolerance, and ethical conduct;

– prepare students for careers in the globalized economy, where intercultural communication is essential.

Specific objectives:

– increase students' awareness of cultural distinctions relevant to European business communication;

– develop critical thinking skills by analyzing diverse perspectives and communication styles;

– foster empathy and intercultural sensitivity among students;

– equip students with verbal and nonverbal communication skills for cross-cultural interactions;

– train students to adapt their communication styles to various audiences and contexts.

Assessment objectives:

– evaluate students' progress in understanding and applying intercultural communication skills;

– measure students' improvement in recognizing and interpreting cultural nuances;

– assess the course's impact on students' attitudes toward cultural diversity and professional ethics.

Implementation approach: the course is structured to cater to the needs of students from non-linguistic faculties, particularly those specializing in IT and computer science. It includes:

– **interactive modules**: covering European cultural values, business etiquette, and strategies for effective communication in multicultural settings;

– **practical learning activities**: simulations, role-playing exercises, and case studies that reflect real-world scenarios;

– **comprehensive delivery**: a blended format combining online lectures, workshops, and in-person seminars for an engaging learning experience;

– **engagement beyond academia**: open lectures, workshops, and conferences involving representatives from public organizations and businesses.

Anticipated outcomes:

– improved confidence in cross-cultural communication, with a 25% increase measured through pre- and post-course assessments;

– enhanced knowledge of European cultural norms, targeting a 30% improvement based on quiz scores;

– greater application of European business communication standards, with a 20% increase in simulated scenario performance;

– increased critical thinking capabilities in multicultural business contexts, reflected in a 15% improvement in assessment scores.

As demonstrated by the needs analysis, this course is specifically designed to address identified gaps in intercultural communication skills, equipping LPNU students with the competencies needed to gain a competitive advantage in the international job market. By emphasizing critical thinking, empathy, and cultural awareness, the course not only prepares students for professional success but also enhances their capacity to collaborate effectively in multicultural environments.

1.4.3 CONCEPT AND METHODOLOGY OVERVIEW

The "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course is built on a carefully designed concept and methodology aimed at addressing the critical need for intercultural communication skills within the framework of sustainable European business practices. The course adopts a learner-centric approach that caters to the diverse academic and professional backgrounds of its participants. By interweaving effective communication, cultural understanding, and sustainability, it creates an inclusive and adaptable learning environment, empowering students to succeed in multicultural professional settings.

Learning hours and outcomes.

The program spans three years, offering a total of 300 teaching hours annually. This includes:

– 100 hours per year dedicated to lectures and practical classes for planned student groups from Lviv Polytechnic National University (LPNU);

– open lectures and seminars designed for participants from other educational institutions, businesses, and public organizations, promoting broader engagement and inclusivity.

The course structure encompasses 120 hours of instruction annually:

– 20 hours of lectures;

– 22 hours of practical classes;

– 78 hours of independent work, including research, assignments, and collaborative projects to foster a well-rounded educational experience.

Lectures, seminars, workshops, and training sessions are conducted by experienced associate professors from the Department of Foreign Languages at LPNU, including O. Nagachevska, M. Voloshyn, G. Kolesnyk, L. Myklash, O. Fuchyla, and V. Dmytruk. To enhance accessibility and flexibility, the course is offered through a "Virtual Educational Environment" (VEE) titled "Navigating European Cultural Diversity: Effective Business Communication in the European Economic Landscape".

Guiding principles of the methodology:

1. **Learner-centric approach**: recognizing the unique needs of students from non-linguistic faculties, the course tailors its curriculum to align with their specific academic and professional aspirations. Grounded in a comprehensive needs analysis, the curriculum bridges the gap between technical expertise and effective communication in multicultural business contexts.

2. **Adaptive curriculum design**: the dynamic nature of business communication is reflected in the course's design. Regular feedback loops and iterative evaluations ensure that the curriculum evolves in line with emerging trends and the needs of its participants, maintaining its relevance and educational impact.

3. **Integration of modern communication tools**: acknowledging the importance of digital proficiency, the course incorporates cutting-edge communication tools and platforms. This equips students with the skills to navigate both traditional and digital communication channels effectively, preparing them for the realities of modern professional environments.

4. **Multidisciplinary collaboration**: the course mirrors the collaborative nature of contemporary workplaces by fostering teamwork among students from diverse academic disciplines. Group projects and interdisciplinary tasks simulate real-world professional scenarios, enhancing adaptability and cross-disciplinary understanding.

5. **Sustainability integration**: sustainability is embedded as a core principle of the curriculum. By weaving ethical and sustainable practices into communication training, the course prepares students to navigate the global business landscape responsibly while contributing to a sustainable future.

Alignment with course objectives.

The methodology aligns closely with the overarching objectives of the course:

– **fostering multidisciplinary and sustainable skills**: ethical and sustainable principles are seamlessly integrated with communication training, ensuring that graduates are prepared to excel in the demanding European business environment;

– **enhancing understanding of European business practices**: through case studies, guest lectures, and simulations, the course provides practical insights into cultural nuances and communication strategies relevant to the European context;

– **boosting sustainable employability**: by equipping graduates with both technical and intercultural communication skills, the course enhances their career prospects within the sustainable European business landscape.

Flexibility and real-world application.

The methodology's inherent flexibility ensures its continued relevance in an ever-changing professional landscape. Regular updates to course content, combined with interactive workshops, industry talks, and networking opportunities, bridge the gap between theoretical knowledge and practical application. This dynamic approach enables students to acquire the skills and experience needed to thrive in real-world multicultural professional environments.

1.4.4 PROJECT MANAGEMENT, QUALITY ASSURANCE, AND MONITORING AND EVALUATION STRATEGY

The "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course is built upon a robust and adaptable framework designed to ensure timely implementation, adherence to high-quality standards, and comprehensive monitoring and evaluation. This approach guarantees the course's relevance, effectiveness, and alignment with its overarching objectives.

Project management:

1. Timely completion:

– a meticulously detailed project timeline has been developed, specifying clear deadlines and milestones for each phase of the course's implementation. This ensures that all activities remain on schedule;

– regular project management meetings are conducted to evaluate progress, anticipate potential challenges, and implement timely corrective measures, ensuring uninterrupted momentum throughout the project lifecycle.

2. Effective communication:

– clear and structured communication protocols have been established within the project team to facilitate seamless information exchange and alignment with project objectives;

– virtual meetings and collaborative platforms are leveraged as primary communication channels, fostering efficient collaboration and real-time knowledge sharing among team members.

Quality assurance:

1. Peer review mechanism:

– a rigorous peer review system is in place to evaluate all deliverables, including curriculum design, material development, and event organization. This ensures that high-quality standards are maintained across all aspects of the course;

– team members, drawing from their diverse areas of expertise, conduct systematic evaluations to uphold academic and professional rigor in the project's outcomes.

2. Continuous feedback loop:

– a feedback loop is integrated into the project, actively seeking input from stakeholders such as students, professors, and external collaborators;

– this iterative process ensures that stakeholder perspectives are incorporated into the course's ongoing development, enhancing its relevance and impact.

Monitoring and evaluation:

1. Quantitative indicators. Key metrics to measure outreach and participation include:

– number of participants in workshops, seminars, and training sessions;

– engagement on digital platforms, including website visits and social media interactions;

– participation rates in networking events and industry talks.

2. Qualitative indicators. Nuanced insights into the project's impact are captured using qualitative measures, such as:

– participant feedback on the relevance and applicability of course content;

– testimonials and success stories that highlight the real-world application of acquired skills;

– expert evaluations of the innovation and effectiveness of the course's approach.

3. Units of measurement, baselines, and target values. Each indicator is paired with specific units of measurement, baseline values established at project initiation, and target values to track progress.

Example:

– **unit of measurement**: number of participants in workshops;

– **baseline value**: 0 participants at project start;

– **target value**: 60 participants by the end of year 1.

4. Regular evaluation cycles:

– comprehensive evaluation cycles are embedded in the project timeline, conducted at the end of each academic year;

– these evaluations assess the effectiveness of teaching modules, the success of events, and their impact on participants' skills and employability. The findings directly inform improvements to the course.

5. Adaptability and continuous improvement:

– the monitoring and evaluation strategy is designed to be flexible, enabling responsiveness to evolving needs while maintaining consistent quality;

– insights derived from evaluations guide continuous improvement efforts, ensuring that the course evolves to meet the demands of students and stakeholders effectively.

Risk management.

To ensure the successful implementation and long-term sustainability of the "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course, it is essential to identify and address potential risks that may arise during the project lifecycle. Risk management serves as a proactive approach to anticipating challenges and devising strategies to mitigate their impact, thereby safeguarding the quality and effectiveness of the course.

The **Table 1.3** provides a comprehensive overview of the possible risks associated with the course, categorizing them by work packages and assessing their impact and likelihood. In addition, the proposed mitigation measures demonstrate a flexible and adaptive strategy designed to maintain the project's momentum and relevance, ensuring it meets the expectations of students, faculty, and stakeholders alike.

Table 1.3 Overview of the possible risks associated with the course

Risk No.	Description	Work package No.	Impact	Likelihood	Proposed risk-mitigation measures
1	Unforeseen external events (e.g., pandemics, geopolitical issues)	All work packages	High	Medium	Regularly monitor global and regional situations for early detection
2	Technical challenges in digital integration, such as software compatibility issues or platform accessibility	Work package #2 and #3	High	Medium	Conduct regular technology checks and invest in reliable platforms
3	Delays in research activities that could impact the timeline and project milestones	Work package #4	High	Medium	Develop a detailed research plan with clear milestones and deadlines
4	Budget constraints that may affect the execution of planned activities	Work package #5	High	Medium	Regularly monitor the budget and expenses
5	Limited participation from non-linguistic faculties, such as IT and computer science students	Work package #3 and #4	Medium	Low	Launch targeted awareness campaigns to emphasize the relevance of the course for non-linguistic faculties
6	Limited participation in public events or networking activities	Work package #4	Low	Medium	Implement promotional campaigns to generate interest
7	Deliverables not meeting quality expectations (e.g., curriculum design, materials, assessments)	All work package	High	Low	Implement a rigorous peer review process for all project outputs
8	Difficulty in maintaining course relevance as professional and cultural landscapes evolve	Work package #3 and #4	Medium	Medium	Regularly update course content to reflect changing trends
9	Negative feedback from students or stakeholders, impacting the course's reputation	Work package #4	Medium	Low	Actively collect participant feedback through surveys and evaluations
10	Limited digital literacy among some participants, affecting their ability to engage with online resources	Work package #2 and #3	Medium	Medium	Provide pre-course training sessions on using digital tools

Effective risk management is a cornerstone of the "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course. By adopting a strategic and structured approach, the project team aims to anticipate challenges, address them proactively, and ensure the smooth progression of all activities. Below are the key features of the unified risk management strategy, designed to uphold the course's quality, adaptability, and impact:

1. Proactive risk identification: early identification of potential risks allows the project team to implement timely mitigation measures, minimizing disruptions and ensuring the project stays on track.

2. Integrated monitoring and evaluation: regular assessments during project reviews help to track risks and their mitigation progress, fostering a responsive and adaptable management approach that sustains momentum.

3. Stakeholder-centered solutions: actively engaging students, faculty, and external collaborators ensures that risk mitigation strategies are inclusive and address the diverse needs of all stakeholders involved in the project.

4. Adaptability and flexibility: mitigation measures are designed to be dynamic, allowing the project to respond effectively to evolving circumstances and maintain its relevance and success over time.

This strategy not only minimizes potential setbacks but also enhances the project's resilience, ensuring its objectives are met efficiently and effectively.

1.4.5 WORK PACKAGES, ACTIVITIES, RESOURCES AND TIMING

The "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" adheres to a meticulously structured six-phased work plan. Each phase comprises interlinked activities designed to systematically achieve project objectives within the 36-month timeframe. This structured approach ensures smooth progression, continuous feedback loops, and ongoing refinement.

Work packages:

WP1. Project initiation and coordination (months 1–2):

– establishes the project team, delineates roles and responsibilities, and fosters cohesion;

– implements robust communication channels and coordination mechanisms, including regular team meetings and online platforms;

– develops a detailed project timeline with clearly defined milestones for efficient monitoring and progress tracking.

WP2. Curriculum development and teaching modules (months 3–6):

– designs a dynamic curriculum framework reflecting multicultural and interdisciplinary perspectives, tailored to identified needs through needs analysis and stakeholder engagement;

– develops engaging and comprehensive course materials, including lectures, interactive seminars, case studies, and supplementary resources, aligned with the latest trends in business communication and EU studies;

– ensures accessibility and adaptability of materials for future implementation.

WP3. Stakeholder engagement and collaboration (months 1–36):

– facilitates ongoing collaboration with stakeholders through regular meetings, workshops, and joint activities;

– organizes events and activities for stakeholder engagement, including:

– round-table discussions on cultural diversity in business communication;

– educational quests exploring European cultural differences;

– promotional events showcasing the project's benefits;

– EuroBizCommunication Club meetings fostering networking and knowledge sharing;

– international conferences and open lectures disseminating project findings;

– gathers feedback from students, faculty, and industry partners throughout the project for continuous improvement.

WP4. Pilot implementation and assessment (months 7–18):

– implements a pilot course with a diverse group of students, representing various academic backgrounds and regions;

– assesses the effectiveness of teaching methodologies and materials through student feedback, faculty observations, and pre- and post-course assessments;

– analyzes and incorporates feedback into the curriculum and teaching approach for refinement before full-scale implementation.

WP5. Full-scale implementation and dissemination (months 19–36):

– broadly rolls out the Jean Monnet Module to a wider target audience across diverse academic institutions and disciplines;

– continuously monitors course delivery, student engagement, and learning outcomes through established evaluation mechanisms;

– facilitates additional activities, such as workshops and guest lectures, to complement the core module and foster knowledge exchange.

Quantify and demonstrate the value: quantifies the project's impact on targeted stakeholders and the broader European economic landscape through measurable KPIs aligned (**Table 1.4**).

● **Table 1.4** Total credits and hours of work

Name of indicators	**Hours**
1	**2**
Number of credits/hours	**4/120**
Total hours of classroom work, including:	**42**
– lecture classes, hours	20
– seminar classes, hours	10
– practical classes, hours	12

● **Continuation of Table 1.4**

1	2
Total hours of independent work and for a credit passing including:	**78**
– calculation (calculation and graphic) works, units/hour	24
– individual research task, units/hour	24
– preparation for training classes and control activities, hours	28
Credit	**2**

1.4.6 LEARNING OUTCOMES, TEACHING AND LEARNING METHODS, AND ASSESSMENT STRATEGIES

The "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course is designed to achieve specific learning outcomes (LOs) that align with the development of intercultural communicative competence among students in IT and computer science specialties. These outcomes are achieved through thoughtfully integrated teaching and learning methods and evaluated using diverse assessment strategies.

The course aims to create a comprehensive learning ecosystem where students engage in project-based activities, academic instruction, student-led research, and public discourse. This approach facilitates the exploration of multicultural linguistic and communicative contexts within the European Union, with a particular focus on their relevance to the evolving European economic landscape and implications for Ukraine. Additionally, the course actively involves various stakeholders, including students, researchers, civil society representatives, and private sector professionals, fostering a collaborative and inclusive environment.

The **Table 1.5** summarizes the key learning outcomes, the corresponding teaching and learning methods, and the methods used to assess their achievement.

● **Table 1.5** Learning outcomes, teaching methods, and assessment strategies

Learning outcomes	Teaching and learning methods	Assessment methods
LO1: Ability to adapt to new conditions, make decisions independently, and initiate original research and innovative complex projects (AB1)	1. Lectures and practical classes using information-receptive, reproductive, heuristic, and research methods. 2. Independent work utilizing the reproductive and research methods	Current control: execution and defense of practical works, oral responses, and frontal polling
LO2: Ability to realize the need for lifelong learning to deepen acquired knowledge and gain new professional expertise (AB2)	1. Lectures and practical classes employing information-receptive, reproductive, heuristic, and problem-statement methods. 2. Independent work using the reproductive method	Current control: selective oral surveys, tests, and assessment of activity. Credit: oral surveys and test control

The structured integration of learning outcomes, teaching methods, and assessment strategies ensures a dynamic and responsive educational experience for students. By emphasizing adaptability, lifelong learning, and innovation, the course prepares participants to navigate the complexities of multicultural professional environments.

This holistic approach equips students with the knowledge and skills necessary to thrive in the global digital economy while fostering collaboration and inclusivity. Furthermore, the engagement of diverse stakeholders strengthens the course's relevance and impact, ensuring its alignment with broader societal and professional goals.

1.4.7 EVENTS OVERVIEW

The events planned within the framework of the "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course are pivotal to achieving its objectives. These events have been thoughtfully designed to provide participants with hands-on experience, actionable insights, and opportunities to engage with peers, faculty, and industry professionals in meaningful ways.

By combining interactive workshops, thought-provoking seminars, and dynamic quests, the program creates a comprehensive learning ecosystem that not only enhances participants' intercultural communicative competence but also prepares them to thrive in multicultural business environments. Each event is tailored to address the specific needs of IT and computer science students, offering practical knowledge and tools to succeed in their future careers.

The **Table 1.6** provides a structured overview of the events, including their types, descriptions, and expected outcomes.

● **Table 1.6** Events

Event No.	Name of the event	Type	Description	Location	Duration (days)	Number of participants
1	**2**	**3**	**4**	**5**	**6**	**7**
E1.1	Starting-up meeting	Project kickoff meeting	Concept development, project planning, team building, and resource allocation	Lviv, Ukraine	1	45
E1.2	Presentation of the project	Promotional event	Topics include an introduction to European cultural diversity, communication strategies, case studies, and skills development (e.g., adaptability, teamwork, and critical thinking)	Lviv, Ukraine	2	50

Continuation of Table 1.6

1	2	3	4	5	6	7
E2.1	Business communication strategy workshop	Workshop	Actionable tactics for effective communication in corporate settings	Lviv, Ukraine	1	35
E2.2	Discovering European business cultures	Educational quest	An interactive quest introducing participants to key components of European business cultures	Lviv, Ukraine	1	35
E3.1	Building your professional image	Workshop	Focus on personal branding, résumé building, and professional networking to enhance awareness of professional communication in a European context	Lviv, Ukraine	1	30
E3.2	Foundations of multicultural business communication	Open lecture series	Provides foundational knowledge on effective communication in multicultural corporate settings	Lviv, Ukraine	5	70
E4.1	Challenges and opportunities in European markets	Round-yable discussion	Facilitates conversations on potential opportunities and challenges in European markets	Lviv, Ukraine	1	45
E4.2	Diversity in action	EuroBizCommunication club meeting	Explores how diversity enhances communication and collaboration in the corporate world	Lviv, Ukraine	1	25
E4.3	Cultural intelligence workshop	EuroBizCommunication club meeting	Focuses on developing cultural intelligence to navigate European markets effectively	Lviv, Ukraine	1	20
E5.1	Tech trends in European business	Internet conference	Virtual sessions with guest speakers to discuss the influence of technology on corporate communication in Europe	Lviv, Ukraine	1	65
E5.2	Sustainable business communication practices in Europe	Round-table discussion	Explores the connection between effective communication and environmental responsibility in corporate settings	Lviv, Ukraine	1	21

Continuation of Table 1.6

1	2	3	4	5	6	7
E5.3	Research insights in multicultural business communication	Science round-table siscussion	Disseminates findings and insights from research in multicultural business communication	Lviv, Ukraine	1	22
E5.4	Global perspectives on multicultural communication	Conference	Provides an international platform to discuss multicultural approaches to corporate communication	Lviv, Ukraine	1	47
E5.5	Future trends in European businesscommunication	Internet conference series	Examines emerging trends and technologies shaping the future of corporate communication in Europe	Lviv, Ukraine	1	78

These events are integral to the successful implementation of the course, offering a diverse range of learning opportunities to address the identified gaps in intercultural communication skills. By emphasizing practical applications, fostering collaboration, and incorporating insights from European business contexts, the events ensure that participants gain both theoretical knowledge and real-world experience.

The variety and structure of the events not only align with the course's goals but also create an engaging and inclusive environment. Ultimately, this program prepares students to confidently navigate the complexities of multicultural professional settings, equipping them with the skills needed to make meaningful contributions to the global digital economy.

1.5 RESULTS AND DISCUSSION

1.5.1 COMPREHENSIVE FRAMEWORK OF THE COURSE

The course "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" provides a comprehensive framework for enhancing students' intercultural communicative competence and preparing them for successful engagement in multicultural professional environments. This program integrates theoretical foundations, practical applications, and independent study to foster cultural awareness, communication skills, and adaptability in European business settings.

The course structure includes lectures, practical classes (seminars and workshops), and independent student work, each contributing to the achievement of specific learning outcomes. Below is a detailed breakdown of these components (**Tables 1.7–1.10**).

● **Table 1.7** Lectures

No.	Topic	Main Issues	Hours
1	European cultural diversity	Overview of European cultural nuances	4
2	Intercultural communication strategies	Understanding diversity in European business settings	4
3	European business etiquette: multicultural aspects	Importance of cultural sensitivity in communication	4
4	Multilingualism in European business communication and labour market	Essential strategies for effective intercultural communication	4
5	Cultural impact on decision-making	Case studies illustrating successful communication	2
6	Business communication skills and European labour market	Building cultural intelligence	2
Total			**20**

● **Table 1.8** Practical classes (seminars and workshops)

No	Topic	Issues and Activities	Hours
1	Interactive quests on European business cultures	Hands-on exploration of key European business cultures	2
2	Business communication strategy workshop	Group activities fostering collaboration and awareness	2
3	Round-table discussions on European markets	Tactical approaches for corporate communication	3
4	Diversity in action: EuroBizCommunication club	Real-world scenarios for skill development	3
5	Online conference: tech trends in European business	Discussions on challenges and opportunities in European markets	2
6	Professional image building workshop	Insights from academia and industry experts	2
7	Cultural intelligence workshop: EuroBizCommunication club	Networking and exploring how diversity enhances collaboration	4
8	Round-table: sustainable business communication	Professional discussions	2
9	Science round-table: research in multicultural communication	Technology's influence on corporate communication	2
Total			**22**

Table 1.9 Independent students' work

No	Topic	Issues and Tasks	Hours
1	Understanding European cultural nuances	Assigned readings and reflective journals	12
2	Strategies for effective intercultural communication	Research projects and presentations on specific European cultures	10
3	European business etiquette and protocols	Case study analysis and role-playing scenarios	12
4	Multilingualism in European business communication	Online discussions and personal strategies for communication	10
5	Cultural impact on decision-making	Literature review and comparative analysis	10
6	Cultivating cultural intelligence and cross-cultural understanding	Developing etiquette guides and simulation exercises	12
Total			**76**

Table 1.10 Learning outcomes, teaching and assessment methods

Outcome	Teaching Methods	Assessment Methods
LO1: Ability to adapt to new conditions and conduct research	Lectures, practical classes, and independent work using heuristic and research methods	Execution and defense of practical works, oral assessments, and frontal polls
LO2: Realization of the need for lifelong learning	Lectures, practical classes, and independent work using problem-solving methods	Selective oral surveys, tests, and activity evaluation
LO3: Proficiency in intercultural communication	Interactive workshops, group discussions, and real-world scenario simulations	Role-playing assessments, reflective journals, and group project evaluations
LO4: Understanding cultural nuances in decision-making	Case studies, seminars, and collaborative projects	Research papers, comparative analysis, and team-based presentations

As demonstrated this course emphasizes active engagement, critical thinking, and practical application to ensure that students not only acquire knowledge but also develop the skills and competencies necessary for effective intercultural communication in European business contexts. Through a blend of lectures, interactive sessions, and independent tasks, participants are empowered to navigate multicultural professional environments with confidence and cultural sensitivity.

1.5.2 FINDINGS FROM THE SURVEY AND INSIGHTS FROM COURSE IMPLEMENTATION

The research findings reveal a critical need to develop intercultural communicative competence among IT and computer science students at Lviv Polytechnic National University, particularly in light of Ukraine's integration into the European Union and the demands of the globalized workforce. A comprehensive survey conducted with 136 1st- and 2nd-year students from IT, engineering, and economics programs provided a detailed analysis of existing gaps in their intercultural communication skills and readiness for multicultural professional environments.

The survey results highlighted that 87% of respondents lacked confidence in cross-cultural communication, indicating a significant gap in their ability to navigate multicultural settings. Furthermore, only 13% of students reported familiarity with European cultural norms relevant to professional business communication, while the majority expressed limited exposure to European values and practices. Notably, 86% of participants expressed strong interest in a structured course to address these gaps, underscoring the necessity and timeliness of the "Navigating Cultural Diversity" project.

The course was designed to address the key areas identified in the survey. It adopts a blended learning approach that integrates theoretical instruction with experiential learning methods such as role-playing, case studies, and simulations. The course's curriculum emphasizes developing critical skills such as cultural awareness, multilingual proficiency, adaptability, and effective communication in multicultural business environments.

Preliminary assessments from the pilot implementation phase revealed notable improvements in students' intercultural communication skills. Post-course evaluations indicated a 35% increase in students' confidence when engaging in cross-cultural communication.

Moreover, practical exercises such as case analyses and interactive workshops significantly enhanced students' ability to navigate cultural differences and adapt their communication strategies to diverse contexts. Faculty observations further noted increased engagement and enthusiasm among students when participating in discussions about European cultural diversity and business practices.

The findings demonstrate that a well-structured course like "Navigating Cultural Diversity" can effectively bridge the gap between students' technical expertise and their intercultural communicative competence. By fostering cultural sensitivity and equipping students with practical tools for multicultural professional interactions, the course prepares them to succeed in international teams and contribute meaningfully to the global economy.

CONCLUSIONS

This study underscores the pivotal role of intercultural communicative competence in preparing IT and computer science students for the demands of the modern globalized workforce.

The results of the needs analysis revealed a clear gap in students' readiness to navigate multicultural professional environments, highlighting the urgency of incorporating intercultural communicative competence into technical education curricula. The survey conducted with 136 1st- and 2nd-year students at Lviv Polytechnic National University revealed that a significant proportion of students lacked confidence in engaging with individuals from different cultural backgrounds, reinforcing the necessity of targeted educational interventions.

The development and implementation of the course "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" serves as a practical response to these challenges. Through its innovative curriculum, which blends theoretical insights with hands-on learning activities, the course addresses the specific needs of IT and computer science students. It equips them with the cultural awareness, adaptability, and professional communication skills necessary to succeed in international collaborations. The course focuses on enhancing students' ability to engage in effective, cross-cultural business communication, thereby preparing them to contribute meaningfully to global projects and navigate multicultural business settings with confidence and professionalism.

The outcomes of the course implementation demonstrate its effectiveness in enhancing students' intercultural communication competence. Post-course evaluations revealed significant improvements in students' cultural sensitivity and communication skills. Specifically, there was a 35% increase in students' confidence in communicating across cultures, and faculty observations noted increased engagement and a deeper understanding of European cultural norms and business practices. These findings emphasize the importance of integrating intercultural communicative competence training into technical education, bridging the gap between cultural sensitivity and technical expertise, and ensuring students' competitiveness in both European and global job markets.

The research and the development of the "Navigating Cultural Diversity: Effective Business Communication in the European Economic Landscape" course underscore the necessity of embedding intercultural communicative competence into the curriculum for future IT and computer science specialists. The course represents a proactive approach to addressing the identified gaps in students' intercultural communication abilities, which were clearly evident in the survey results. By focusing on practical learning and integrating intercultural communication strategies, the course aims to bridge the divide between technical expertise and cultural competence, preparing students to navigate complex multicultural work environments effectively.

In light of the research findings, it is evident that integrating intercultural communicative competence into the higher education curriculum for IT and computer science students is not only beneficial but essential. It aligns with broader educational goals of preparing future professionals who can contribute meaningfully to an increasingly interconnected and multicultural global economy. The development of such courses is a critical investment in the success of students, ensuring they possess the necessary skills to thrive in international teams, cross-cultural business settings, and global digital environments.

SUGGESTED PERSPECTIVES FOR FURTHER RESEARCH:

1. Integration of digital tools: further research could explore how digital tools like virtual reality and artificial intelligence can enhance intercultural communication training, offering students more immersive and interactive learning experiences.

2. Longitudinal studies: long-term studies are needed to evaluate the sustained impact of ICC training on students' professional success and career progression in multicultural environments.

3. Cross-institutional comparative studies: investigating the effectiveness of ICC programs in various educational institutions across different cultural contexts would provide valuable insights into best practices and scalable approaches for teaching ICC in technical fields.

4. Industry partnerships: future research could focus on collaborations between universities and industry partners to better align academic ICC programs with real-world professional needs, ensuring that students are equipped with relevant skills for the workforce.

5. Expansion of ICC training across disciplines: research could also explore the feasibility of expanding ICC training to other disciplines, such as the social sciences and humanities, to foster a more inclusive, interdisciplinary approach to global communication skills.

These proposed directions for future research aim to build upon the foundations laid by this study, further advancing the field of intercultural communicative competence education and ensuring that students are well-equipped to meet the challenges of the increasingly diverse global job market.

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CHAPTER 2

HARMONIZATION OF FORENSIC EXPERT TRAINING WITH CURRENT DEVELOPMENT TRENDS IN UKRAINE AND ABROAD: DETAILED ANALYSIS AND IMPLEMENTATION PROSPECTS

ABSTRACT

Modern forensic science lies at the intersection of science, technology, and law, requiring a comprehensive approach to the training of forensic experts. The globalization of crime, digitalization, and the development of innovative research methods necessitate a fundamental reform of the expert training system in accordance with international standards.

This chapter of the monograph presents a detailed analysis of forensic expert training in leading countries, including the USA, Germany, the United Kingdom, France, Canada, Switzerland, Australia, and Poland. The authors examine existing effective training models that can be adapted for the Ukrainian system. A comparative analysis of undergraduate forensic science programs at the University of Lausanne (Switzerland) and the Educational and Scientific Institute No. 2 of the National Academy of Internal Affairs of Ukraine is presented.

The study highlights key areas for modernization, particularly the unification of educational programs. The emphasis is placed on the urgent need to adapt curricula to modern demands, including harmonization with international standards, integration of advanced knowledge on the application of innovative methods in practice (artificial intelligence, digital forensics, blockchain), and strengthening practical training based on real case studies. Furthermore, the importance of an interdisciplinary approach and expanding cooperation between universities, expert institutions, and law enforcement agencies is underlined.

KEYWORDS

Forensic science, criminalistics, expert training, international standards of expert education, artificial intelligence, blockchain, legal ethics, cooperation with law enforcement agencies, big data analysis, innovative methods, interdisciplinary approach.

In modern conditions, forensic science is a crucial element of the justice system, ensuring the objectivity and scientific validity of evidence in criminal, civil, and administrative proceedings.

Given the increasing complexity of crimes amid scientific and technological progress, particularly cybercrime, financial fraud, terrorism, and environmental offenses, there is a growing demand for a new generation of experts capable of applying, analyzing, and synthesizing innovative technologies, working with interdisciplinary data, and meeting international standards.

At the present stage of societal development, globalization, digitalization, and the increasing demands for the efficiency of justice necessitate the harmonization of forensic expert training with the best global practices in the context of constant change and improvement, along with the adaptation of Ukrainian legislation to the acquis communautaire of the European Union. In this context, the experience of leading countries serves as a benchmark for reforming Ukraine's system of forensic expert training.

The modern system of forensic expert training is in a state of continuous evolution, driven by the growing complexity of forensic tasks, technological development, and globalization. An important task is the adaptation of educational programs to current needs, including harmonization with international standards, integration of innovative technologies, and the formation of practical skills. The chapter examines the experience of Ukraine and eight leading countries in forensic expert training: the USA, Germany, the United Kingdom, France, Canada, Switzerland, Australia, and Poland.

Despite certain achievements, the Ukrainian system of forensic expert training faces numerous challenges limiting its effectiveness and competitiveness at the international level. One of the major problems is the insufficient integration of educational programs with international standards, leading to gaps in the professional knowledge and skills of experts. Modern challenges, such as the globalization of forensic research and the development of new technologies, particularly in the field of digital forensics, require forensic experts to possess not only solid theoretical knowledge but also the ability to adapt quickly and apply innovative methods in practice.

Another significant problem is the lack of practical orientation within training programs, resulting in many graduates lacking sufficient experience in dealing with real-life forensic cases and using advanced technologies, applied in forensic examinations. This limits their ability to work effectively in contemporary criminal investigations, which often require the use of complex analytical tools and technologies.

Additionally, the insufficient cooperation between educational institutions, law enforcement agencies, and international expert centers is a notable concern. In circumstances where international cooperation is a key factor in combating transnational crime, the lack of knowledge and experience exchange between countries in the field of forensic science leads to a gap between educational standards and practical requirements.

Therefore, the need to harmonize forensic expert training, considering the latest development trends, is an urgent issue for Ukraine. Solving this problem requires a comprehensive approach, including the reform of educational programs, improvement of practical training, implementation of innovative technologies, and development of international cooperation in the field of forensic science.

2.1 CURRENT STATE AND GLOBAL EXPERIENCE IN FORENSIC EXPERT TRAINING: THEORETICAL AND METHODOLOGICAL ANALYSIS

The issue of forensic expert training has been the subject of research and publications by numerous domestic and foreign scholars.

The work of M. Morelato, L. Cadola, M. Bèrubè, O. Ribaux, and S. Baechler presents a strategy for teaching and learning in forensic science, developed at the University of Lausanne (Switzerland) and adapted at the University of Technology Sydney (Australia) and the Universitè du Quèbec à Trois-Rivières (Canada) [1].

The goal of the strategy is to analyze and elaborate on real-life situations using a progressive approach to teaching and learning, which is based on theory and practical exercises, placing students in authentic scenarios.

The case-based learning approach enables students to develop or modify their existing knowledge through real-life experiences, reflective observation, active experimentation, and communication. This approach has proven more effective for achieving long-term learning outcomes and fostering a deep learning approach. It challenges students' ability to solve complex problems they are likely to encounter in the workplace.

Case studies provide structured and transversal learning material, which has been successfully adapted in various countries and contexts. This approach also shifts the educational focus from methods to reasoning processes and forms of argumentation necessary at all stages of forensic activity.

Through this innovative learning process, students move away from perceiving the Court (trial) as the sole ultimate goal of forensic science studies. They learn to perform diverse roles, adopt proactive attitudes, and work both individually and collaboratively. Such a teaching and learning strategy breaks existing isolation in forensic science by focusing on processes and critical thinking [1].

J. González-Rodríguez provided a professional review of forensic science education programs in Europe, excluding the United Kingdom and Ireland [2]. The results of his work are presented in the **Table 2.1**.

Table 2.1 Forensic science university courses in Europe (excluding UK & Ireland)

Institute/program's housing unit/ location/website	Degree & course title	Course language
1	**2**	**3**
Austria **Medical University of Vienna** Department of Forensic Medicine Forensic Molecular Biology Vienna	(In development)	German
https://www.meduniwien.ac.at/hp/fileadmin/gerichtsmedizin/DGM_Org_neu_2016/2016_05_17_Org_eng.pdf		

Continuation of Table 2.1

1	2	3
Bulgaria **Varna Free University** Department of Security and Safety Law Faculty Varna	Master: Forensic Science Expertise	Bulgarian
http://vfu.bg/en/ects_guide/fi les/uf/mag/se/ske.html		
Germany **Steinbeis College** Berlin	MA: Criminology	
http://www.fachhochschule.de/FH/Studium/Master_of_Arts_Criminal_Investigation_17738.html		
University Humbolt Berlin	(A historical well known program was closed in 1994, following the fall of the Berlin Wall. Currently, programs are offered in partnership with King's College London)	
http://www.kcl.ac.uk/study/postgraduate/taught-courses/forensic-science-msc-mres-pg-dip-pg-cert.aspx		
Bonn-Rhein-Sieg University of Applied Sciences Department of Natural Sciences Sankt Augustin	BSc: Forensic Sciences	German (50%) English (50%)
https://www.h-brs.de/en/anna/forensic-sciences-bsc		
Brandenburg University of Technology Cottbus-Senftenburg Faculty of Environment and Natural Sciences Cottbus	MSc: Forensic Sciences & Engineering	German
https://www.b-tu.de/en/study/study-programmes/detail/123-forensic-sciences-and-engineering		
Italy **Sapienza University of Roma** Faculty of Physical and Natural Sciences Rome	MSc: Forensic Analytical Method	Italian
http://www.uniroma1.it/didattica/master/2015/metodologie-analitiche-forensi-0		
University of Bologna Professional Master's Programmes Bologna	MSe: Forensic Chemical & Chemical-Toxicological Analyses	Italian
http://www.unibo.it/en/teaching/professional-master/2015-2016/forensic-chemical-and-chemical-toxicological-analyses-8638		
The Netherlands **The University of Amsterdam** Institute for Interdisciplinary Studies Graduate Schools of Sciences Amsterdam	MSe: Forensic Science	English
http://gss.uva.nl/future-msc-students/content/forensic-science.html		

Continuation of Table 2.1

1	2	3
Avans University of Applied Sciences Breda	Bachelor of Chemistry Bachelor of Biology	English & Dutch
http://www.avans.nl/international/programs/programfi nder/international-forensic-science-short-programme-breda-voltijdshort-course/introduction		
Portugal **The University of Coimbra** Faculty of Medicine Rua Larga, Coimbra	Master: Legal Medicine & Forensic Science	Portuguese
https://apps.uc.pt/courses/en/course/1392		
Instituto Superior de Ciências da Saúde Egas Moniz Higher Health Sciences Egas Moniz Institute Lisbon	BA: Forensic & Criminal Sciences	Portuguese
http://www.egasmoniz.com.pt/pt-pt/ensina/iscsem/cursas/licenciaturas/licenciatura-em-ciências-forenses-e-criminais.aspx		
Spain **The Autonomous University of Barcelona** Graduate School Cerdanyola del Vallès, Barcelona	Master: Criminology – Forensic Sciencea Graduate Diploma: Criminalistcsb Forensic Science & Criminal Intelligencec Forensic Handwritting Analysisd	Spanish
[a]http://www.uab.cat/web/postgraduate/master-in-criminology/general-information-1217916968009.html/param1-1487_en/param2-2014/ *[b]http://www.uab.cat/web/postgraduate/graduate-diploma-in-criminalistics-analysis-of-information-and-advancedtechniques-in-forensic-sciences/general-information-1217916968009.html/param1-1471_en/param2-2014/* *[c]http://www.uab.cat/web/postgraduate/graduate-diploma-in-forensic-science-and-criminal-intelligence/generalinformation-1217916968009.html/param1-3002_en/param2-2014/* *[d]http://www.uab.cat/web/postgraduate/graduate-diploma-in-forensic-handwriting-analysis/generalinformation-1217916968009.html/param1-3058_en/param2-2013/*		
The University of Alcalá Spanish University Research Institute of Police Sciences Faculty of Law Alcalá de Henares, Madrid	Master: Police Sciencea PhD: Forensic Scienceb	Spanish
[a]https://www.uah.es/es/estudios/estudios-oficiales/masteres-universitarios/Ciencias-Policiales/ *[b]https://www.uah.es/es/estudios/estudios-oficiales/doctorados/Ciencias-Forenses-D412/*		
University of Murcia Faculty of Biology Espinardo Campus Murcia	Master: Forensic Sciences	Spanish
http://www.um.es/web/biologia/contenido/estudios/masteres/ciencias-forenses		

Continuation of Table 2.1

1	2	3
University of the Basque Country Master and Doctoral School	Master: Forensic Analysis	Spanish/Basque
http://www.ehu.eus/en/web/masteranalisisforense/aurkezpena		
University of Valencia Department of Preventive Medicine Valencia	Master: Forensic Science	Spanish
http://formacion.adeituv.es/ciencias-forenses/#		
Pablo de Olavide University Social and Legal Sciences Seville	Master: Criminology & Forensic Science	Spanish
https://www.upo.es/postgrado/Master-Ofi cial-Criminologia-y-Ciencias-Forenses		
Sweden **The University of Uppsala** Faculty of Medicine Uppsala	MSe: Forensic Science	Swedish
http://www.uu.se/en/admissions/master/selma/program/?pKod=MFV2M&lasar=16/17		
Switzerland **The University of Lausanne** Batiment BCH Lausanne	BSe: Forensie Seience[a] MSe: Physical Identification[b] Chemical Criminalistics[c] Traceology & Crime Analysis[d*] Digital Investigation &Identification[e] PhD: Forensic Science[f] Certificate: Essentials of Forensic Interpretation[g] Essentials of DNA Interpretation[i] Certificate of Advanced Studies: Statistics in the Interpretation of Evidence[h]	French French French French French French & others English English English
www.unil.ch/esc *[a]http://www.unil.ch/esc/bachelor* *[b]http://www.unil.ch/esc/master-id* *[c]http://www.unil.ch/esc/master-cc* *[d]http://www.unil.ch/esc/master-tracologie* *[e]http://www.unil.ch/esc/msc-investigation-numerique* *[f]http://www.unil.ch/esc/home/menuinst/doctorats-et-recherches/doctorat-en-science-forensiq.html* *[g]http://www.formation-continue-unil-epfl.ch/essentials-forensic-interpretation* *[h]http://www.formation-continue-unil-epfl.ch/statistics-evaluation-forensic-evidence-cas* *[i]http://www.formation-continue-unil-epfl .ch/essentials-dna-interpretation* *[*]With the University of Montréal, Department of Criminology*		
Turkey **Istanbul University** Institute of Forensic Sciences Cetrahpasa Kampusu Istanbul	MS: Forensic Science[a] PhD: Forensic Science[b]	Turkish Turkish
[a]http://adlitip.istanbul.edu.tr/en/ms-in-forensic-sciences/ *[b]http://adlitip.istanbul.edu.tr/en/phd-in-forensic-sciences/*		

Source: [2]

The author describes forensic science education in Europe as a "patchwork" that is difficult to unravel. In many countries, there are no studies, dedicated to forensic science education, leading to degrees being open to non-governmental professionals.

In these countries, there are connections between official, governmental, or police laboratories and academic institutions, as well as opportunities for internal education leading to academic status. In many European countries, forensic activities and research may be conducted at departments of forensic medicine without conferring a scientific degree, except for medical specialization.

Many countries also offer forensic science courses to law students or as part of criminology programs. Finally, there is a network of universities claiming to offer forensic science degrees, which are mostly delivered remotely [2].

In the work, dedicated to forensic expert training [3], authors S. Grey and B. Swanston made key conclusions that forensic science education can prepare students for various careers in the field, including work as forensic anthropologists, criminal investigators, forensic scientists, and forensic toxicologists. It is noted that many positions in this field require certification by one of the numerous specialized organizations responsible for the accreditation of forensic experts [3].

The issue of an optimal model and mechanism for forensic expert training to enhance their professional level and advance the field to a qualitatively new stage has been addressed by scholars V. Alekseichuk and I. Starodubov [4]. In their view, in most cases, obtaining the qualification of a forensic expert requires comprehensive higher education. For example, for the specialization "Economic Research in the Field of Intellectual Property", in addition to majoring in 076 "Entrepreneurship, Trade, and Stock Exchange Activity" or 081 "Law", specialists should preferably have higher education in one of the following fields within the knowledge area 0305 "Economics and Enterprise": 051 "Economics", 056 "International Economic Relations", 072 "Finance, Banking, and Insurance", or 071 "Accounting and Taxation". At the same time, to conduct, for instance, an objective examination of an invention, the expert must have a technical education; for the analysis of computer programs – education in computer science; and for conducting economic research – an economic background, and so forth [4].

2.2 THEORETICAL AND METHODOLOGICAL FOUNDATIONS AND CURRENT TRENDS IN FORENSIC EXPERT TRAINING IN GLOBAL PRACTICE

Any forensic examination is an applied scientific study of objects, conducted in accordance with rules, determined by the specifics of its subject and the scope of information necessary for its performance, drawn from relevant fields of science and technology.

The objects of forensic examinations, in a broad sense, may include substances, materials, industrial and other products, technologies, works of art, plants, animals, human beings, documents, and more. The goals and tasks of forensic examinations are determined by the area of human activity, within which they are conducted.

Forensic examination is a specific type of expert activity with a special legal status.

The essence of forensic examination lies in the analysis, upon the assignment of an individual or authority conducting legal proceedings, of material objects (physical evidence) and various documents by a qualified person (expert) with the purpose of establishing factual data relevant to the correct resolution of the case.

Upon the completion of the examination, the expert issues an expert opinion, which, according to law, is one of the sources of evidence, and the factual data contained therein constitute proof.

According to the current legislation of Ukraine, the key bearer of specialized knowledge is the forensic expert, who applies such knowledge both in procedural form – when its results have evidentiary value – and in non-procedural form.

The only formal requirement for an individual to act as a forensic expert under Ukrainian law is the possession of specialized knowledge.

The concept of "specialized knowledge" is not legally defined. In academic literature, it is traditionally understood as a system of theoretical knowledge and practical skills in a particular field of science, technology, art, or craft, acquired through special training or professional experience, necessary for solving questions arising in the course of criminal or civil proceedings. Commonly known and legal knowledge is not considered specialized.

However, in today's conditions, new achievements of rapidly developing science, technology, and emerging disciplines are continuously integrated into forensic practice.

In our view, these developments inevitably cause a transformation of the concept of "specialized knowledge". The boundaries of the expert's and specialist's competence, as well as the very necessity of their involvement in a case, directly depend on the meaning attributed to this term. Therefore, this issue is not merely academic but has serious practical significance.

The relationship between specialized and commonly known knowledge is inherently variable and depends on the level of societal development and the extent, to which scientific knowledge is integrated into everyday life. As knowledge of a particular phenomenon, process, or object expands and deepens, it becomes increasingly differentiated, systematic, and accessible to a wider audience. As a result, the sphere of everyday knowledge is enriched.

Returning to the question of who may act as forensic experts under Ukrainian law, such individuals are those who possess the necessary knowledge to provide opinions on specific issues under investigation.

The professional and qualification requirements for forensic experts, employed in state specialized institutions or working independently, are outlined in Article 10 of the Law of Ukraine "On Forensic Examination" dated 25.02.1994, No. 4038-XII [5]. The law stipulates that positions of experts in state forensic institutions may be held by professionals with relevant higher education, a qualification level of at least "specialist", who have completed appropriate training and obtained the qualification of forensic expert in a specific specialty.

In Ukraine, academic training of forensic experts is primarily conducted on the basis of legal and technical universities, among which the leading institutions are:

– The National Academy of Internal Affairs – Educational and Scientific Institute No. 2 is currently the only institution that offers training for applicants with an expert-criminalistic focus. It provides training for master's degree seekers in the specialty "Law" with a specialization in "Forensic Examination";

– Taras Shevchenko National University of Kyiv – offers specialized courses in criminalistics and forensic examination, including DNA analysis and trace evidence examination;

– Kharkiv National University of Internal Affairs – provides courses in digital forensics and ballistics;

– Odesa State University of Internal Affairs – specializes in handwriting examination and forensic anthropology.

Let us briefly examine the state of forensic expert training in some foreign countries.

United States

The U.S. system of forensic expert training is one of the most advanced globally. It is based on cooperation between universities and law enforcement agencies. The FBI Academy offers programs in criminalistics, forensic medicine, and digital forensics.

A strong emphasis is placed on practical training. Students undergo internships in laboratories and participate in real criminal investigations.

In terms of innovation, the U.S. actively utilizes automated systems for evidence analysis, such as the CODIS DNA database and the IAFIS fingerprint database.

However, forensic scientists are often confused with crime scene investigators, although these two professions differ significantly (**Table 2.2**) [6–8]. They require different qualifications, have distinct work characteristics, and employ different technologies [9, 10].

Table 2.2 Main differences between forensic experts and crime scene investigators

Forensic science	Crime scene investigator (CSI)
A significant portion of the work is done in laboratories, where forensic data is collected and analyzed based on evidence collected during crime scene examinations	A large part of the job involves visiting and analyzing crime scenes
To work in this field, forensic scientists typically must have at least a bachelor's degree	While a degree in forensics or other science is desirable, forensic investigators can also start their careers as police officers and then move up to the position of forensic investigator
There are many opportunities for experts to specialize in a wide variety of fields	Crime scene work does not allow for many specializations, although the skills learned can be applied to other positions, such as working in government organizations

Source: [6]

Forensic experts are well-paid professionals with significant career opportunities. In fact, employment in forensic science is projected to grow by 13% by 2032, much faster than the national average.

Germany

In Germany, forensic expert training is decentralized. Each federal state has its own educational programs, tailored to regional needs. The system is characterized by narrow specialization, covering such areas as toxicology, ballistics, handwriting analysis, etc. Continuous cooperation with research centers is common. For example, the Max Planck Institute for Criminal Law is a leading institution in developing innovative analysis methods.

United Kingdom

In the UK, it is advisable to choose a course, accredited by the Chartered Society of Forensic Sciences (CSFS) for those wishing to obtain a degree in forensic science. One may earn a degree directly in forensic science or in a related discipline (e.g., chemistry, biology, medical sciences, or physics) and later apply for forensic positions. Postgraduate qualifications in forensic science or related subjects are also available.

The British system emphasizes ethics and interdisciplinarity. Cranfield University offers courses on evidence analysis, DNA processing, and digital data examination. Collaboration with the police plays an important role, enabling students to work with real evidence.

France

The French Institute of Forensic Sciences in Lyon is one of the leading centers for expert training. Programs include internships in laboratories, working on real cases, and using modern equipment for toxicological and biological data analysis.

Canada

Canadian universities, particularly the University of Toronto, integrate innovative technologies into their programs. Students study artificial intelligence, blockchain, and cybersecurity, which is increasingly relevant given the rise in cybercrime.

Australia

Australian universities, such as the University of Melbourne, focus on international standards. Programs include evidence analysis using modern technologies and the study of international law for addressing transnational crimes.

Poland

In Poland, the Central Forensic Laboratory cooperates actively with universities. Students study spectrometry, forensic anthropology, and DNA analysis techniques.

The analysis of international forensic practice shows that a higher education degree alone is not sufficient for a forensic expert [11–15]. The emergence of new technologies creates both opportunities and challenges for forensic experts, changing methods of research and evidence analysis.

Artificial Intelligence (AI) plays an increasingly important role in modern society. AI technologies have been integrated into navigation, smartphone applications, advertising, smart homes and vehicles, finance, etc. Terms such as “digital economy”, “digital school”, and “digital forensics” have become commonplace [16].

The AI field is developing rapidly, undergoing significant changes daily, constituting a true technological revolution. Alongside obvious advantages and conveniences, AI technologies give rise to

new types of crime and present serious challenges for law enforcement worldwide. For forensic science, this means an expansion of research objects and the need to adapt to new realities [16].

Since its inception, forensic science, as both a scientific and practical discipline, has continuously incorporated the most advanced and effective research methods available at the time.

Modern AI algorithms are capable of processing vast amounts of data, including surveillance footage, digital evidence, or biological samples. They can identify patterns and anomalies, often overlooked by human analysts. Moreover, machine learning techniques enable the automation and optimization of processes, such as fingerprint analysis, ballistics examination, and DNA profiling. This significantly increases the accuracy of research and reduces the risk of human error.

Another technological breakthrough affecting forensic science is the use of advanced visualization methods. Thanks to 3D scanning, modeling, virtual reality (VR), and high-precision microscopy, experts achieve an unprecedented level of detail in analyzing evidence and crime scenes [17].

Forensic science is undergoing a significant transformation due to technological advancements. For instance, 3D scanning enables the creation of highly accurate digital replicas of crime scenes, allowing investigators to examine them from different perspectives and analyze spatial characteristics. VR technologies immerse investigators in virtual reconstructions of events, facilitating a better understanding of object positioning and event dynamics [17].

Additionally, modern microscopy methods, such as scanning electron microscopy (SEM) and atomic force microscopy (AFM), enable forensic experts to examine evidence at the nanoscale. This capability reveals details that would be inaccessible through traditional microscopes, significantly expanding the scope of forensic examinations.

Furthermore, the integration of blockchain technology into forensic practice is being discussed in professional circles as a means to enhance data integrity and transparency, ensuring authenticity and immutability of records.

In forensic science, the reliability of evidence can be compromised by frequent issues, associated with traditional evidence management systems, including data manipulation, unauthorized access, and a lack of transparency. Blockchain technology has emerged as a viable approach to addressing these challenges by offering a decentralized, transparent, and immutable framework for data management [18–20].

By creating an immutable and decentralized record of evidence movement and analysis, blockchain technology can help mitigate the risk of tampering or misuse, further strengthening the credibility of forensic investigations as a source of proof. Some existing systems may face difficulties in handling large volumes of evidence or adapting to the increasing complexity of legal cases [18, 19].

Many traditional systems rely on centralized databases, making them vulnerable to hacking, unauthorized access, and data manipulation. These systems may also lack robust security measures to protect confidential information. Without advanced encryption and access controls, the risk of data breaches and unauthorized disclosure of evidence remains high.

However, the adoption of these new technologies in forensic science is not without challenges. Issues related to data privacy, cybersecurity, and the potential for misuse or over-reliance on these

technologies must be carefully examined and addressed. Moreover, forensic experts will need specialized training and education to effectively utilize these new tools and methodologies.

As the field of forensic science continues to evolve, it is crucial for practitioners and researchers to stay informed about emerging technologies and their potential applications. By embracing innovation while maintaining a commitment to scientific rigor and ethical principles, forensic experts can harness the power of these technologies to enhance the accuracy, efficiency, and reliability of their work, ultimately strengthening the pursuit of justice and public safety.

The conducted analysis indicates a growing demand for highly skilled professionals in the analysis and interpretation of evidence.

In our opinion, the emergence of new technologies and methodologies encourages forensic practitioners to acquire new knowledge, skills, and qualifications necessary to meet the challenges they face.

2.3 THE SYSTEM OF FORENSIC EXPERT TRAINING IN UKRAINE: CURRENT STATE, CHALLENGES, AND PROSPECTS FOR HARMONIZATION WITH GLOBAL DEVELOPMENT TRENDS

For many years and until today, forensic experts of almost all types and categories (except for specialists in forensic medicine and forensic psychiatry, who are trained by relevant departments of medical universities) in Ukraine have been trained through the retraining of individuals who hold either natural sciences or legal degrees. As a result of such retraining, these individuals obtained so-called admission – a qualification certificate granting the right to conduct specific types of forensic examinations.

For the independent training of newly hired employees who are not yet authorized to perform forensic examinations, an individual plan is drawn up and approved by the head of the forensic institution according to the expert training program of the respective agency. A mentor, selected from the most experienced employees, is assigned to a trainee who lacks forensic qualifications. The mentor provides methodological assistance in mastering theoretical courses, acquiring practical skills with instruments and equipment, monitors the implementation of the individual training plan, and involves the trainee in forensic examinations and studies.

Unfortunately, physicists, chemists, biologists, engineers, and other specialists with natural science or technical backgrounds, who are recruited to forensic institutions, often lack even the basic knowledge of substantive and procedural law, criminalistics, and forensic science theory. Typically, they are experts in very narrow fields, and the knowledge, gained during their university studies, is used only partially – about 20–30%. Internships and short courses, designed to teach them the basics of procedural law and criminalistics, fail to provide the necessary depth. Legal knowledge and general legal culture, which are crucial for forensic experts in their daily work, are usually acquired only after several years of practical experience, which leads to numerous expert errors and omissions.

Lawyers who still undergo retraining as forensic experts face even greater difficulties since they lack the necessary technical and scientific foundation to work with increasingly complex expert equipment.

Thus, in Ukraine, professional forensic expert activity may be carried out by:

a) employees of state specialized forensic institutions who have been trained at specialized state institutions;

b) private forensic experts who are not employees of such institutions but have completed training (internship) at specialized institutions under the Ministry of Justice of Ukraine and have obtained the qualification of a forensic expert;

c) other specialists (experts) from relevant fields of knowledge under the procedures and conditions, defined by the Law.

It is important to note that the training programs for candidates applying for positions in the system of research institutions of forensic examinations under the Ministry of Justice of Ukraine, the expert services of the Ministry of Internal Affairs, the Ministry of Defence, the Security Service of Ukraine, and the State Border Guard Service of Ukraine are defined by internal departmental documents and may differ, considering the specificities of the future professional activity depending on the agency.

Within the framework of this study, for illustration purposes, we will examine two training programs for candidates applying for the position of forensic expert in institutions under the Ministry of Justice of Ukraine, using the example of expert specialties 4.1 "Examination of Human and Animal Traces" and 1.1 "Examination of Handwriting and Signatures" (**Tables 2.3–2.5**) [21].

Firstly, it should be noted that the training of specialists who intend to obtain the qualification of a forensic expert and work in state specialised institutions or not to be an employee of these institutions is divided into two stages. The first stage is carried out under a training programme on theoretical, organisational and procedural issues of forensic examination. So far, the National Scientific Centre 'Bokarius Institute of Forensic Expertise named after Hon. Prof. M.S. Bokarius' has a licence to conduct educational activities in the field of internship under this programme [21].

Table 2.3 Typical thematic plan

No.	Topic name	Total teaching hours	Lecture sessions	Practical sessions
1	**2**	**3**	**4**	**5**
1	Theoretical foundations of forensic examination and the history of its development. The concept of forensic examination, subject, object and tasks of forensic examination. The role of forensic examination as a means of proof	4	4	–
2	Forensic activity. Regulatory and legal acts regulating forensic activity in Ukraine. Subjects of forensic activity. Standardization of forensic activity according to international standards	8	8	–

● **Continuation of Table 2.3**

1	2	3	4	5
3	Forensic examination methods. Expert methods. Stages of expert research	4	4	–
4	Forensic expert, his/her rights and obligations. Legal responsibility of a forensic expert. Expert and specialist (procedural aspect)	8	8	–
5	Forensic expertise as a form of using specialized knowledge. Classification of forensic expertise	4	4	–
6	The procedure for appointing a forensic examination in various types of legal proceedings. Organization of forensic examination	8	8	–
7	Expert opinion (structure, content, design)	4	4	–
Total number of hours		40	40	–

The second stage of training takes place directly at the expert institution in accordance with the training programs for the relevant expert specialties.

● **Table 2.4** Typical thematic plan for training in expert specialty 4.1 "Research of human and animal traces"

No.	Topic name	Total teaching hours	Lecture sessions	Practical sessions
1	2	3	4	5
1	Subject and system of forensic trace examinations. Forensic science about traces. Identification and diagnostic studies in trace examination	6	6	–
2	Identification and diagnostic studies in trace examination	6	6	–
3	Detection, fixation and removal of traces at the scene of the crime	7	7	–
4	General methodology of forensic trace research	7	7	–
5	Examination of human footprints and shoe prints	48	7	41
6	Examination of traces of teeth, lips, auricles and skin of a person's head	49	7	42
7	Examination of human properties (motor skills) by knots and loops, connected by them	49	7	42
8	Examination of the mechanism of soil layer formation on clothing and footwear	49	7	42

● **Continuation of Table 2.4**

1	2	3	4	5
9	Glove trace examination	49	7	42
10	Animal footprint examination	49	7	42
11	Preparation of draft expert opinions	20	–	20
12	Reviewing draft expert opinions	6	–	6
Total hours		345	68	277

● **Table 2.5** Typical thematic plan for the preparation of the expert specialty "Study of handwriting and signatures"

No.	Topic name	Total teaching hours	Lecture sessions	Practical sessions
1	Theoretical and methodological principles of forensic handwriting examination	10	1	9
2	Theoretical and methodological principles of forensic handwriting examination	1	1	9
3	Procedural and methodological provisions for the appointment and conduct of forensic handwriting examination. Registration of research results	5	5	–
4	The concept of handwriting examination methodology and general principles of its construction	15	3	12
5	Systematization of handwriting and signature features	20	2	18
6	Identification study of handwritten texts, executed under usual conditions	20	3	17
7	Study of handwritten texts, executed under the influence of any confounding factors	67	15	52
8	Research of signatures made under usual conditions	40	5	35
9	Research of signatures, made under the influence of natural distracting factors	35	5	30
10	Research of signatures, made under the influence of artificial distracting factors	30	5	25
11	Complex research in solving forensic handwriting problems	10	2	8
12	Preparation of draft conclusions	20	–	20
13	Review of conclusions (draft conclusions)	6	–	6
Total number of hours		288	47	241

For further comparison of expert training systems, the specified hours will be converted into the number of credits, required to obtain an educational qualification of a certain degree in the relevant specialty. ECTS, or the European Credit Transfer and Accumulation System, is a pan-European system for credit transfer and accumulation.

Thus, the training program for forensic experts specializing in 1.1 "Handwriting and Signature Analysis" amounts to 11 ECTS credits, excluding prior higher academic education.

The training program for forensic experts specializing in 4.1 «Human and Animal Trace Analysis» amounts to 13 ECTS credits, excluding prior higher academic education.

Undoubtedly, the quality of forensic expert training through individual and group internships and short-term courses cannot compare to systematic education in higher education institutions.

Forensic expertise allows for specialization. This raises the question of what educational and knowledge requirements should be imposed on future forensic experts in the current stage of scientific development, given the complexity of the tasks, assigned to them.

In Ukraine, the issue of the necessity of specialized forensic expert training remains unresolved. One approach to forensic expert training involves a standardized approach to general professional disciplines while defining specialized disciplines based on types of forensic expertise. Proponents of this approach propose training forensic experts in higher education institutions under the Ministry of Internal Affairs of Ukraine through a six-year educational program. Graduates receive a diploma in «Forensic Expertise» and are authorized to conduct traditional forensic examinations, including trace analysis, fingerprint analysis, ballistics, cold weapons analysis, portrait expertise, handwriting analysis, and forensic technical document examination. The training of experts in forensic engineering and technical expertise could be conducted in technical universities with appropriate equipment, as well as in law faculties in the format of a second legal education.

Despite significant advancements in the development of educational programs, the key issue remains the insufficient integration of practice into the educational process. For instance, only a limited number of students have access to modern laboratory equipment, and internships in forensic institutions are not always mandatory and, under martial law conditions, not always feasible. The main reasons for the lack of practical training in forensic education include:

– overemphasis on theory: educational programs often focus on theoretical aspects while neglecting practical application;

– lack of interaction with employers: weak connections between educational institutions and stakeholders lead to educational programs that do not align with real labor market needs;

– cultural and intellectual barriers: in Ukraine, the stereotype that a diploma is the main criterion of success remains widespread, complicating the implementation of alternative learning and assessment formats.

However, in recent years, there has been a positive trend, including the introduction of digital forensics courses to combat cyber threats, the use of 3D modeling for crime scene reconstruction, and the training of forensic genomics experts to work with biological evidence.

In our view, forensic expert training should be based on a combination of several key approaches.

Firstly, an interdisciplinary approach. Forensic expertise requires the integration of knowledge from various fields, including law, criminalistics, natural sciences, computer technology, and psychology. For example, a digital forensics expert must understand the legal foundations of evidence collection, methods of retrieving and analyzing digital data, and the ethical aspects of the work. The educational program should prepare graduates to perform tasks in various fields, including legal, forensic, technical-criminalistic, and consulting areas. Implementation of this approach can include:

– development of joint projects, where students participate in real investigations under the guidance of specialists from different disciplines;

– creation of interdisciplinary study groups, in which students from different specialties (lawyers, IT specialists, biologists, etc.) collaborate on forensic cases, simulating real expert group work;

– use of digital platforms to access databases, simulate forensic processes, and enable interdisciplinary student interaction.

Secondly, a competency-based approach. Educational programs should focus on developing professional competencies, including:

– analytical thinking;

– problem-solving skills;

– teamwork abilities;

– oral and written communication skills.

Third, an innovative approach. In today's environment, forensic training is impossible without the use of cutting-edge technologies, such as artificial intelligence, blockchain to ensure the integrity of evidence, as well as modern laboratory tools for DNA analysis, toxicology and digital data.

In addition, it is important to undergo appropriate training-internship with an experienced mentor to gain access to the accumulated experience in the field of forensic examination.

We also emphasize that active participation in professional organizations on platforms for sharing research results, collaborating on complex cases and solving problems and ethical issues in the forensic examination community, and obtaining training opportunities are important for forensic experts to stay abreast of the latest developments, methods and best practices in their field.

The most suitable for the expert system of Ukraine, according to many experts, is the European model of education. It should be noted that in European countries reforms were carried out simultaneously in all spheres of life, including education. Only successful reforms by a country became the basis for becoming a candidate for accession to the European Community. For the training of experts, both general and special criteria were developed, which were reflected in documents on education [22–28].

The developed criteria embodied all the best taken from the activities of various European reformer countries in the field of forensic expertise. Educational reforms in European countries, in turn, began long before the adoption of the Bologna Agreement, ratified on June 19, 1999 in the city of Bologna (Italy), and signed by 29 ministers of education. The document was later called the "Bologna Declaration". With this act, the participating countries agreed on the general

requirements, criteria and standards of the national higher education system, creating the European Educational and Scientific Space since 2010.

Within the framework of this study, for clarity, we will examine the forensic expert training program using the example of the Swiss University L'Université de Lausanne (**Fig. 2.1–2.3**) [28].

The first degree – Bachelor of Criminology/Forensic Science, is the first step in basic scientific training, which allows you to acquire a methodological, scientific and forensic way of thinking.

The bachelor's degree is valued at 180 ECTS credits and usually lasts 6 semesters. The forensic science education program is a comprehensive, interdisciplinary scientific training program that, in addition to forensic science itself, includes subjects from the natural sciences, such as physics, biology, mathematics and especially chemistry, as well as a significant component from the humanities (criminal law, criminology), medicine (forensic medicine) and engineering (computer science, visualization). The proportion of laboratory work is very high in relation to courses and seminars.

To obtain the degree of Bachelor of Forensic Science and Bachelor of Science (BSc) in Forensic Science, it is necessary to be admitted to the University of Lausanne on the basis of their qualifications, in accordance with art. 81 of the RLUL; on the basis of a dossier, in accordance with art. 82b and 82c of the ZZNU and Directive 3.16 of the Executive Board; after a preliminary examination in accordance with art. 82 and 82a of the ZZRP, as well as the Regulation governing the preliminary examination for admission to work in the ESCB, and Directive 3.16 of the Executive Board.

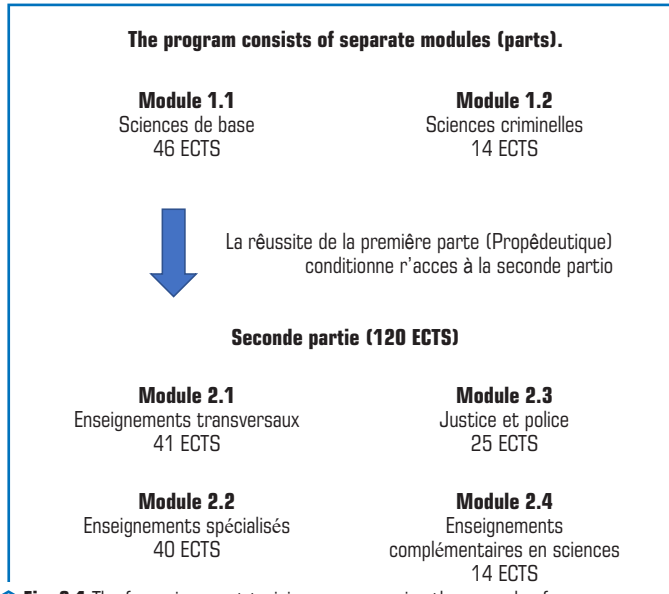

Fig. 2.1 The forensic expert training program using the example of the Swiss University L'Université de Lausanne

The university bachelor's degree curriculum establishes a list of subjects that must be passed in the 1st series of examinations to obtain 60 ECTS credits (module 1). Students must pass the 1st series of examinations for the bachelor's degree during the summer and/or autumn session immediately following the relevant academic year. Failure to meet this requirement will be considered an unsatisfactory grade, except in cases of authorized academic leave or force majeure. The 1st year of study aims to lay the theoretical foundations in chemistry, basic sciences and forensics.

Curriculum
MODULE 1 (60 ECTS) Bachelor's plan

Module 1.1: Fundamental Sciences (46 ECTS)	**Module 1.2: Forensic Science (14 ECTS)**
Mathematics I	General Forensic Science: Typology of Traces
Mathematics II	General Forensic Science: Methodology
Algorithms and Computational Thinking	Introduction to Law/Methodology
Python Programming	Introduction to Criminology
Computation and Networks	
Experimental Physics I	
Experimental Physics II	
Advanced General Chemistry	
Organic Chemistry	
Chemistry TP	

Fig. 2.2 Module 1 of the forensic expert training program using the example of the Swiss University L'Université de Lausanne

In the second module, the program becomes more specialized and focuses more on forensics.

The curriculum lists the subjects, included in module 3. The exams of the third series of the Bachelor of Laws lead to 63 ECTS credits.

Each discipline is considered completed if the grade received is at least 4 or if the assessment is marked as "pass". Upon meeting this requirement, the corresponding ECTS credits for that discipline are awarded.

The curriculum also requires students to engage in independent research on a given topic.

To obtain a Bachelor's degree in forensic science/criminalistics, students must complete all modules within the maximum duration of study. In cases of unsatisfactory academic performance, ECTS credits are granted only for completed modules. A student who fails to complete the university's undergraduate program in forensic science is expelled from the program and is no longer eligible for re-enrollment in this course.

Upon meeting all academic requirements, the student is awarded a degree titled: Baccalauréat universitaire ès Sciences en science forensique/Bachelor of Science (BSc) in Forensic Science/ Bachelor of Science (BSc) in Criminalistics.

The Master of Science in Forensic Science is a graduate program comprising 120 ECTS credits with an expected duration of four semesters. The primary objective of this master's program is to enable students to develop, deepen, and expand the knowledge, acquired during their undergraduate studies in forensic science.

MODULE 2 (120 ECTS credits)

Module 2.1: Interdisciplinary Teaching (41 ECTS credits)	**Module 2.2: Specialized Teaching (40 ECTS credits)**
Microscopy	Papiral Traces
Forensic Tactics	Biological Traces
Introduction to Digital Forensics	Object Traces
Introduction to Interpretation of Scientific Evidence	Detection of Traces of People and Objects
Crime Scene Investigation Techniques	Practical Digital Forensics
Forensic Practice	Exploitation of Digital Traces
Independent Work	Inorganic Microtraces
	Fire Investigation Methods
	Drugs
	Firearms
	Technical Document Examination
Module 2.3: Justice and Police (25 ECTS credits)	**Module 2.4: Additional Science Courses (14 ECTS credits)**
Forensic Investigation	Probability and Statistics
Criminal Law	Biochemistry I
Special Criminal Law	Structural Analysis
Court Organization and Procedure	Analytical Separation Methods
Forensic Medicine	
Introduction to Criminological Methods	

Fig. 2.3 Module 2 of the forensic expert training program using the example of the Swiss University L'Université de Lausanne

This master's program offers three distinct specializations:

– identification: a transdisciplinary curriculum covering key areas of forensic identification, including fingerprint analysis, DNA analysis, biometrics, toolmark examination, firearm examination, and handwriting/signature analysis, with a particular focus on probabilistic methods of interpretation.

– forensic chemistry: this specialization aims to study analytical chemistry methods. The program consists of a theoretical component, complemented by practical laboratory work utilizing analytical chemistry techniques and their forensic applications.

– digital investigation and identification.

Students must choose their specialization upon enrollment in the program.

Thus, the total number of earned credits amounts to 300 ECTS. For comparison, in Ukraine, the equivalent figures are 13 ECTS and 11 ECTS.

In our opinion, there are significant prospects for Ukraine in this field. To align the Ukrainian system with international standards, the following measures should be implemented:

– increase practical training: establish forensic training centers and provide access to modern equipment;

– enhance international cooperation: conclude agreements with foreign universities to facilitate knowledge exchange;

– implement innovations: develop courses integrating artificial intelligence and digital technologies;

– improve ethical training: emphasize accountability for forensic examination results.

By embracing innovation while maintaining a commitment to scientific rigor and ethical principles, forensic experts can harness the power of modern technologies to enhance the accuracy, efficiency, and reliability of their work, ultimately reinforcing the credibility of forensic science.

CONCLUSION

The harmonization of forensic expert training with modern development trends is a strategically important task for ensuring the efficiency of the justice system. An analysis of the experiences of Ukraine and eight leading countries (the USA, Germany, the United Kingdom, France, Canada, Switzerland, Australia, and Poland) highlights several key aspects requiring special attention. Globalization, technological progress, and the intensification of integration processes necessitate a revision of traditional approaches to expert training, prompting the development of new educational models, adapted to contemporary challenges.

An analysis of international experience shows that the most effective forensic expert training systems are based on an interdisciplinary approach that combines theoretical knowledge, practical training, and the use of innovative technologies.

Integrating practical experience into the educational process through the creation of training laboratories, an increased number of internships in real forensic institutions, and student involvement in real casework-will contribute to the development of professional skills and enhance graduates' competitiveness in the labor market.

Additionally, the implementation of innovative technologies, including artificial intelligence, machine learning, blockchain, 3D modeling, and modern laboratory methods, will ensure high accuracy and objectivity in forensic examinations.

International cooperation must function on an ongoing basis. The conclusion of agreements between Ukrainian and foreign universities, the organization of academic exchange programs, and joint research initiatives will facilitate the integration of Ukraine's forensic expert training system into the global community.

A significant aspect is the adaptation of educational programs to international standards, which involves the introduction of mandatory modules on forensic informatics, cybersecurity, and forensic genomics into the curriculum. This harmonization will enhance the competitiveness of Ukrainian experts on a global scale, opening new opportunities for professional growth and international collaboration.

Forensic expert training should encompass not only knowledge of specialized methodologies and procedures but also the development of critical thinking, analytical skills, and the ability to work with large volumes of information. Modern forensic research increasingly relies on big data analysis, requiring experts to effectively use analytical tools, assess the reliability of information, and formulate well-reasoned conclusions.

A particularly important issue is professional ethics and the independence of forensic experts. The development of an ethical culture, high standards of professional ethics, and responsibility for forensic conclusions are crucial for strengthening public trust in the justice system.

Moreover, interdisciplinarity plays a key role. Expanding educational programs by integrating knowledge from related fields (such as psychology, information technology, and natural sciences) will enable specialists to work effectively in response to modern challenges.

Ukraine has already made some progress in this area, particularly in developing educational programs in digital forensics, forensic genomics, and the application of advanced technologies in evidence analysis. However, further modernization is needed, which includes incorporating international experience, expanding funding, and creating conditions for graduates to integrate into the global labor market.

Additionally, the possibility of implementing a dual-degree system for forensic experts should be considered, allowing them to receive education simultaneously at Ukrainian and European institutions. This approach will enhance expert qualifications and support their professional development in an international context.

Thus, the harmonization of forensic expert training with modern development trends is a multifaceted process that requires the synergy of efforts from the state, academic institutions, educational establishments, and international partners. Only through a systematic approach can Ukraine prepare specialists who meet the highest standards and effectively contribute to the justice system.

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CHAPTER 3

CYBER POLYGON AS A TOOL FOR TRAINING CYBERSECURITY PROFESSIONALS

ABSTRACT

The continuous escalation of cyber threats and the evolution of attack methods on information systems necessitate the training of highly skilled cybersecurity professionals who can effectively respond to real-world threats. There is a need for training programs that provide students not only with theoretical knowledge but also with practical experience in countering cyberattacks. Cyber polygons serve as a critical tool in preparing professionals, enabling students to develop vulnerability assessment skills and implement defense strategies in an environment that simulates real-world attack and defense scenarios.

This study is based on the cyber polygon of the Department of Solid-State Electronics and Information Security, which includes a comprehensive suite of training scenarios covering various aspects of cybersecurity. Three key scenarios are outlined in this work. The first involves web application vulnerability scanning using Qualys, allowing students to learn risk assessment and develop recommendations for enhancing security. The second scenario utilizes Metasploitable 2 as a simulation platform for practicing network attack and defense techniques. The third scenario, developed in collaboration with UnderDefense, involves tasks related to GitLab and Active Directory, where students engage in ethical hacking within a corporate infrastructure.

Through the use of the cyber polygon, students gain practical skills in vulnerability detection, risk assessment, and the application of comprehensive protection methods. They also acquire experience in managing Active Directory infrastructure, using LDAP for remote access, analyzing GitLab security, and performing attacks in realistic network environments. Team competitions and work on various scenarios enable students to master both offensive and defensive techniques, including brute forcing, remote code execution (RCE), Server Message Block (SMB), and local privilege escalation (LPE), strengthening their preparedness for careers in cybersecurity.

The training scenarios developed on the basis of the department's cyber polygon provide students with the necessary experience to work in the field of cybersecurity, deepening their understanding of risks and protection methods. The skills acquired enhance their competitiveness in the job market, equipping them to address information system security challenges in contemporary environments. The cyber polygon not only builds professional competencies but also fosters teamwork and strategic thinking, which are critically important for a successful career in cybersecurity.

KEYWORDS

Cyber polygon, cybersecurity, vulnerabilities, Active Directory, GitLab, Qualys, Metasploitable 2, ethical hacking, risk assessment, team competitions, Kerberoasting, pentesting, web application security, RCE, SMB, privilege escalation, LLMNR, educational process, practical training.

In today's world, cybersecurity occupies a central position among the strategic directions in the development of information technologies. The rising number of cyber threats and the rapid sophistication of cybercriminal tactics underscore the demand for skilled professionals. Each year, there is an increase in attacks on corporate, government, and personal systems, highlighting the need for experts who are capable not only of protecting networks and infrastructures but also of anticipating potential threats. To meet these needs, students must acquire not only theoretical knowledge but also practical skills in identifying vulnerabilities and securing systems under realistic conditions.

The primary objective of this chapter is to describe the methodology of cybersecurity training facilitated by the cyber polygon of the Department of Solid-State Electronics and Information Security. This cyber polygon provides students with the opportunity to study modern security tools while immersing them in practical attack and defense scenarios, which strengthens their knowledge and enhances their analytical and technical skills.

The chapter presents the training methods utilized within the cyber polygon, including the use of specialized tools and the organization of team competitions, which aid students in mastering ethical hacking and cyber defense skills.

The Department of Solid-State Electronics and Information Security (hereinafter, SSEIS) at Uzhhorod National University actively incorporates the cyber polygon into the educational process to ensure the practical preparation of students. This cyber polygon, developed using the latest technologies and methodologies in cybersecurity, serves as the foundation for training students through the simulation of real-world scenarios. It allows students not only to study the theoretical foundations of information security but also to apply their knowledge in practice, providing better preparation for their future careers.

The chapter is organized into several key sections, each detailing a specific aspect of the training process on the cyber polygon. The first section provides a detailed description of the cyber polygon and the principles behind its operation. Subsequent sections focus on specific training scenarios: the methodology for vulnerability scanning using the Qualys system, which enables students to gain skills in analyzing the security of web applications; the process of setting up a local network and establishing conditions for team competitions involving attack and defense exercises, demonstrated through the use of Metasploitable 2. The final section explores a new scenario developed in collaboration with UnderDefense, where students work with GitLab and Active Directory, learning contemporary methods of attack and defense within corporate systems.

3.1 OVERVIEW OF THE CYBER POLYGON

The SSEIS cyber polygon is a multifunctional environment designed to simulate real-world cyber threat scenarios and train individuals in effective response techniques. The main objectives of the cyber polygon include: developing students' professional skills and advancing the qualifications of cybersecurity specialists; conducting scientific research and testing new information protection technologies; training and retraining government employees, municipal officials, and military veterans in cybersecurity; and promoting cybersecurity awareness and the profession of cybersecurity experts.

The cyber polygon is tailored for practical exercises, covering aspects of ethical hacking, network science, and infrastructure protection. Within this environment, various scenarios of differing complexity are implemented, bringing students closer to the actual challenges faced by cybersecurity professionals. These scenarios allow participants to refine their offensive and defensive skills, fostering critical and strategic thinking, quick decision-making, and adaptability in the face of cyber incidents.

All scenarios on the cyber polygon closely resemble real-world cases and encompass a full spectrum of tasks that cybersecurity professionals may encounter. Training tasks include both offensive techniques (such as port scanning and vulnerability exploitation) and defensive measures (such as firewall configuration, blocking suspicious IP addresses, and traffic monitoring). Each scenario is designed to build skills in risk assessment and the development of corresponding defense strategies.

The SSEIS cyber polygon consists of an extensive architecture that incorporates various devices and network equipment, providing both attack and defense teams with the necessary resources to simulate cyberattacks and defensive measures. The cyber polygon's architecture is segmented between devices for the defense team and devices for the attack team, enabling the setup of symmetrical engagements in a secure environment.

The cyber polygon includes several types of devices for the blue team (defense), each serving a specific function:

1. Workstations for each defense team member: these workstations allow each defense team member to carry out tasks such as traffic analysis and attack detection and blocking. They are configured to handle complex monitoring and data processing tools that require high computational power and efficiency. The technical specifications for the workstations are as follows:

– CPU: Quad Core Processor or higher, ensuring fast processing of large data volumes and supporting multitasking;

– RAM: minimum of 8 GB, essential for the stable operation of traffic analysis and monitoring applications;

– storage: 128 GB SSD or more, providing quick data read and write speeds during attack simulations;

– graphics adapter: any type of graphics adapter to support graphical interfaces of monitoring software.

2. Honeypots: honeypots serve to create deceptive targets for the attack team. Placed within the operational network, these devices mimic active systems without actual functionality,

which can confuse attackers and lead them to spend time investigating these decoys. This approach allows the defense team to focus on real threats while using honeypots to enhance analytical thinking.

The technical specifications for honeypots include:

– CPU: Dual Core Processor or better, as the workload on these devices is minimal;

– RAM: 2–4 GB, sufficient for supporting basic system functions;

– storage: 64 GB SSD, providing adequate storage for minimal functionality.

3. Server – core of the defense system: the server is the main asset to be protected, housing the target data. As the primary target for the attack team, the defense team's role is to ensure its security and operational stability. This server typically handles high traffic volumes, making it a potential target for DDoS attacks. To withstand such attacks, the server is equipped with high-level resources. The technical specifications for the server are as follows:

– CPU: Quad Core Processor or higher, to endure heavy loads;

– RAM: minimum of 16 GB, necessary for processing intensive traffic and maintaining stability under DDoS conditions;

– storage: 256 GB SSD, providing sufficient speed and storage capacity for safeguarding critical data.

On the cyber polygon, laptops serve as endpoints for the red team (attackers), allowing team members to simulate various types of attacks and attempt to gain access to the protected resources of the defense team. The red team's tasks involve network scanning, vulnerability discovery, executing attacks, and penetrating the target server. Laptops for Attack Team Members: Each member of the attack team is provided with a personal laptop, enabling them to perform different types of attacks, such as port scanning, identifying vulnerable services, and utilizing exploits to penetrate the network. These tasks require high-performance devices to ensure smooth operation of attack and scanning tools. The technical specifications for the laptops used by the attack team are as follows:

– CPU: Quad Core Processor or higher, allowing fast data processing and efficient operation of attack software;

– RAM: minimum of 8 GB, essential for stable performance of scanning tools like nmap, Metasploit, and others;

– storage: 128 GB SSD or more, ensuring quick access to saved data and scan results;

– graphics adapter: basic graphics card, sufficient to support the interface of scanning and attack simulation tools.

Role of virtual machines in Attack Team tasks: all actions by the attack team are performed on virtual machines within VirtualBox, ensuring the security of the cyber polygon's primary infrastructure and allowing quick system resets to the initial state. Each team member uses a virtual machine running Kali Linux, a specialized distribution for security testing. Kali Linux includes a suite of attack and analysis tools, such as nmap, Metasploit, and Wireshark, enabling the red team to conduct a full attack cycle.

Tools used by the Attack Team:

– nmap: for network scanning, identifying active endpoints, open ports, and services;

– metasploit: for executing exploits and testing server and network device vulnerabilities;

– Burp Suite, Hydra, SQLmap: additional tools for web application attacks, password brute-forcing, and database vulnerability analysis.

With this setup, the attack team can simulate full-scale cyber threats, allowing participants to develop practical ethical hacking skills and understand strategies for attacking network infrastructures.

Various types of networking equipment are used to integrate all devices on the cyber polygon into a single network and control access. The cyber polygon includes firewalls, switches, and routers, enabling the creation of a multi-layered network with high levels of security and flexibility:

1. Firewall: the Cisco ASA 5506 firewall is used on the cyber polygon to protect the defense team's network from external attacks and control access to it. The firewall is a primary security tool, as it limits the red team's access to the defense network, reducing the likelihood of unauthorized intrusion.

Key specifications of the Cisco ASA 5506:

– Data Transfer Rate: 750 Mbps, providing a stable connection during high-traffic attack simulations;

– Firewall Throughput: 250 Mbps, enabling the processing of a large number of network requests;

– IDS/IPS Throughput: 125 Mbps, allowing the use of intrusion detection and prevention tools effectively;

– Ethernet Ports: 9, supporting the connection of various defense team devices and protecting the network infrastructure;

– VPN Connections: Up to 50, enabling secure access channels between subnetworks;

– VLAN Connections: Up to 30, facilitating the creation of virtual networks for improved isolation of defense team devices.

The Cisco ASA 5506 allows for the configuration of firewall rules that can restrict access to critical network components and control traffic between subnetworks. Depending on the training scenario, firewall configuration can be performed either by instructors or students, providing hands-on learning opportunities.

2. Switches: switches are used to connect the endpoints of both the attack and defense teams into a unified network. Operating at the data link layer of the OSI model, switches facilitate efficient data transfer between devices within the same team. Switches also support network segmentation, providing flexibility in configuring the network environment for both teams.

3. Routers: routers enable connectivity between the subnets of the attack and defense teams, creating a unified network that allows for interaction between the two teams. This setup is essential for executing various attack types that require direct connections between networks. The cyber polygon utilizes Cisco and D-Link routers, supporting both static and dynamic routing modes, which offer adaptability during simulations of different threat types.

To ensure the cyber polygon's security, the networks of the attack and defense teams are fully isolated from the department's real network, mitigating risks related to infiltration into the

corporate or external networks. Network isolation provides participants with complete freedom to interact with vulnerable systems and model attacks, ensuring that training outcomes have no impact on the department's core infrastructure.

All practical tasks on the cyber polygon are carried out in a virtualized environment using the VirtualBox platform, ensuring infrastructure security and flexibility in scenario configuration. The use of virtual machines allows for quick creation and restoration of training environments, granting participants full autonomy within a secure and isolated setting.

The use of VirtualBox in conjunction with Kali Linux enables the creation of reproducible environments for each student or group of students. Instructors can prepare virtual machines with a pre-installed suite of software and network configurations tailored to specific training scenarios. Upon completion of each session, the system can be reverted to its initial state using snapshots, eliminating the need for prolonged setup times.

Virtualization and the specialized software Kali Linux provide students with a unique opportunity to work with real cybersecurity tools in a secure environment that closely simulates the actual working conditions of a professional.

The network topology created for the SSEIS cyber polygon is shown in **Fig. 3.1**.

Participating in the training scenarios on the cyber polygon offers students invaluable hands-on experience with real cybersecurity tools and a deep understanding of network protection principles and vulnerability assessment. Working on the cyber polygon allows students to master the full cybersecurity cycle – from attack simulation to developing defense strategies. Below, we will review the primary scenarios used on the SSEIS cyber polygon.

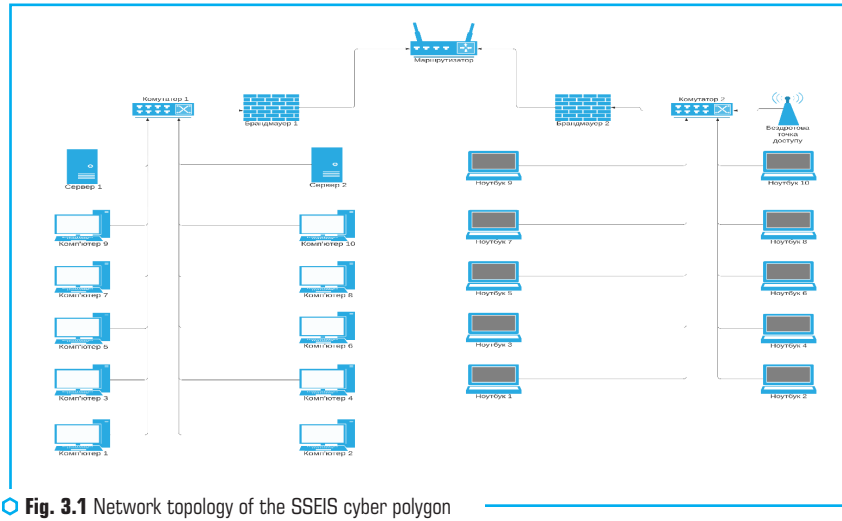


Fig. 3.1 Network topology of the SSEIS cyber polygon

3.2 METHODOLOGY FOR WEB APPLICATION VULNERABILITY SCANNING

Scanning web applications for vulnerabilities is a core responsibility for information security specialists. Modern web applications have become one of the most common entry points for attackers attempting to access confidential information, financial data, or other critical resources. With the rise of digital technologies, web applications are now integral to almost every fiel – from finance to healthcare. Ensuring their security is therefore a priority, as identifying and eliminating vulnerabilities allows specialists not only to protect information assets but also to prevent potential losses that may result from successful attacks.

The primary educational goal of the web application vulnerability scanning task is to develop students' skills in identifying and analyzing vulnerabilities that may compromise the security of information systems. This task is an integral part of the SSEIS cyber polygon training program, where students learn to use advanced tools for automated scanning and results analysis. They also gain insight into the factors that contribute to vulnerabilities, the potential consequences, and methods to mitigate risk.

The task is conducted using the Qualys platform, a leading tool for automated vulnerability scanning widely adopted in the cybersecurity industry. It provides solutions for detecting, assessing, and managing vulnerabilities across IT infrastructures, including networks, servers, workstations, and web applications. Through this platform, students become familiar with an industry-standard tool and learn to apply it under real-world conditions.

In the training process, using Qualys allows for automated security checks, enabling students to focus on analyzing identified issues. The Qualys interface allows students to easily visualize discovered vulnerabilities, assess their criticality and impact on the system, and offers detailed recommendations for remediation. These features are valuable for developing practical skills, as they enable students to understand the complete vulnerability management cycle – from identification to resolution.

This task specifically uses the Qualys Web Application Scanner (WAS), a cloud-based service for automated vulnerability scanning of web applications and APIs. Qualys WAS helps detect a wide range of vulnerabilities, including:

1. OWASP Top 10 Vulnerabilities (the most common threats to web applications), such as SQL injection, cross-site scripting (XSS), and insecure deserialization.

2. Sensitive Data Exposures (PII leaks), which could lead to violations of GDPR, HIPAA, and PCI DSS requirements.

3. Malicious Software – detection of malicious code embedded in web applications that could jeopardize user security and harm the company's reputation.

4. Insecure Configurations and Settings that could leave the web application vulnerable to attacks.

By identifying these threats, students gain a deeper understanding of the processes involved in securing web applications, develop skills in vulnerability analysis and remediation, and prepare themselves for professional roles in cybersecurity.

Before beginning the tasks in this scenario, users need to select a target web application to be tested using Qualys' automated tools. One option is the specialized website of the SSEIS department, designed to help students practice skills in both attacking and defending, making it an ideal platform for scanning. Additionally, students are encouraged to create their own web applications as scanning targets. This approach allows students to develop their own projects – ranging from a simple landing page to a more complex web application with authentication and a database. Once developed, the web application is hosted on the department's cloud servers, ensuring accessibility for subsequent scanning with the Qualys system.

To start using Qualys, each user must create an account with their institutional email. Qualys provides a free trial that allows for limited testing of applications within a set timeframe, enabling students to scan their own web applications without the need for paid services.

After account creation, users proceed to the Web Application Scanning section, where they carry out all primary steps of the task. The main stages of this process include:

1. Creating a web application record in the Qualys system.
2. Configuring scan parameters ("Option Profile").
3. Performing "Discovery" and "Vulnerability" scans to identify elements of the web application and assess existing vulnerabilities.
4. Generating a comprehensive report based on the vulnerability scan for further analysis.
5. Analyzing the report and formulating recommendations to improve the web application's security.

This approach enables students to experience the full cycle of working with a web application from a cybersecurity perspective: from developing their own product to scanning and analyzing its security using the professional tool Qualys.

Qualys provides a detailed approach to creating a web application record, allowing flexible customization of the scanning process. In the first step, users choose whether to create a new record "from scratch" or integrate elements from previously tested web applications. Within this scenario, students use the "clean" record option to familiarize themselves with all the customization features Qualys offers for creating a web application record.

Main Record Configuration Stages:

1. Asset Details: in this section, users enter the web application's name, URL, and attributes to facilitate easy identification of this record among others in the Qualys system.

2. Application Details: this section allows configuration of the web application's scan structure. Here, users can select specific URLs to scan, define the API type (or leave it unset if not applicable), which is convenient for simple web applications like landing pages. For complex applications, correctly configuring this section helps focus on critical components, optimizing scanning time.

3. Scan Settings: Scan settings can be configured later if needed, but here, users can: add an Option Profile for future scanning; select the type of scanner – external (recommended), internal (for networks), or a scanner appliance; assign a scanner to the record to prevent changes by other users; set a time limit for the scan; add robots.txt and sitemap.xml files; and configure header injections.

4. Crawl Settings: defines crawling options for testing scenarios. Integrating Selenium scripts for automated testing actions within the web application allows for personalized scanning scenarios.

5. Redundant Links: excludes unnecessary links from the scan process, which can reduce scan time and focus attention on the critical parts of the application.

6. Authentication: sets authentication parameters such as login credentials. For simple websites, this section may often be optional.

7. Exclusions: selects scan exclusions, allowing users to skip certain vulnerabilities and concentrate on critical areas.

8. Advanced options: additional parameters such as DNS Override and scan forms, which allow for more detailed scan configuration.

9. Malware monitoring: enables malware monitoring, a valuable tool for ongoing security monitoring, especially during the development stage and when testing new updates.

These settings allow students to configure the web application record in Qualys to focus the scanner on relevant aspects, avoid redundant actions, and ensure a high level of detail in the scanning process.

The next step is to create an Option Profile, which is a set of instructions defining the scanning configuration for the web application in Qualys (**Fig. 3.2**). The Option Profile includes all the necessary parameters to specify which aspects should be scanned and with what level of intensity. This setup allows the scan process to be tailored to the unique needs of the web application, improving the accuracy of vulnerability detection.

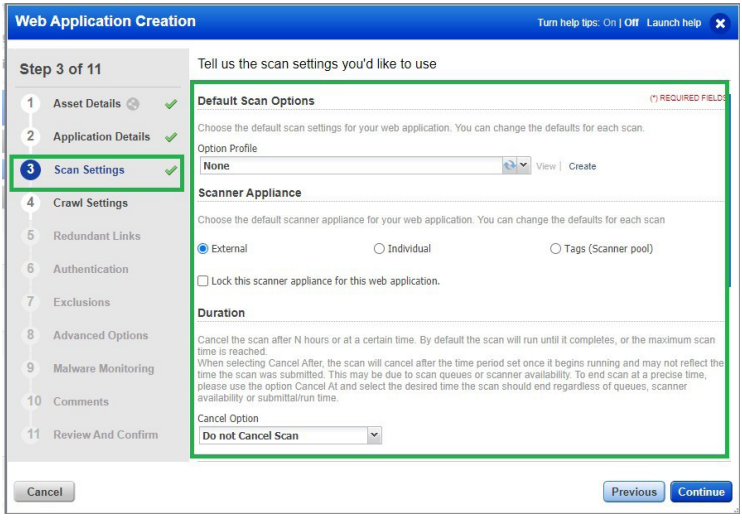


Fig. 3.2 Creating a web application record in the Qualys system

Main configuration elements of Option Profile cover the sections scan parameters and search criteria:

1. Scan Parameters – the main configuration block for setting the scan's intensity and specific characteristics (**Fig. 3.3**). It includes several sections:

– general settings: in this section, the user selects the types of requests to be sent to the website (GET, POST, GET & POST, or None) and can set the number of unique forms to process, optimizing scan time. Additional settings include the maximum number of links to scan, agents for simulating user access, parameter templates, and the option to ignore common binary files;

– crawling options: allows the choice between full or "smart" page scanning. Full scanning covers all page components, whereas "smart" scanning focuses on core elements to optimize time, ignoring less critical parts. For this scenario, full scanning is recommended;

– behavior settings: sets a limit on the number of errors after which the scan will automatically stop. For instance, timeouts can be configured for working with slower sites, as well as handling unexpected errors;

– performance settings: enables selection of detailed or simplified scanning levels and customization of intensity – from minimal to high – based on the precision and duration requirements of the scan;

– bruteforce settings: here, the user specifies whether a bruteforce attack should be conducted on the web application.

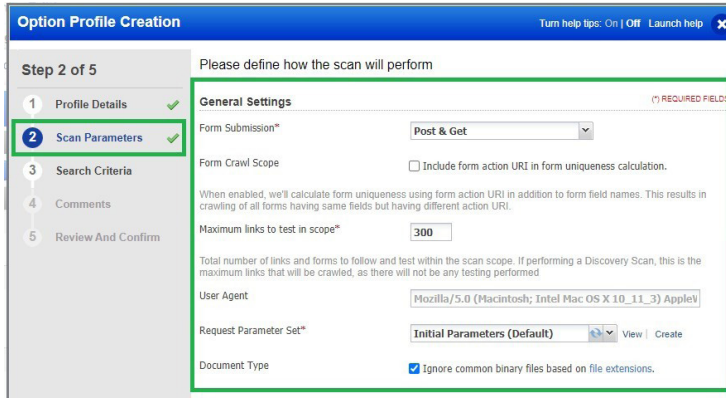


Fig. 3.3 Creating an option profile

2. Search Criteria – a section for selecting additional criteria to enhance scan quality:

– detection scope: allows selection of the detection type and specifies if additional XSS payloads will be used to check for cross-site scripting vulnerabilities;

– sensitive content: specifies the types of sensitive information to which the scanner should pay attention, such as credit card numbers or social security data;

– keywords URL search: enables the specification of keywords for URL searches, which can narrow the scan focus and speed up the identification of critical elements.

This detailed Option Profile configuration allows students to tailor the scan to the requirements of a specific web application and focus on identifying the most critical vulnerabilities essential for ensuring information security.

The next stage is performing Discovery and Vulnerability scans based on the created Option Profile. The Discovery scan is aimed at gathering information about the web application, which can be useful for identifying vulnerabilities (**Fig. 3.4**). This preliminary scan collects data on the website's structure, configurations, and characteristics, enhancing the efficiency of the main Vulnerability scan. The Vulnerability scan, in turn, conducts a thorough examination of the web application to uncover potential security risks (**Fig. 3.5**).

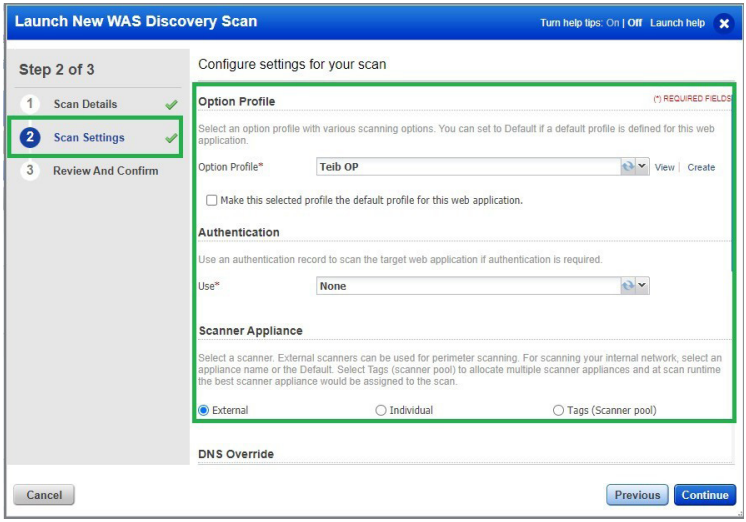


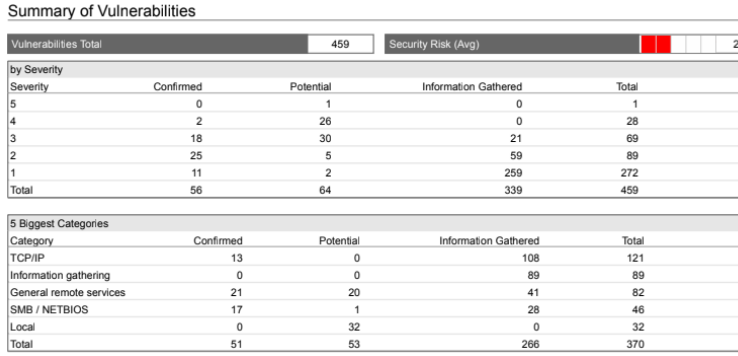
Fig. 3.4 Discovery scan settings

Qualys provides detailed scan customization options to enhance efficiency, allowing a focus on specific components of a web application or types of vulnerabilities. These settings include:

1. Scan details: this section allows users to define the main scan details, including its name, criteria for selecting web applications (by name or tags), and the specific web application to scan from the list of available applications.

2. Scan settings: this part includes all critical parameters for the upcoming scan, such as: selecting a previously created Option Profile; setting authentication parameters (if needed); choosing the type of scanner (external, internal, or a scanner appliance); activating DNS Override, setting a time limit for the scan or leaving the option "Do not stop"; and deciding whether to send email notifications upon scan completion.

After completing the Discovery scan, a full Vulnerability scan should be run with the same settings as for the Discovery. The results can be viewed in the Qualys web interface or downloaded in a convenient format.



Summary of Vulnerabilities

Vulnerabilities Total	459	Security Risk (Avg)	2.4

by Severity

Severity	Confirmed	Potential	Information Gathered	Total
5	0	1	0	1
4	2	26	0	28
3	18	30	21	69
2	25	5	59	89
1	11	2	259	272
Total	56	64	339	459

5 Biggest Categories

Category	Confirmed	Potential	Information Gathered	Total
TCP/IP	13	0	108	121
Information gathering	0	0	89	89
General remote services	21	20	41	82
SMB / NETBIOS	17	1	28	46
Local	0	32	0	32
Total	51	53	266	370

Fig. 3.5 Overview of vulnerabilities found in the report

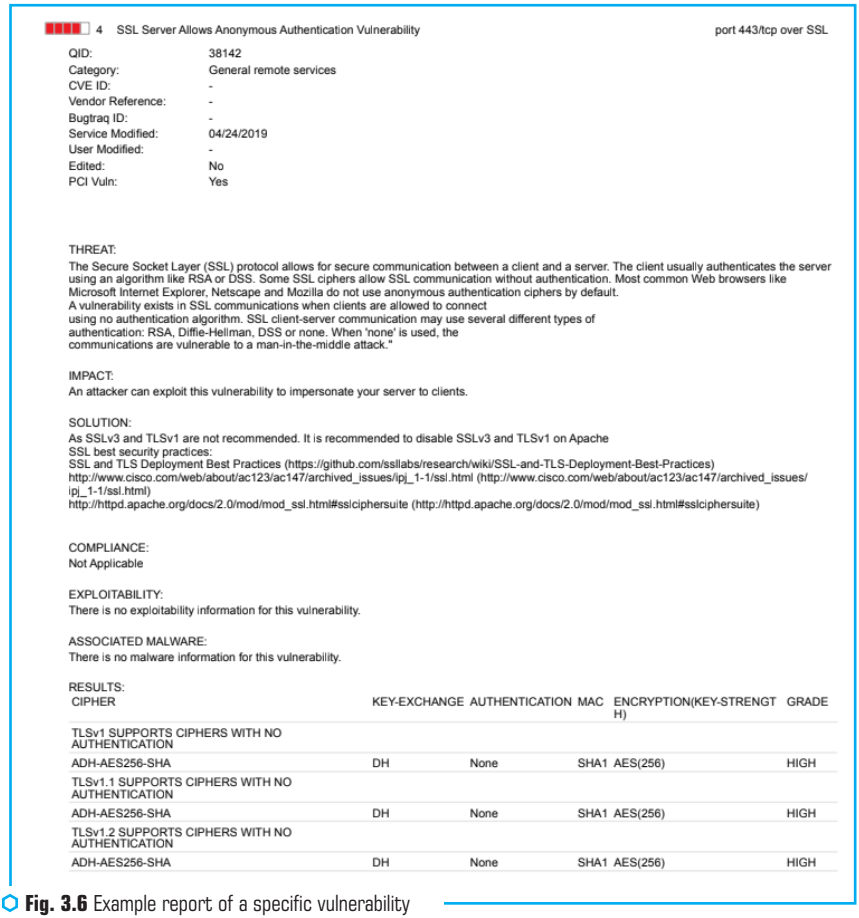
The analysis of results is a key stage in this scenario since the scanning process itself is automated. The ability to interpret a detailed report, highlight main issues, and propose solutions is an essential skill for cybersecurity professionals. This enables them to present scan results to clients in a clear format, pointing out necessary fixes and explaining methods to address vulnerabilities.

The report provided by Qualys is technically comprehensive and includes the following elements (**Fig. 3.6**):

1. The total number of identified vulnerabilities.
2. A breakdown of vulnerabilities by severity.
3. Information on operating systems and active services.
4. Detailed descriptions of each vulnerability, along with remediation recommendations.

Based on this technical report, students are tasked with creating a concise summary highlighting key vulnerabilities and proposing remediation measures. This scenario not only familiarizes them with the automated scanning process but also develops their skills in prioritizing risks, linking vulnerabilities to potential business impacts, and distilling essential information.

The exercise teaches students to present core insights in a way that is accessible to clients, even those without technical expertise in cybersecurity. This approach helps clients assess the security level of their web application and identify necessary actions to enhance its protection.



4 SSL Server Allows Anonymous Authentication Vulnerability — port 443/tcp over SSL

QID:	38142
Category:	General remote services
CVE ID:	-
Vendor Reference:	-
Bugtraq ID:	-
Service Modified:	04/24/2019
User Modified:	-
Edited:	No
PCI Vuln:	Yes

THREAT:
The Secure Socket Layer (SSL) protocol allows for secure communication between a client and a server. The client usually authenticates the server using an algorithm like RSA or DSS. Some SSL ciphers allow SSL communication without authentication. Most common Web browsers like Microsoft Internet Explorer, Netscape and Mozilla do not use anonymous authentication ciphers by default.
A vulnerability exists in SSL communications when clients are allowed to connect
using no authentication algorithm. SSL client-server communication may use several different types of
authentication: RSA, Diffie-Hellman, DSS or none. When 'none' is used, the
communications are vulnerable to a man-in-the-middle attack."

IMPACT:
An attacker can exploit this vulnerability to impersonate your server to clients.

SOLUTION:
As SSLv3 and TLSv1 are not recommended. It is recommended to disable SSLv3 and TLSv1 on Apache
SSL best security practices:
SSL and TLS Deployment Best Practices (https://github.com/ssllabs/research/wiki/SSL-and-TLS-Deployment-Best-Practices)
http://www.cisco.com/web/about/ac123/ac147/archived_issues/ipj_1-1/ssl.html (http://www.cisco.com/web/about/ac123/ac147/archived_issues/ipj_1-1/ssl.html)
http://httpd.apache.org/docs/2.0/mod/mod_ssl.html#ssliphersuite (http://httpd.apache.org/docs/2.0/mod/mod_ssl.html#ssliphersuite)

COMPLIANCE:
Not Applicable

EXPLOITABILITY:
There is no exploitability information for this vulnerability.

ASSOCIATED MALWARE:
There is no malware information for this vulnerability.

RESULTS:

CIPHER	KEY-EXCHANGE	AUTHENTICATION	MAC	ENCRYPTION(KEY-STRENGTH)	GRADE
TLSv1 SUPPORTS CIPHERS WITH NO AUTHENTICATION					
ADH-AES256-SHA	DH	None	SHA1	AES(256)	HIGH
TLSv1.1 SUPPORTS CIPHERS WITH NO AUTHENTICATION					
ADH-AES256-SHA	DH	None	SHA1	AES(256)	HIGH
TLSv1.2 SUPPORTS CIPHERS WITH NO AUTHENTICATION					
ADH-AES256-SHA	DH	None	SHA1	AES(256)	HIGH

Fig. 3.6 Example report of a specific vulnerability

3.3 RED AND BLUE TEAM COMPETITIONS ON THE CYBER POLYGON

Red and blue team competitions are a crucial component of cybersecurity training, as they simulate real cyber conflicts. In this training format, the red team acts as attackers, emulating the

actions of malicious actors, while the blue team is responsible for defense, responding to attacks, and ensuring system stability. This approach allows students to not only develop both offensive and defensive skills but also gain hands-on experience managing cyber incidents, which is invaluable for their professional growth.

The educational goal of this format is for students to learn how to analyze attack tactics and methods, devise their own defense strategies, and respond to threats swiftly. This fosters strategic thinking, enabling students to anticipate potential adversary scenarios and prepare accordingly. Mastering both attack and defense skills provides students with a comprehensive understanding of cybersecurity, helping them assess system weaknesses from both perspectives.

Beyond technical skills, red and blue team competitions foster "soft" skills such as teamwork, effective communication, decision-making under pressure, and adaptability to unpredictable situations. Students learn to coordinate their actions to achieve a common objective, which is a vital aspect of working in cybersecurity.

The red and blue team competition scenario on the cyber polygon is one of the first developed and involves a direct contest between the attacking (red) and defending (blue) teams. The red team's task is to gain access to the blue team's network infrastructure using any available tools, while the blue team learns to analyze traffic, block malicious network actions, and ensure the continuous operation of its systems.

This scenario's environment encompasses all major features of the cyber polygon. The red and blue teams are stationed in separate rooms without direct contact with each other. Each team has access to a specified set of hardware and software. The red team is equipped with ten laptops and a switch connecting all devices into a local network. Their software includes tools like nmap and Metasploit. The blue team has ten computers, two servers, a switch for network connectivity, and a router that links them to the red team's network. Additionally, the defense team has access to other cyber polygon resources, such as firewalls, servers, and intrusion detection/prevention systems (IPS/IDS). Although these additional tools are not required in the basic scenario, students can configure them to increase security and complicate the task for the opposing team.

All operations within the cyber polygon for this scenario are conducted on virtual machines. This ensures isolation from the cyber polygon's core devices, preventing potential vulnerability issues and facilitating the deployment and reset of systems to their initial state after the competition ends. Virtual machines are deployed using VirtualBox, a popular virtualization software known for its user-friendliness, relative simplicity, and support for major operating systems. Kali Linux is the operating system used for the virtual machines.

Kali Linux is a Debian-based Linux distribution specialized in security testing. For ease of use, Kali Linux includes a "Top 10 Security Tools" category, featuring widely-used security tools such as aircrack-ng, burp-suite, hydra, john, maltego, metasploit, nmap, sqlmap, wireshark, and zaproxy. This setup provides quick access to essential tools for various cybersecurity tasks, allowing the red team to efficiently simulate real-world attack scenarios.

Kali Linux also provides a comprehensive suite of tools for specialized tasks, including:

1. Reverse Engineering: Tools for debugging programs or analyzing executable files.

2. Stress Testing: Tools for endurance testing of networks, web environments, and VOIP systems.

3. Hardware Hacking: Utilities for working with Android and Arduino devices.

4. Forensics: Digital forensics tools such as Volatility, Autopsy, and Guymager, used for disk imaging, memory analysis, and file examination.

The main target of the competition is a server computer, which serves as the core objective in the scenario. The red team's goal is to gain access to this server, while the blue team must protect it, prevent unauthorized access, and block any attacks. The server runs Metasploitable 2 – a Linux distribution intentionally designed to be vulnerable for testing and demonstration of common security weaknesses.

Metasploitable 2 is designed to work with security tools and to provide a practical learning environment for common vulnerabilities (**Fig. 3.7**). This virtual machine is supported on platforms such as VirtualBox, VMware, and other popular virtualization environments. By default, the network interfaces of Metasploitable 2 are configured to NAT and Host-only, restricting access to external networks. While it is technically possible to install Metasploitable 2 as a primary or auxiliary operating system, this is strongly discouraged due to the numerous intentionally embedded vulnerabilities. The optimal approach is to deploy Metasploitable 2 as a virtual machine in VirtualBox, connected to the primary server of the blue team.

All systems in this scenario are designed to function without Internet access, meaning the cyber polygon environment is fully isolated from the department's main network. This approach allows students to work in a secure setting without concerns over potential consequences from interacting with real networks. The isolation ensures both a safe and convenient work environment as well as the security of the entire infrastructure.

The attack team follows several crucial steps to gain access to the target server and analyze its vulnerabilities for potential intrusion:

1. Scanning the Blue Team's Network: the first task for the red team is to scan the defense team's network to identify the endpoints, operating systems installed on them, open ports, and services running on each port. Armed with this information, the attack team can determine potential targets and entry points. This task is performed using the nmap utility included in Kali Linux.

Nmap (Network Mapper) is a popular and versatile network scanning tool used by cybersecurity professionals to quickly identify active devices, open ports, services, operating systems, and vulnerabilities within a network infrastructure. With Nmap Scripting Engine (NSE) capabilities, it enables not only basic scans but also specialized attacks. Using NSE, the attack team can discover vulnerabilities, exploit services, read service banners, and perform basic security audits.

Through these steps, the red team can systematically uncover weaknesses, analyze the defense team's network, and simulate potential attack paths, enhancing their understanding of penetration testing and cybersecurity tactics in a controlled, isolated environment.

2. Vulnerability identification in discovered services. After identifying the server running Metasploitable 2 and gathering information about open ports, service names, and versions, the attack team proceeds to search for vulnerabilities in one or more of the discovered services. Each team member typically focuses on a different service, with each task directed at exploring specific vulnerabilities within that service. This approach allows the team to leverage the full potential of Metasploitable 2 and gain comprehensive hands-on experience.

By dividing tasks among members, the red team can systematically investigate a wide range of services, analyzing each for known vulnerabilities that could be exploited. This targeted exploration provides a holistic view of vulnerability management and penetration testing, enhancing the team's ability to identify, assess, and exploit potential weaknesses in a real-world simulation environment.

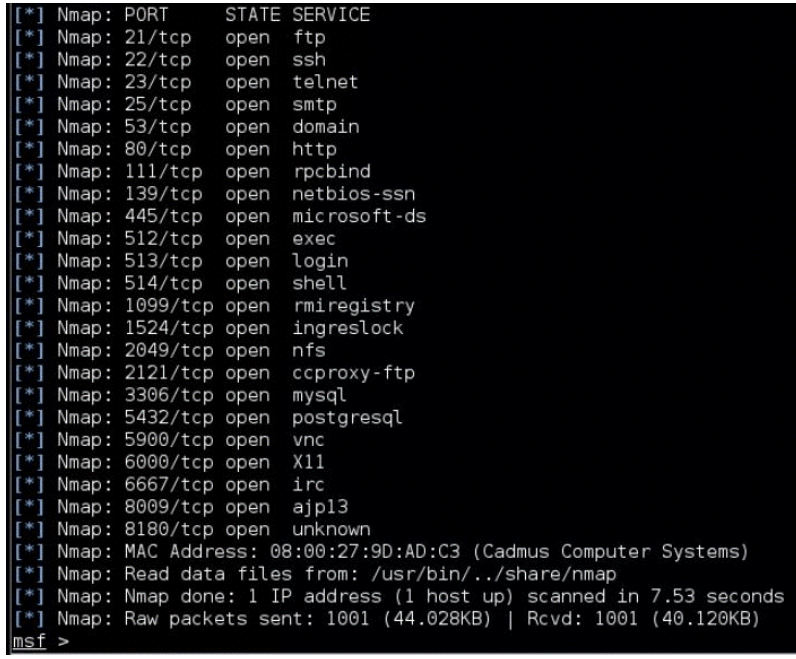


Fig. 3.7 Example of nmap scan results for Metasploitable 2

Metasploitable 2 contains an extensive list of vulnerable services across various ports. For each service, detailed information is available, helping the attack team understand which vulnerabilities can be exploited to gain access to the server. This information serves as a critical guide for targeting specific services and planning effective exploitation strategies (**Table 3.1**).

Table 3.1 Information on Entry Points in Metasploitable 2

Port No.	Service	Version	Exploite
21	FTP (vsftpd)	2.3.4	vsftpd 2.3.4 Backdoor
22	SSH	OpenSSH 4.7p1 Debian	Debian OpenSSL Predictable RNG
23	Telnet	Linux telnetd	No direct exploit
25	SMTP (Postfix)	Postfix 2.9.6	No direct exploit
53	DNS (Bind)	9.4.2	BIND TSIG Remote DoS
80	HTTP (Apache)	2.2.8	Apache Tomcat Manager Exploit
111	RPCbind	2.0	RPC DCOM Remote Overflow
139	NetBIOS/SMB	Samba 3.0.20	Samba Trans2open Overflow
445	SMB	Samba 3.0.20	Samba Trans2open Overflow
512	exec	BSD rexec	Remote Command Execution
512	login	Linux login service	No direct exploit
513	rlogin	BSD rlogin	Remote Command Execution
514	shell	BSD rsh	Remote Command Execution
1099	RMI Registry	Java RMI	Java RMI Server Insecure
1524	Ingreslock	Ingres Database	Ingreslock Backdoor
2049	NFS	Network File System	No direct exploit
2121	FTP (ProFTPD)	1.3.1	ProFTPD 1.3.1 Mod_copy Command Execution
3306	MySQL	5.0.51a	MySQL Remote Root Exploit
5432	PostgreSQL	8.3.0	PostgreSQL Pwnage
5900	VNC	VNC	VNC Authentication Bypass
6000	X11	X11 Server	Open X11 Server Exploitation
6667	IRC (UnrealIRCd)	UnrealIRCd 3.2.8.1	UnrealIRCd Backdoor Command Execution
8180	HTTP (Tomcat)	Apache Tomcat 5.5	Tomcat Manager Application Exploit

3. Exploitation and Persistence of Access. Using the gathered information on vulnerabilities, the attack team deploys appropriate exploits to gain access to Metasploitable 2 (**Fig. 3.8**). This task typically involves creating a "trace" – a file that logs details such as the port number, service name, version, the exploit used, and the timestamp of the intrusion. If access is gained through a database (such as MySQL or PostgreSQL), the task might include adding an entry to a table that has been pre-created by instructors.

At this stage, the attack team achieves its objective by securing access to the server and leaving a trace in the form of a file or database entry. This trace serves as evidence of task completion, marking the successful execution of the attack scenario.

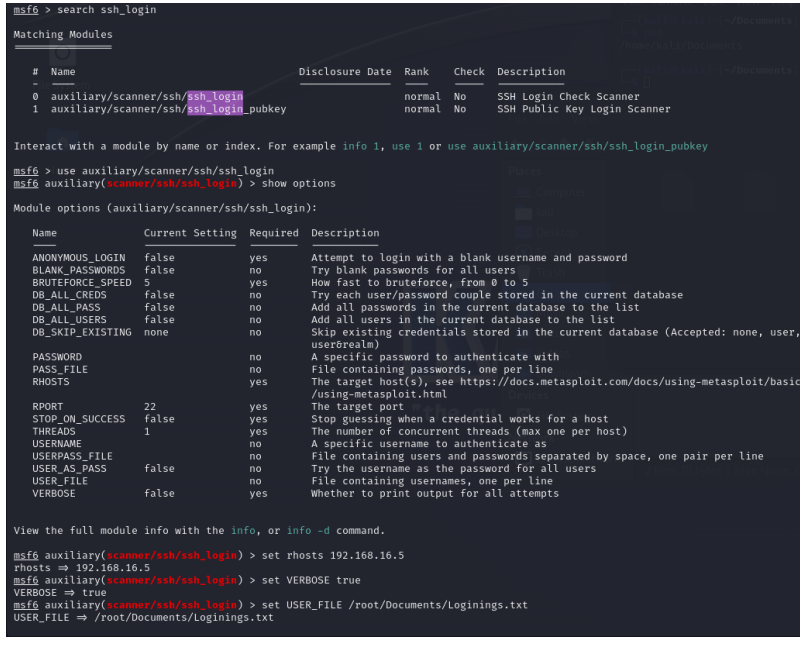


Fig. 3.8 Example of SSH Vulnerability Exploitation Using the Metasploit Framework

Defense Team tasks divided by knowledge level:

1. Monitoring and documenting Attack Team actions: for entry-level blue team members, the primary task is to monitor and document the actions of the attack team in detail. This approach is crucial for cybersecurity professionals, as a comprehensive cyber incident report, presented in clear language, enables management to understand the issue's nature and decide on preventive measures for the future. Effective report writing requires the ability to include all essential information about the threat source, attack methods, and potential impacts.

2. Active countermeasures against the Attack Team: for those with sufficient knowledge, the blue team members can directly counter the actions of the attack team. This includes actively monitoring the attackers' actions, analyzing server vulnerabilities, quickly patching these weaknesses,

and blocking unauthorized access to the network. In case an attack does occur, the defense team can block access to their infrastructure using the attackers' IP or MAC addresses.

The defense team uses Wireshark, a tool for in-depth packet analysis, for active network monitoring. With Wireshark, the blue team can: detect anomalies in network traffic that may indicate unauthorized access attempts (**Fig. 3.9**). Capture packets that could contain exploits or signs of port scanning. Identify the attackers' IP and MAC addresses, allowing for rapid localization of the attack source.

Tools such as Suricata and Snort offer automated threat detection by analyzing traffic in real-time, making them valuable additions for advanced network monitoring and strengthening the defense team's capabilities against complex attacks.

For vulnerability analysis, the defense team can use nmap to gather information on open ports and services, as well as to identify outdated or vulnerable components. nmap's insights help the team better understand network topology and find weaknesses in the configuration.

Upon detecting unauthorized access attempts, the defense team can implement several blocking methods:

1. Blocking the attackers' IP or MAC addresses at the firewall level to restrict network access.

2. Setting up traffic filtering to limit access from suspicious IP addresses or network segments used by the attack team.

3. Using Network Access Control (NAC) to restrict network access to authorized MAC addresses or according to specific access policies.

These measures help isolate the infrastructure from potential threats and maintain network control, even in case of intrusion.

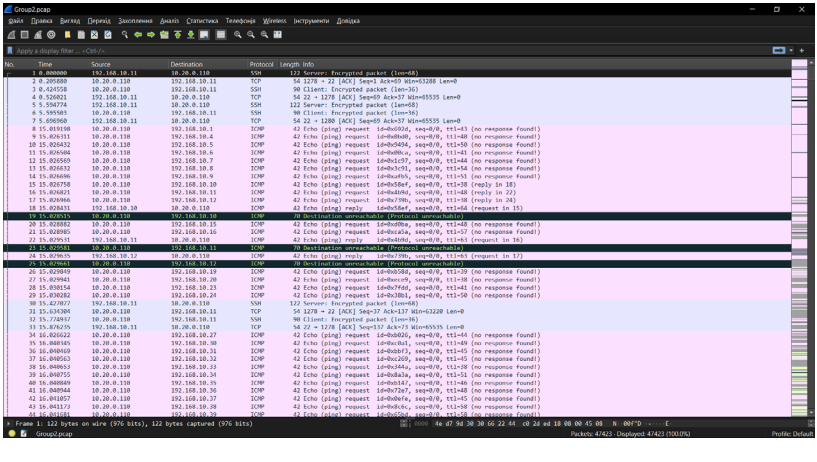


Fig. 3.9 Example of Using Wireshark for Network Traffic Analysis

Through participation in the red and blue team competition, students gain valuable hands-on experience in configuring network devices, identifying vulnerabilities, and securing network infrastructure.

Throughout the exercise, students develop skills in network scanning, traffic analysis, and threat detection, which provides them with a deeper understanding of network operations and security methods.

Red team members learn to apply scanning techniques, identify vulnerabilities in services running on open ports, and use exploits to penetrate vulnerable systems. They gain proficiency with tools like nmap and Metasploit, understand ethical hacking methods, and appreciate the importance of vulnerability remediation, helping them grasp the mindset of potential adversaries.

The blue team hones its skills in actively defending the network, identifying cyber threats, responding swiftly to incidents, and documenting cyber incidents in a clear and accessible manner. By working with tools like Wireshark, Suricata, and Snort, students practice techniques for traffic analysis and attack blocking, enabling them to operate effectively both in monitoring mode and in active defense against attackers.

This training format provides students with a comprehensive understanding of cybersecurity, fostering strategic thinking and teamwork skills essential for real-world cybersecurity roles.

3.4 PRACTICAL CYBER DEFENSE SCENARIO FOR CORPORATE INFRASTRUCTURE DEVELOPED IN COLLABORATION WITH UNDERDEFENSE

A new training scenario on the SSEIS cyber polygon, developed in partnership with UnderDefense, focuses on in-depth cybersecurity skills, particularly in detecting and exploiting vulnerabilities within complex network infrastructures. This scenario is designed for hands-on learning of ethical hacking methods and protection of critical systems, such as GitLab servers and Windows Active Directory (AD) infrastructure. Students participating in this scenario gain practical knowledge of attack and defense stages within corporate networks, aligning their experience closely with real-world cybersecurity tasks.

The primary goal of the scenario is to familiarize students with comprehensive techniques that allow them to understand the architecture of modern corporate networks, identify potential threats, and implement effective security measures. Through this scenario, students develop the following key skills:

1. Identifying external perimeter vulnerabilities: using brute-forcing techniques to locate services and exploiting vulnerabilities for remote code execution (RCE).

2. GitLab and SSH operations: exploring open repositories for confidential data (e.g., SSH keys) and accessing the server through SSH.

3. Privilege escalation on Ubuntu server: utilizing known exploits, such as pkexec (LPE), to gain elevated privileges.

4. Active directory (AD) attacks: discovering and exploiting weaknesses in SMB configurations, executing Kerberoasting, and using techniques to obtain administrative rights.

5. Traffic monitoring and interception: analyzing data, including LDAP requests, to practice information protection skills.

The scenario's development was made possible through collaboration with UnderDefense, a company that provides cybersecurity support and expertise in ethical hacking methodologies. UnderDefense contributed expert knowledge in attack scenario formulation, vulnerable system setup, educational case creation, and access to up-to-date vulnerabilities, particularly with GitLab and Active Directory. This collaboration ensures that the training tasks meet modern industry standards and cybersecurity needs.

Scenario Components: external and internal network perimeters:

1. External perimeter: the external perimeter includes an Ubuntu 20.04 server hosting GitLab, with a Pre-Auth RCE vulnerability (CVE-2021-22205) and other exploits like pwnkit for privilege escalation. In this phase, students use brute-forcing methods to locate GitLab, access an SSH key, establish a connection with the server, and subsequently elevate privileges to an administrator level.

2. Internal perimeter (AD network): the internal perimeter contains an Active Directory-based network, including a Domain Controller (DC) and two workstations. Students explore SMB signing issues, LLMNR, and perform various AD attacks, such as Kerberoasting, traffic interception, and NTDS.DIT extraction. This stage simulates real threats arising from improper corporate network configurations.

This scenario allows students to practice network infiltration across different complexity levels and develop a comprehensive approach to identifying, analyzing, and mitigating cybersecurity threats.

In this scenario, the external perimeter is represented by an Ubuntu 20.04 server with GitLab installed, serving as the primary external target for the red team. The server configuration is specifically designed to illustrate key principles of ethical hacking and assess the security of an organization's external infrastructure. The server includes several known vulnerabilities that students can leverage to complete their tasks.

GitLab serves as one of the primary services commonly used in real corporate infrastructures for code hosting, project management, and collaboration. In this scenario, GitLab is configured as a publicly accessible service on the Ubuntu server, allowing students to use subdomain enumeration and visible service analysis techniques to locate GitLab within the network. Once detected, students can attempt to exploit GitLab vulnerabilities to gain access to the server.

The server runs an outdated version of Ubuntu 20.04 LTS, containing several critical vulnerabilities that can be used for privilege escalation. One major vulnerability is pwnkit (related to the pkexec command), which enables Local Privilege Escalation (LPE). Pwnkit is a well-known vulnerability that allows a non-authenticated user to gain root access to the system by exploiting a misconfiguration in the pkexec command.

This server setup, which includes such vulnerabilities, enables students to practice exploiting weaknesses in outdated software. The primary objective of this phase is to teach students the

impact of these vulnerabilities on infrastructure security and to demonstrate how a lack of regular updates can create entry points for attackers.

The attack phases on the external perimeter in this scenario are structured to allow students to complete the full cycle from service detection to system control through vulnerability exploitation. Each step is based on real-world penetration methods, allowing students to gain hands-on experience with cybersecurity tools:

1. Discovery phase using ffuf: in the initial phase, the attack team uses ffuf (Fast web Fuzzer) to brute-force subdomains and virtual hosts to locate the GitLab server, which will be the target for further penetration. With ffuf, students search for existing subdomains and hidden services that may not always be visible through standard scans. This stage helps students develop skills in active information gathering and configuring ffuf for discovering subdomain variations that may house critical services.

2. Exploitation of the Pre-Auth RCE vulnerability (CVE-2021-22205): after locating the GitLab server, the next step is exploiting the Pre-Auth RCE vulnerability (CVE-2021-22205). This vulnerability allows command execution on the server without requiring authentication. Students can use this vulnerability to gain initial access to the server, highlighting the severe consequences of not regularly updating GitLab. In this phase, students learn to use public exploits for RCE vulnerabilities and gain an understanding of the importance of proper server configuration.

After gaining access, students continue their investigation by reviewing the contents of Git repositories, which may contain confidential information. One possible way to obtain SSH access is by finding SSH keys that were accidentally left in a public repository. After locating and verifying the SSH key, students establish an SSH connection to the server using the discovered key, granting them full access to the system. This step emphasizes the importance of proper access key management and removing sensitive information from public repositories.

The final stage involves privilege escalation on the server to obtain root-level access. Students exploit the pkexec vulnerability (a flaw in pwnkit) that allows Local Privilege Escalation (LPE) on Ubuntu. Using this vulnerability, students can escalate privileges and gain complete control over the server. This stage introduces students to the risks associated with outdated software and provides insight into methods for mitigating such vulnerabilities.

By following these steps, students learn the full process of penetrating the external perimeter of a corporate network, which includes active target discovery, vulnerability exploitation for access, searching for sensitive data in repositories, and privilege escalation to establish system control.

The internal perimeter of the corporate network in this scenario is represented by an Active Directory (AD) infrastructure that includes one AD server and two workstations. This setup mimics a typical corporate network architecture, which is often a target for attacks aimed at gaining access to internal resources. The main objective for the attack team is to compromise AD and access user data, while the defense team's goal is to prevent attacks and protect critical infrastructure components.

The internal network is divided into several components that replicate a real corporate system environment. In this part of the scenario, students work with typical AD configurations and common vulnerabilities that often remain exposed in networks due to misconfigurations:

1. Active directory (AD) server: the AD server functions as a centralized management system responsible for user authentication, access control, and permissions management within the internal network. The AD server stores user accounts, security policies, and other configurations, making it a primary target for attacks aimed at accessing critical information. Students explore attack methods on AD, such as Kerberoasting and information gathering through LDAP queries, to understand vulnerabilities characteristic of this infrastructure.

2. Two workstations: the workstations are components of the internal network and play an important role in this scenario. They are used as intermediate targets through which the attack team can reach the AD server or other resources. In a real corporate environment, workstations are often attacked due to accessible resources, SMB settings, and other services. In this scenario, students exploit vulnerabilities related to the absence of SMB signing and LLMNR (Link-Local Multicast Name Resolution) to access internal resources and gather information about other devices on the network.

SMB Signing and LLMNR Configuration. SMB Signing: The lack of SMB signing on workstations makes them vulnerable to attacks that allow adversaries to intercept or modify data transferred between devices.

In this scenario, students exploit this vulnerability to conduct a Pass-the-Hash attack, enabling them to compromise workstations and use the captured hashes to access other resources. LLMNR (Link-Local Multicast Name Resolution): LLMNR is a protocol used for resolving local names within a network, but it can become a security risk if not properly protected. Students learn to use LLMNR to capture account hashes and perform attacks related to local name resolution implementation. This protocol allows attackers to gather information for further attacks on AD or other network resources.

The AD server is the main target that the attack team aims to reach. Compromising it provides access to all user accounts and critical information about the internal network.

Workstations are used as intermediate targets for gathering information, breaking user accounts, and accessing the AD server. Students learn to leverage weak configurations to gradually penetrate the network, which helps them develop skills in privilege escalation and identifying vulnerabilities in Windows-based environments.

Attacks on the internal AD network perimeter in this scenario involve gradual network penetration through vulnerability discovery, credential compromise, and access to critical systems. This progression allows students to experience the full escalation path within a corporate environment and gain practical skills with real attack methods.

In the first stage, the attack team scans the network for vulnerabilities to identify security misconfigurations on three hosts within the internal network, specifically:

1. Lack of SMB signing, allowing attackers to intercept or alter data exchanged between hosts.

2. Active LLMNR (Link-Local Multicast Name Resolution), which can be used to intercept hostname requests and capture account hashes.

Using these vulnerabilities, students learn to gain initial access to hosts, which is an essential step for further escalation.

After identifying vulnerabilities, the attack team conducts an SMB protocol attack by exploiting the lack of signing to capture user1 account hashes. This phase teaches students Pass-the-Hash techniques, allowing them to authenticate using captured hashes without knowing the password. The obtained hashes can then be cracked with password recovery tools, providing compromised credentials that grant access to AD.

The next step involves executing a Kerberoasting attack, which allows attackers to request Kerberos tickets for privileged accounts (specifically for user2, who is a local administrator on machine1). A Kerberos ticket may contain the account's hash, which is used for system authentication. This phase helps students learn how to leverage Kerberos to access vulnerable accounts, especially in networks where local administrators are present on different hosts.

After obtaining user2's hash, students use tools to crack the Kerberos hash to retrieve the password for user2, who has administrator rights on machine1. Administrator access allows the attack team to examine the host configuration, modify security settings, and further penetrate the AD internal network. This stage demonstrates the critical importance of properly configuring and securing administrator accounts.

At this point, the attack team uses the secretsdump tool to extract sensitive data from machine1, where user2 has administrator rights. With secretsdump, students retrieve account data, including hashes for user3, which can then be used to access machine2 via RDP. This expands the attackers' control over additional network hosts, providing access to important resources.

The final phase involves using LDAPExplorer2.exe to access the LDAP server while intercepting traffic. Once connected, the attack team can query data through the LDAP protocol and set up their own LDAP listener to collect account information. After this, the attackers can log into the Domain Controller (DC) and download the NTDS.DIT file, which contains critical domain account data, including password hashes for all users.

This scenario requires various software and tools to create a realistic training environment that mirrors corporate network infrastructure. All components are configured to ensure access control, security monitoring, and environmental isolation, allowing students to safely practice cybersecurity tasks:

1. Windows Server (versions 2016, 2019, or 2022): Windows servers are essential for building an Active Directory (AD) infrastructure, widely used in corporate settings. The choice of version (2016, 2019, or 2022) depends on the training requirements and allows students to become familiar with different AD features and administrative methods, as well as configuring Domain Controllers (DC), managing Group Policies, and setting security parameters.

2. Windows 10 Pro: Windows 10 Pro serves as the operating system for workstations in the internal network. This OS is widely used in corporate environments and provides the necessary

functionality to model typical workstations. Windows 10 Pro supports SMB and RDP protocols, and allows for security policy configuration, making it ideal for studying vulnerabilities like SMB and LLMNR.

3. Ubuntu 20.04: an outdated version of Ubuntu 20.04 is used in the scenario, which is vulnerable to privilege escalation exploits (e.g., pwnkit). This OS is installed on the GitLab server and acts as the attack entry point. Ubuntu 20.04 allows students to explore open-source systems, analyze Linux vulnerabilities, and work with services such as SSH and GitLab.

4. LDAPExplorer2.exe: a tool for working with LDAP queries, LDAPExplorer2.exe enables students to query Active Directory, analyze AD structure, retrieve account data, and gather sensitive information. This tool helps students understand LDAP authentication mechanisms and client-server interactions.

5. Wazuh: a security monitoring and incident management system, Wazuh enables log analysis and network activity monitoring (**Fig. 3.10**). It provides detailed network event information, helping students investigate security logs, detect anomalies, and respond to incidents.

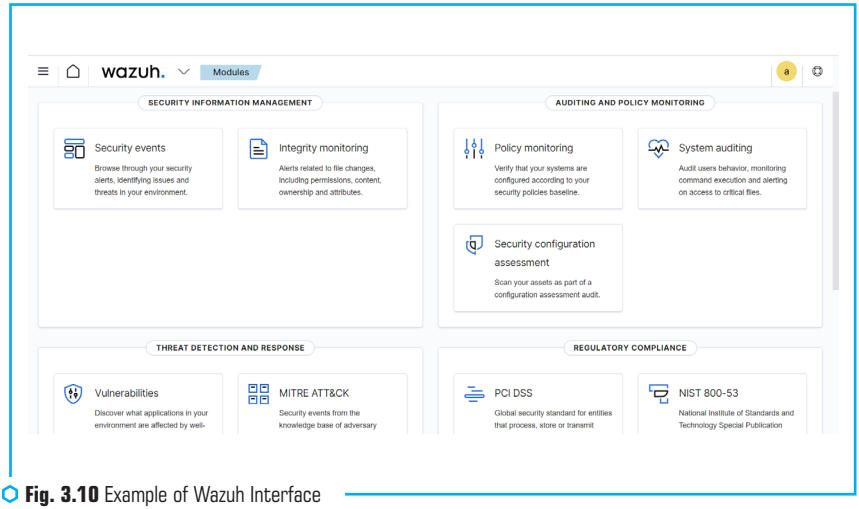


Fig. 3.10 Example of Wazuh Interface

To support a realistic and secure learning environment, an isolated network has been created, fully separated from the university or corporate infrastructure. This network isolation ensures safety and allows students to practice complex cyber operations without risking other networks.

LLMNR and SMB: the LLMNR (Link-Local Multicast Name Resolution) and SMB protocols are configured for ease of use in training, specifically for demonstrating vulnerabilities associated

with these protocols. LLMNR settings in the network allow for modeling interception attacks, while the absence of SMB signing simulates real corporate networks, which can be vulnerable to SMB attacks.

Access control: various access control settings are applied to restrict access and prevent unauthorized actions. These settings help students learn to configure security policies for external threat protection and manage user rights within the network.

These software components and network configurations provide a realistic corporate environment simulation, enabling students to practically master key aspects of cybersecurity, from monitoring and log analysis to access configuration and virtual resource management.

Skills acquired during the scenario:

1. Vulnerability detection, risk assessment, and defense method development: students learn to identify critical infrastructure vulnerabilities and assess the risks associated with these weaknesses. Developing defense methods includes practicing attack scenarios and preventive actions, providing participants with an in-depth understanding of cybersecurity. This skill is essential for security professionals who need to assess threats and propose solutions to protect systems against potential attacks.

2. Experience in AD management, GitLab protection, and LDAP for remote access: the scenario provides hands-on experience with Active Directory management, a key component of corporate networks. Students learn methods for configuring and securing GitLab, including understanding risks related to repository management. Skills in using LDAP for remote access and conducting LDAP queries give students important knowledge about AD structure and security, helping them secure data in AD environments in the future.

3. Attack and defense skills development, including brute-forcing, RCE, SMB, and LPE practice: participation in the scenario allows students to practice attack skills such as brute-forcing subdomains and virtual hosts, RCE attacks (remote code execution), and attacks on the SMB protocol, which are often left open in corporate environments. Additionally, students gain practical experience in local privilege escalation (LPE) through Linux system vulnerabilities. This comprehensive skill set enables future cybersecurity professionals to understand attack methods and protect systems from such threats.

This training scenario is as close as possible to real situations that cybersecurity professionals may encounter in their jobs. Thanks to the scenario structure, students experience the full cycle of attacks and defense – from identifying vulnerabilities to developing a comprehensive defense system. Training in environments that simulate real threats allows them to gain confidence in their technical skills and apply acquired knowledge to protect against current cyber threats.

The hands-on experience in ethical hacking and cyber defense gained through this scenario provides students with a deeper understanding of internal processes in corporate networks, helps them avoid critical configuration errors, and effectively protects information that may be targeted in attacks. As a result, they enter the job market with valuable practical skills and the readiness to take on complex cybersecurity tasks.

3.5 RESULTS OF CYBER POLYGON UTILIZATION IN EDUCATION

The cyber polygon at the Department of Solid-State Electronics and Information Security is actively used for hands-on training of students at all levels, from freshmen to master's students. Over its period of use, the range has demonstrated excellent results: students have shown high interest in new types of tasks involving real-world cyber threat modeling and protective measures. Many students provided valuable feedback, which has served as the foundation for further refinement of scenarios and expanded functionality of the cyber polygon, making the learning process more dynamic and aligned with professional challenges.

In addition to educational practice, the cyber polygon serves as a platform for preparing student teams for various competitions and professional events in cybersecurity. This environment helps students develop teamwork skills, hone technical abilities, and prepare for ethical hacking competitions, Capture the Flag (CTF) events, and other contests where quick threat response and effective collaboration are essential.

CONCLUSION

The cyber polygon at the Department of Solid-State Electronics and Information Security offers a unique training environment that allows students to practice defensive and offensive skills in conditions closely mirroring real corporate networks. Working with the cyber polygon provides students with access to various scenarios and tools, enabling them to develop a well-rounded set of practical skills essential for a modern cybersecurity professional.

The first scenario, using Qualys, focuses on developing skills in automated vulnerability scanning for web applications. Students gain experience with one of the leading tools for security assessment, which enables them to identify vulnerabilities, analyze risks, and plan mitigation strategies. Through this scenario, participants enhance their ability to systematically analyze vulnerabilities and create reports with recommendations for security improvement.

The second scenario, involving Metasploitable 2, allows students to undertake ethical hacking tasks in a controlled environment. Due to its numerous vulnerabilities, this setting provides students with the opportunity to study attack methods such as port scanning, exploit searches, and server penetration through known vulnerabilities. Practicing these techniques gives students insight into real attack vectors and effective defensive measures.

The third scenario, developed in collaboration with UnderDefense, includes work with GitLab, Active Directory, and Ubuntu. Students start with the external perimeter, conducting attacks on an Ubuntu server with GitLab, and progress to a complex internal network with Active Directory, where they encounter realistic tasks aimed at breaching AD through vulnerabilities such as the absence of SMB signing and Kerberoasting attacks. This scenario offers in-depth training in network management and protection of critical corporate infrastructure components.

Through these three scenarios, the cyber polygon provides participants with comprehensive training in cybersecurity, covering both offensive and defensive aspects. Students learn to identify vulnerabilities, develop effective measures for cyber threat protection, and work with modern cybersecurity tools. The experience gained prepares them to begin their professional careers with confidence and contributes to an overall increase in cybersecurity standards in society.

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CHAPTER 4

COMBINATION OF THE METHOD OF THEORETICAL GENERALIZATION, BIOGRAPHICAL METHOD AND SURVEY METHOD IN RESEARCHING SUSCEPTIBILITY TO THE NEW

ABSTRACT

The study gradually reveals the methodology for studying the phenomenon of susceptibility to the new, which is an important component of a person's cognitive-emotional and personal development. Within the framework of the three-year research cycle, an interdisciplinary approach was applied, which combines the methods of theoretical generalization, the biographical method and the survey method.

At the first stage, the classification features of susceptibility to the new were outlined using theoretical generalization, which allowed the author to formulate the concept of the phenomenon.

The second stage involved the use of the biographical method for the empirical analysis of the life stories of prominent personalities, such as A. Fleming, V. Roentgen, I. Duncan, F. Haber, H. Ford, S. Jobs. These examples illustrate different types of susceptibility to the new: from involuntary to voluntary, from sensory to cognitive-emotional.

The biographical method has proven its validity and effectiveness in studying deep personality characteristics, such as sensitivity to change, ability to innovative thinking, intuition, emotional involvement in the creative process. Particular attention is paid to the accumulation of external and internal impulses, which are transformed into active deeds and new ideas.

At the third stage, a survey was conducted, the results of which supplemented and expanded theoretical generalizations. The developed questionnaire contained five questions, formed in accordance with the author's concept, and was combined with a formalized interview. As a result, the key features of individuals susceptible to the new were identified: openness to experience, insight, curiosity, readiness for interaction, sensitivity to change, emotional flexibility, ability for global cooperation, critical thinking, empathy.

The survey results allowed us to carry out a content analysis of definitions related to the phenomenon of susceptibility to the new, to identify typical combinations of traits and classification features, which allows us to speak about the uniqueness of each individual. The study outlines the prospects for further scientific research, in particular, the study of correlations between key factors, the development of diagnostic tools and the compilation of a classification index. The data obtained contribute not only to a deeper theoretical understanding of the phenomenon under study,

but also open up new opportunities for its practical application in the field of education, psychology, innovation management and personal development.

KEYWORDS

Susceptibility to the new, innovative thinking, interdisciplinary approach, theoretical generalization, biographical method, survey method, classification, creativity, cognitive-emotional processes, personal development.

Education, which is aimed at fulfilling the strategic tasks of economic development, is determined, on the one hand, by the achievements of fundamental sciences, on the other hand, by the development of production. In the context of the chosen topic, in our opinion, such documents as the "National Doctrine for the Development of Education of Ukraine in the 21st Century", the policy brief "Industry 5.0: A Transformative Vision for Europe" are important.

"National Doctrine for the Development of Education of Ukraine in the 21st Century", formulating the goal (creating conditions for the development, self-affirmation and self-realization of the individual throughout life), specifies it in the task – establishing a strategy for accelerated, anticipatory, innovative development of education and science [1].

Among the main features of Industry 5.0, a human-centric approach and individually tailored regulatory changes regarding achieving the level of compliance are highlighted [2]. The slogan used is "there can be no Industry 5.0 without a 5.0 government!" (section "Governance 5.0") regarding the specified topic can be as follows "Industry 5.0 must correspond to education 5.0." (both at the level of educational process management, and the actual management and technologies of teaching and learning). At the same time, according to the State Employment Center, the labor market in Ukraine is faced with an acute shortage of labor, workers in various industries and different levels of education [3]. In a speech by the Deputy Minister of Economy of Ukraine Tetyana Berezhna at the Kyiv International Economic Forum 2024, it was noted that according to the International Labor Organization, Ukraine needs to attract 8.6 million additional workers, and according to a study by the Ministry of Economy, 4.5 million people are needed. Among the ways to overcome this are the creation of an inclusive labor market (which will return people who have left), investing in labor productivity (including the creation of more programs that will help Ukrainians be more competitive in the labor market) [4].

The above outlines new requirements for subjects of professional and innovative activity (at the same time, for professional training): the ability to promptly update specific knowledge, skills and abilities to ensure the multifunctionality of existing personnel; the ability to form new models of social behavior, construct a personal system of values and identification structures. The mechanism for creating a new identity (collective and individual) is susceptibility to the new. Its explication through the interpretation of the traditional and updated, constant and changing, social and

personal components of social progress, professional adaptation and activity in a competitive environment involves new aspects in general philosophical and psychological and pedagogical dimensions. Educational institutions, methods, technologies should become a factor in successfully solving the problem of promoting the identification and stimulation of the development of susceptibility to the new. In this regard, the idea of professional education as a continuous process of promoting the identification and stimulation of the development of susceptibility to the new, the ability to mental, behavioral, emotional new formations is radically changing.

The above-mentioned updates the generalization and presentation of the author's experience in using the potential of an interdisciplinary approach and combining various methods in the study of susceptibility to the new (theoretical generalization method, biographical method and survey method).

4.1 CHARACTERISTICS OF RESEARCH METHODS

Since the study lasts several years, most intensively in 2022–2025, we can note the sequence and phased application of the theoretical generalization method (2022–2023, first stage), the biographical method (2023–2024, second stage), the survey method (2024–2025, third stage). At the first stage, we used the understanding and opportunities, provided by the interdisciplinary approach, disclosed by A. Kolot [5]. The generalized results of the first stage of the study are presented in the original publication by N. Sas [6]. During the second stage, the author used the understanding of the biographical method of N. Denzin [7]. The main results and generalizations are presented in the author's work [8]. At this stage, a thematic analysis of the survey results is carried out. [9] are publications, in which this is presented

Susceptibility to the new is a rather complex, multifaceted and multi-vector phenomenon, the study of which allows using the potential of an interdisciplinary approach and complementary methods: the method of theoretical generalization, the biographical method and the survey method.

Scientific and theoretical generalizations at the first stage of the study (2022–2023) were carried out on the basis of an interdisciplinary approach. The author supports the understanding of interdisciplinarity as a scientific and pedagogical innovation that generates the ability to see, recognize, perceive what is inaccessible within the framework of a separate science (discipline) with its specific, narrowly focused object, subject and research methods [5]. The interdisciplinary approach helps to overcome the narrowness of the pedagogical view and enrich pedagogical science with the achievements of modern economic, sociological, philosophical, psychological sciences regarding a specific topic. By applying the achievements of other sciences related to a specific topic, the integration of the latter is achieved at the level of constructing interdisciplinary objects, subjects, the processing of which allows obtaining new scientific knowledge (in our case, regarding susceptibility to the new).

In the process of scientific research, the scientific achievements in philosophy, sociology, economics, psychology, pedagogy were analyzed regarding the relevance, objective necessity and

possibility of targeted influence on the development of susceptibility to the new of an individual, group, organization (institution, establishment).

A relatively small number of works on susceptibility to the new motivated the expediency of a comprehensive understanding of the materials, devoted to this problem. In particular, the sources, used during the scientific research and to which there are references in generalizing publications (all types of publications: monographs, articles, abstracts of scientific works, conference materials, results of examinations, interviews with practitioners), were studied [6].

The use of the biographical method at the second stage (2023–2024) of the study is due, firstly, to the lack of experimental and test methods for studying such a deep process as susceptibility to the new; secondly, the susceptibility to the new of outstanding personalities (the peculiarities of its manifestation in various forms) has a clearly expressed character, does not cause doubt, and ensures the representativeness of the data obtained; as those that meet the specified requirements and objectives of the study, the following were selected: autobiographies by I. Duncan "My Life" and H. Ford "My Life, My Achievements", biographical works by A. Maurois "The Life of Alexander Fleming", D. Stolzenberg "Fritz Haber: Chemist, Nobel Prize Winner, German, Jew: Biography", K. Benek "William Conrad Roentgen", V. Isaacson "Steve Jobs.

We used the definition of the biographical method as the method of "life stories", "vita" (according to N. Denzin) [7]. All available information was taken into account (records of their autobiographical works, speeches, interviews, etc.). In particular, the autobiographies of Isadora Duncan "My Life" and Henry Ford "My Life, My Achievements" do not simply describe the life path of I. Duncan and H. Ford. Each author focuses on the unique aspects of his or her life, on a subjective, personal approach to describing the history of his/her life's work ("free" dance of Isadora Duncan and "self-moving cart" of Henry Ford).The analysis of the subjective anamnesis of the own life by I. Duncan and H. Ford convinces that the authors have a rather complex structure of subjective experience and are able to separate their own "image of the Self" from the image of the surrounding world, are able to "perceive themselves as an active subject of their own life history, different from the social world." All together gives reason for the appropriate conclusions on the research topic.

Biographical works by A. Maurois "The Life of Alexander Fleming", D. Stolzenberg "Fritz Haber: Chemist, Nobel Prize Winner, German, Jew: Biography", K. Benek "William Conrad Roentgen", V. Isaacson "Steve Jobs. The biography of the Founder of Apple" are written on the basis of memoirs and interviews of family members, contemporaries about A. Fleming, F. Haber, V. Roentgen, S. Jobs. They recreate a historical, time-expanded perspective of events.

The specified sources are used for analysis in the study of a specific issue as those that meet the specified requirements and objectives of the study.

In the third phase (2024–2025), the study uses methods to collect non-numerical data, such as personal experiences, attitudes, and behaviors. The study is flexible and open-ended and does not have a predetermined hypothesis, which allows the researcher to collect qualitative and quantitative data, explore different perspectives, and identify potential patterns or themes that can guide further research.

The study is conducted on a small sample. The number of survey participants is 16 people. The age of the survey participants ranges from 33 to 72 years (average age is 52.5 years). By gender, the indicators were distributed as follows: 11 women and 5 men. By race (skin color): brown (4 people), yellow (2 people), white (9 people). Representatives of different races among the respondents do not reproduce the entire palette of races, nations, nationalities and ethnicities, whose representatives live in Brazil, but reproduce the fact of variability of adaptation, appropriation of the experience of other peoples, its transformation, and, as a result, potential loyalty to the new (knowledge, experience, etc.).

According to the results of the analysis of the level of education among the respondents: secondary education – 1 person, higher education – 3 people, master's students of higher education – 7 people, postgraduate students – 2 people. By type of professional activity: teachers – 5 people, civil servants – 2 people, librarians – 2 people, engineer, truck driver, scientific manager, event organizer, doctor – 1 person each. Respectable age (implies significant life and professional experience) and high educational level (implies a wide range of knowledge) made it possible to consider the participants experts. Thus, the respondents are precisely those people who, by their main characteristics, correspond to the purpose and objectives of the study, namely, obtaining information about their views, educational and life experience, regarding their willingness to learn new things. In addition, participation in the survey of representatives of various types of professional activity stimulates the conclusion regarding the potential replication of the study results to a wide audience (based on the projection of the results of individual representatives of a particular profession to the level of large professional groups). The collected data were subjected to thematic analysis and descriptive statistical analysis.

The questions are formulated in accordance with the author's concept of susceptibility to the new [6]. The surveys involve filling out questionnaires. Despite the fact that the questionnaire was prepared for a correspondence survey, in our study it was combined with a formalized interview. The answers are not limited by time and amount of information. The participants are free to answer as they wish, not limited to a predetermined choice. There are no right/wrong answers. In addition to the fact that the survey results are analyzed in the aggregate of responses, the survey takes place during an online meeting, which provides direct observations of the interviewers on the reaction of the respondents to a particular question and to the entire questionnaire as a whole.

4.2 FEATURES OF THE MANIFESTATION OF DIFFERENT TYPES OF SUSCEPTIBILITY TO THE NEW (USING THE EXAMPLE OF BIOGRAPHIES OF A. FLEMING, V. ROENTGEN, I. DUNCAN, F. HABER, H. FORD, S. JOBS)

This work is related to the generalization of information regarding the identification of different types of susceptibility to the new according to previously identified classification features. The biographical method performed the following tasks: to identify the main features of susceptibility

to the new in A. Fleming, V. Roentgen, I. Duncan, F. Haber, H. Ford, S. Jobs, according to the developed classification. To understand what influenced the identification of susceptibility to the new in each specific case.

In the author's classification of the definition of susceptibility to the new, the following are defined by divisible (generic) concepts: form of cognition of reality; leading aspects of the perceived object; dominant sensations; field of activity; components of the subject's experience; cognitive-emotional processes; environment of selected information; hierarchical level of the subject of management.

Based on the form of cognition of reality, we distinguish involuntary and voluntary susceptibility to the new.

Involuntary (unintentional) receptivity to the new arises when a person does not set a goal to perceive something and does not make an effort of will for this. In our opinion, the manifestation of involuntary (unintentional) receptivity to the new is best illustrated by the biographical information of A. Fleming (based on the book by A. Maurois "The Life of Alexander Fleming") [11].

In particular, according to the memoirs of contemporaries, it was characteristic of Fleming to bring a little frivolity and fantasy into serious issues. According to Freeman's memoirs, planning anything in advance was not characteristic of A. Fleming. He was content with collecting facts and giving fate complete freedom. Since no one is able to predict what will come of the decision he/she makes, this is not such a bad method. Thus, the Water Polo team determined A. Fleming's choice of St. Mary's College; the rifle team forced him to choose bacteriology, and in both cases the choice turned out to be successful. This way of choosing a life path may seem incredible, reckless and indicative of complete indifference to everything.

For example, the discovery of penicillin (which saved and still saves the lives and health of a large number of people) by A. Fleming is attributed to his carelessness and a random coincidence. While studying influenza, he did not wash laboratory glassware in time and did not throw away influenza cultures for several weeks. Once, in one of the many unwashed Petri dishes, he discovered mold, which, to his surprise, suppressed the inoculated culture of staphylococcus bacteria. A. Fleming left the dish on the laboratory table and went to rest. The alternation of cold and warm weather in London created favorable conditions for the growth of mold and bacteria. In our opinion, in addition to the coincidence of circumstances, an arbitrary susceptibility to the new (prepared by previously acquired special knowledge and experience) worked. We agree with A. Maurois, A. Fleming had long been looking for a substance that would destroy pathogenic microbes without harming the patient's cells. This magical substance accidentally flew onto his desk. But he would not have paid attention to the unfamiliar visitor if he had not been waiting for him for fifteen years [11].

Voluntary, purposeful susceptibility to the new is characterized by the fact that a person sets a goal to perceive something and makes willful efforts for this. In our opinion, the combination of involuntary and voluntary susceptibility to the new served Wilhelm Conrad Roentgen in the discovery of Roentgen rays or X-Rays. K. Benek in his biographical work "William Conrad Roentgen" cites the following recollections of W. Roentgen: "I have long been interested in the problem of

cathode rays from a vacuum tube. I followed with great interest the research of Hertz, Lenard and others on this issue and decided to conduct my own research as soon as I had time for it." The following dialogue testifies to the high degree of purposeful concentration. To the question of K. Benek: "What did you think when you discovered a new type of rays?" W. Roentgen replied: "I did not think, I investigated. Having discovered the existence of a new kind of rays, I began to find out what they would do. And then, by concentrating on the cause of the glow, it was discovered (within a few weeks) that the cause of the glow was the direct rays coming from the cathode-ray tube; that the radiation cast a shadow, and it could not be deflected by a magnet – and much more. In addition, it turned out that human bones cast a denser shadow than soft tissues, which is still used in roentgenoscopy.

"There is a lot of work ahead, and I am busy, very busy," he said at last and stretched out his hand in farewell, his gaze already wandering over his work in the room. The words: "I am busy," seemed to describe in one sentence the essence of his character and the motto of a very unusual person" [12].

Depending on the leading aspects of the perceived object, we distinguish the following types of susceptibility to the new: susceptibility to new changes in space, time, movement, form of objects. We imagine that this can be both a reaction to changes in the object that have occurred, thereby launching the process of changing the environment (for example, service functionality), and predicted changes in space, time, movement, form (will cause a change in the object, service functionality, etc.).

The dominant basis of susceptibility to the new can be sensations (distant, contact, deep). Accordingly, we distinguish visual, auditory, olfactory, gustatory, tactile, pain susceptibility to the new, and susceptibility to the new deep sensitivity (internal organs, muscle sensitivity, etc.). Indicative, illustrative in relation to the specified classification feature is the emergence and development of impressionism in painting, sculpture, music. In choreography – the "free" dance of Isadora Duncan based on own sensations, caused by music.

The rhythm of the waves of the ocean, on the shore of which the family lived, and the absence of restrictions from parents and governesses in childhood, contributed to the formation (according to I. Duncan) of an original manner (of ideas and movements), the inspiration for dance, which was an expression of freedom. I. Duncan notes that her leading character trait in childhood was a constant spirit of protest against the narrowness of the society, in which she and her family lived, against the limitations of life.

I. Duncan defines spontaneity as the main characteristic of the "new" choreography, (which was characteristic of I. Duncan in childhood and which she never lost). "As a child, I expressed in dance the sudden joy of growth; as a teenager, the joy that turns into fear at the first feeling of underwater currents, the fear of ruthless cruelty and the destructive progressive course of life. Later, I began to depict my struggle with Life, which the public called Death, and my attempts to wrest ghostly joys from it [13].

It is appropriate, in our opinion, to recall doctors who resorted to self-infection with the disease in order to describe the symptoms and effects of treatment based on their own feelings.

By sphere, we distinguish susceptibility to the new in society, science, art, etc.

As already noted, the perception of the new, forecasting involves all the previous experience of the subject, which makes it possible to distinguish susceptibility to the new, depending on what part of the subject's experience is involved and, in turn, on the formation of what part of the future experience it is aimed. In particular, this is the perception and formation of new worldviews; emotional, cognitive and practical experience in relation to the object of research. Susceptibility to the new can be "turned on" (involuntarily or arbitrarily) by the interests, aspirations, hopes of the subject (which, in turn, causes a favorable or inhibitory effect).

This is what explains the fact of the influence of ideology on social changes in different countries of the world over the last two or three centuries. Political parties and social movements that carried out radical transformations in all spheres of society were guided by ideological doctrines, ideals, and programs that became a direct impetus for change. The most significant in world history were the Great French Revolution of the 18th century, the struggle for independence and assertion of independence of the United States of America in the 18th century, the Paris Commune of the 1970s, the October Revolution of 1917 in Russia, the Chinese Revolution of the late 1940s, and others. It is believed that all of them were carried out under the banner of the struggle for the implementation of certain ideological principles and values (liberal-bourgeois, Marxist-Leninist, Maoist, etc.). The most progressive modern ideology may be the ideology of creating a state whose goal is happiness for all citizens [14].

According to the cognitive-emotional processes that stimulate the discovery, we distinguish analytical, synthetic, analytical-synthetic, emotional susceptibility to the new.

Thus, patriotic aspirations to serve one's homeland motivated F. Haber – a German chemist of Jewish origin, winner of the Nobel Prize in Chemistry, for his contribution to the synthesis of ammonia, necessary for the production of fertilizers and explosives; the father of chemical weapons. It is no coincidence that Dietrich Stolzenberg, summarizing the opinions of many researchers of the life and work of F. Haber, wrote that he was a great scientist, devoted to his idea and his country [15].

The identification and formation of ideas, cognitive representations, and beliefs that influenced F. Haber's actions and choice of professional activity were facilitated by the occupations of his relatives (significant persons), primarily his father and uncle. Siegfried Haber, Fritz Haber's father, was a successful dye merchant, which, in our opinion, influenced the choice of chemistry as a future professional activity. Fritz Hermann, Fritz Haber's uncle, was active in politics and the managing director of a newspaper in Breslau (it was the example and influence of his uncle that contributed to the identification and formation of a sensitivity to the new, which was stimulated by the idea of serving the Fatherland, Germany).

Coming from a Jewish family, F. Haber converted to Christianity (Protestantism), in a certain way accepting German nationalism as his religion (according to D. Stolzenberg). At his insistence, his fiancée (later first wife), Clara Immerwahr, also became a Christian. They even married as Christians, although both came from Jewish families.

Later, F. Haber's scientific research and exploration were driven by the principle: "In peacetime, a scientist belongs to humanity, but in wartime he belongs to his country."

In particular, in the first decade of the twentieth century, the world's demand for nitrogen, necessary for the production of fertilizers, was much greater than the available supply. The main source of the chemicals, needed for fertilizers, was discovered in a huge deposit of guano (seabird droppings), 220 miles long and several feet thick, along the coast of Chile. Unfortunately, this natural source of ammonia was disappearing relatively quickly.

During the First World War, when Germany lost access to the nitrate mines as a result of the British naval blockade, F. Haber believed that Germany was unfairly landlocked during the war and deprived of the supplies necessary for life. Laboratory experiments by F. Haber (Haber-Bosch process) allowed to obtain synthetic ammonia, which became a raw material for fertilizers, as well as for explosives and ammunition.

According to Stoltenberg, F. Haber helped create fertilizers for plant growth and productivity, which, in turn, helped Europeans avoid total starvation; in addition, the Haber-Bosch process allowed the German war machine to last for four years (Germany would have had to surrender at the end of 1915) [15].

During the war, Haber invested his energy in continuing to support Germany. Although Haber hated war, he believed that the use of chemical weapons could save many lives if the exhausting trench warfare was stopped. He developed a new weapon using chlorine gas, which was put into production in January 1915. Thus, ammonia was actively used during the First World War as a chemical weapon. On April 22, 1915, the Germans carried out the first ever gas attack in history in the Ypres area under the leadership of Fritz Haber.

Another direction of F. Haber's research is indicative (in relation to the research topic). In 1920, he began research on the extraction of gold from seawater, hoping that if successful, this enterprise would allow Germany to pay reparations to the Entente countries. However, after many years of research, he came to the conclusion that the concentration of gold, dissolved in seawater, is much lower than reported in the works of his predecessors, and that the extraction of gold from seawater is economically unprofitable. Thus, the discovery of susceptibility to the new in F. Haber was stimulated by cognitive-emotional (cognitive-patriotic) processes.

Henry Ford was stimulated by a passion for invention, the desire to invent a "self-propelled cart" and then endlessly improve it (author of 161 US patents), which led him to develop a technological line (conveyor), and, ultimately, to establish the production of a "car for everyone." In his book "My Life, My Achievements", H. Ford, recalls that he was the son of a farmer. He knew that farm work requires a lot of time and there is no time left for trips to the city, trips to the theater, cinema. One of the greatest advantages of the car, he considered a beneficial effect, creating opportunities for expanding the horizons of the farmer (due to the reduction of time for such and other trips). Therefore, the idea of creating a steam cart and using it as a means of transportation came to mind of an experienced mechanic who had a good workshop at his disposal. At that time, the idea of creating a *self-propelled cart* was consonant with the idea of a *horseless carriage* [16].

V. Isaacson in the book "Steve Jobs. Biography of the founder of Apple" indicates that Steve Jobs's real talent was not in creating computers, but rather in anticipating the desires and needs of potential consumers; understanding the transformative impact of personal gadgets [17].

V. Isaacson draws attention to how strong impressions of S. Jobs at a young age later inspired him in his work. First of all, this is the family of Paul and Clara Jobs, Steve's adoptive parents, who not only recognized his intelligence and exceptional abilities, but were ready to adapt their own lives for his benefit. So Steve grew up not only with the understanding that he had once been abandoned (by his biological parents), but also with the awareness of his own uniqueness. In his opinion, this is what played the most important role in the formation of his personality.

Paul Jobs (Steve's father) repaired and resold used cars, kept a garland of photos of his favorite models in his garage. He was the first to draw his son's attention to the details of the design (lines, holes, chrome, seat trim). Steve watched Paul Jobs haggle during deals because he knew better than others how much something should cost (Steve about his father). These early observations later became fixed in Steve's mind.

The book describes the role of teachers who contributed to the development of Steve's cognitive interests (despite the fact that Steve was not a "nerd"). So, on the recommendation of one of them, Lang, Steve visited the Hewlett-Packard Research Club. Engineers from a laboratory were invited there to talk about what they were working on, in particular, the use of LEDs. Young people in the research club were encouraged to participate in various projects.

One of the subjects Jobs studied became part of the mandatory curriculum in Silicon Valley: an electronics class, taught by John McCallum. This subject personified the interests of the younger generation of inventors.

During his studies, Steve showed the ability to communicate with people of a much higher level to solve design problems. In particular, as a member of the Hewlett-Packard Research Club, Jobs decided to design a frequency counter that would determine the number of vibrations per second in an electronic signal. He needed some parts that HP produced, so he picked up and called the director, Bill Hewlett, in Palo Alto at his home number. Bill Hewlett, interested in the young researcher, helped with spare parts, and also offered a job at a factory where frequency counters were made (young Jobs worked there for a whole summer after completing his first year at Homestead School).

Another time, in McCallum's class, Steve needed a part that he couldn't find anywhere else, so he called the manufacturer, Burroughs, in Detroit, and said he was developing a new product and wanted to test their part. The thing he needed arrived by airmail a few days after that conversation. When McCallum asked Jobs where he had gotten the part, the guy told him – with undisguised pride – about his collect call and the story he had told the manufacturer.

W. Isaacson presents Jobs' recalls about his admiration for Eichler's houses (his houses were well-designed, cheap, and solid; they brought clean design and simple taste to people with lower incomes; they had beautiful little details, like underfloor heating, etc.). The observation ignited in him a desire to create beautifully designed products for the mass market. Jobs enjoyed good

design (which was inexpensive and easy to use). This vision later became a core requirement for Apple products. This was embodied in the first Macintosh and later, in the iPod.

The very area where the Jobs family lived was saturated with the spirit of invention and entrepreneurship, "…differed from thousands of others across America in that even the losers were, as a rule, engineers." In favor of creating an environment that would contribute to the development of the talent of S. Jobs and other young people, the idea of Frederick Terman, dean of the engineering department of Stanford University, was implemented – the creation of an industrial park with an area of 280 hectares on the territory of the university, so that private companies could commercialize the ideas of his students. The first tenant was the company Varian Associates, where Clara Jobs worked. According to S. Jobs himself, the implementation of Terman's idea did more than anything else for the development of the techno-industry here.

V. Isaacson, adhering to the principle of objectivity, cites the memories of S. Jobs's friends and acquaintances (and Jobs about them), who draw attention to the influence of peers on Steve. The most impressive thing was meeting Steve Wozniak: "Woz was the first person in my life who knew more about electronics than I did. I liked him right away. I looked a little older than my age, and he looked the opposite, so we were like peers." That partnership led them to another, more successful joint adventure. Wozniak came to the same conclusion: "It gave us the opportunity to feel what we were capable of with my engineering skills and his perspective." Wozniak would be a quiet wizard who would be happy to share his next brilliant invention, and Jobs would figure out how to make it as convenient as possible, pack everything nicely, find buyers and earn a few bucks on it. In addition to Wozniak, according to Steve Jobs, his friends inspired him to engage in spiritual practices and develop successful behavior skills. F. Haber, H. Ford, S. Jobs influenced the formation of the world, in which we live today.

According to the environment of the selected information, we distinguish susceptibility to external and internal information.

In particular, for a closed model of the innovation process, susceptibility to internal information is important, capable of solving all problems related to the innovation process within the enterprise, organization, institution. For example, 25 research centers belong to Medtronic (USA), where 45,000 employees produce innovations [18].

If we extrapolate certain provisions of nanotechnology to the indicated issue ("nano" means one billionth (10^{-9}) of something) and take into account that there are more than eight billion people on the globe, we can conclude that each person is a potential carrier of a proposal that will change the work being performed, the technological process, etc. for the better. The combination of such nano-proposals can cause a cumulative effect and lead to significant changes. In the context of the theory of open innovation, susceptibility to external information, receiving valuable proposals from partners, end consumers, constructive cooperation with competitors becomes important. According to H. Chesbrough, open innovations are "valuable ideas that can come from both the company itself and from outside and can be provided on the market as a result of both the actions of the company itself and other structures" [19].

By the number of people involved, we distinguish individual, group (innovation, project group), collective (enterprise, organization, institution) susceptibility to the new.

Separate attention is paid to the susceptibility to the new of management entities, which, accordingly, makes it possible to distinguish by hierarchical level the management entity (head of the structural component of the enterprise, organization, institution; head of the enterprise, organization, institution; government body of the country; region; industry) that exerts one or another influence on the economic policy of the management objects.

4.3 THEMATIC ANALYSIS OF EXPERTS' PERCEPTIONS OF INDIVIDUAL COMPONENTS OF SUSCEPTIBILITY TO THE NEW, CHARACTERISTICS OF INDIVIDUALS SUSCEPTIBLE TO THE NEW, THEIR LEVEL DIFFERENTIATION

The purpose of the survey is to identify information and perceptions of respondents regarding individual components of susceptibility to the new, characteristics of individuals susceptible to the new, their level differentiation, and to determine the most stable ones for further in-depth development. Five questions were formed:

1. Read the text, answer the question:

"Nano" means one billionth (10^{-9}) of something. Nanotechnologies predict that a change at the level of individual particles will lead to a change in the whole (for example, the qualities of materials, substances). Given the number of people living on the globe (more than eight billion), each person can contribute an idea that will change any group, organization, or institution for the better.

Other things being equal, what feature distinguishes those who are able to do this?

The question is aimed at identifying the respondents' opinions regarding the components of susceptibility to the new. The analysis of the answers shows that the respondents named the following components of susceptibility to the new: openness (3 individuals), insight, curiosity, readiness (for example, to communicate), sensitivity one person each. The remaining answers, although not close to understanding susceptibility to the new, nevertheless concerned the conditions and ways of developing susceptibility to the new; personality traits that are important for putting forward an idea and during its implementation; stages of implementing an idea.

The results obtained were critically evaluated and compared with previously obtained data based on the biographical method [8], alternative explanations and interpretations were considered. A content analysis of the definitions of susceptibility to the new, *openness*, *insight*, *curiosity*, *readiness*, *sensitivity* was carried out.

In particular, susceptibility to the new is defined as the ability of a person to perceive signs of the new (future) and be guided by the formed idea (consciously or unconsciously) in their practical activities. Susceptibility to the new is the degree of relative advance of an individual over other members of his/her social system in the perception of new ideas, phenomena, discoveries that will determine the future [6].

In the context of our study, the definition of *openness* is understood as the ability to select information, ideas, impulses of the new (even unconscious ones). The openness factor reflects the motivation to explore the world around us in various ways, the complexity and flexibility of processing information of different types [20].

Within the openness factor, scientists distinguish six subscales [21], namely: openness to aesthetics; openness to activity; openness to fantasy; openness to feelings; openness to ideas; openness to values. In our opinion, these can be directions of information selection within the framework of susceptibility to the new. In particular, this is confirmed by the results of the author's scientific research using the biographical method in the study of susceptibility to the new [8].

Insight is interpreted through the ability of a person to notice, understand and predict the development of events, situations, processes and phenomena in real life conditions. In turn, the *ability to notice* means to feel, perceive, pay attention, see the insignificant, any trifle, hidden. On the one hand, insight is associated with foresight, intuition, competence and life wisdom, on the other hand, there is also childish insight – the acquisition of a pure soul and mind, an impartial attitude towards something and the ability to consider a problem from different points of view.

Curiosity, *interest* – is a quality, associated with inquisitive thinking, such as research and learning, motivated by a desire to obtain information [22], which comes from a passion or thirst for knowledge, information and understanding.

The definition of readiness to accept change is used along with the concepts of *mental flexibility and neuroplasticity*, meaning freedom of thought from biased assumptions and stereotyped ways of solving, the ability to find new solutions when changing the environment and task conditions. Readiness to accept change (mental flexibility, neuroplasticity) can relate to cognitive skills, memory, thinking, muscle memory, associated with motor skills.

Sensitivity – one of the main functions of the nervous system, which consists in the ability of the body to perceive with receptors and be aware of irritation from the environment and internal organs. That is, the concept of *sensitivity* is a component of the broader concept of *reception*, which, in addition to conscious information, also includes information from the autonomic nervous system. Each type of sensitivity is responsible for a separate analyzer, which consists of receptors, pathways and the corresponding area of the cerebral cortex. External analyzers (exteroceptive) include: visual analyzer, auditory analyzer, olfactory analyzer, taste analyzer, tactile analyzer; internal (interoceptive): motor analyzer. The above definitions of the categories of *susceptibility to new things, openness, insight, curiosity, readiness, sensitivity allow us to conclude that sensitivity cannot be a characteristic of susceptibility to new things. It is likely that sensitivity is the biological basis of openness, insight, curiosity, readiness*.

2. Read the text, answer the questions:

Huawei (China) research centers are located in Russia, China, India, the USA, France, Germany and other countries. Huawei has more than 65,000 employees, engaged in innovation, research and development. They are involved in different countries, in different factories and laboratories.

What trait can be considered characteristic of all these people?

The second of the five questions (according to the indicated topic) is aimed at revealing the respondents' opinion regarding the traits of a person susceptible to new things?

We grouped the respondents' answers by similarity and complementarity:

– self-worth, motivation, responsibility;

– empathy, resilience, enthusiasm, courage of mind, ability to generate creative ideas, flexibility in solving problems;

– education (its level, versatility of knowledge, openness to mastering different knowledge, using it to develop one's own ideas);

– not believing in limitations, looking for answers;

– the ability for global cooperation (cultural adaptability; ability to adapt and work effectively in diverse cultural environments; effective communication; ability to work together in geographically distributed teams).

The methods of theoretical generalization, the survey method, and the biographical method were used as complementary methods.

In particular, based on theoretical generalizations (works by N. Taleb, V. Pekar, I. Prigozhin, H. Hacken, etc.), the author identified the following features of a personality susceptible to the new:

– an active attitude towards the future, involving the "future factor";

– a critical attitude towards the past, which "takes" with it everything that contributes to overcoming the crisis and further development;

– flexibility and mobility, willingness to take risks;

– the ability to self-organize;

– the ability to change in response to external challenges [6].

The identified groups of characteristics were confirmed to some extent by examples of biographical information about S. Jobs (according to V. Isaacson "Steve Jobs. Biography of the founder of Apple") and H. Ford (according to H. Ford "My life, my achievements").

In particular, the respondents' opinions on the importance of self-worth, motivation, and responsibility (not only towards colleagues, but also towards future generations) are illustrated by the following examples. "Steve's most important goal was ... to create a company that would be so saturated with innovative creativity that it would outlive its founder." According to H. Ford, the goal of business is to transform the world into a source of joy. Another important goal, even the duty of every person, is to take care of the well-being of the country.

Confirmation of the importance of the following group of distinguished characteristics of people susceptible to the new (empathy, resilience, enthusiasm, courage of mind, ability to generate creative ideas, flexibility in solving problems) is found in numerous testimonies of S. Jobs's employees. For example, Debbie Coleman recalls that Steve Jobs always stood up for what he believed in and respected colleagues who held such a position.

According to H. Ford, there is no such idea that would be good only because it is old, or bad because it is new. Ideas themselves are valuable, but each of them, in the end, is just an idea. It is important to be able to implement it practically.

One of the groups of traits characteristic of people who are susceptible to the new includes education (high level of education/training; different (versatile) knowledge; openness to learning knowledge, obtained in other countries, and using it to develop their own ideas). The analysis of the biography of S. Jobs shows that he studied at a higher education institution for two years and then stopped studying. Instead, he gained knowledge non-formally and informally. He attended individual courses that interested him as a free visitor (for example, he studied fonts), visited a club of like-minded people, communicated with people with common interests (for example, with Steve Wozniak, etc.). The biography notes that Steve Jobs was a hippie-anti-materialist; he was an adherent of Zen philosophy and made a pilgrimage to India, and later decided that his calling was to create a business. However, these contradictory concepts were intertwined rather than creating an internal conflict. Steve himself recalled: As a child, I considered myself a humanitarian, but I liked working with electronics. Then I read that one of my heroes, Edwin Land from Polaroid, spoke about the importance of people who could stand with one foot in the humanities and the other in the exact sciences. So I decided that this is what I wanted to do.

As S. Jobs' biography shows, he did not receive higher specialized education (for example, in the field of computer science and modeling of personal computers). Instead, his susceptibility to the new (in particular, in the field of electronics) found its confirmation in the circle of those like him; the development of knowledge, skills and abilities occurred through "mutual infection". S. Jobs is characterized by obtaining important skills and abilities for him (leadership, the ability to present oneself, influence people, entrepreneurship, etc.) by imitating people, known to him (father, friends, etc.). Later, he attracted the best, in his opinion, engineers, designers, marketers, etc. to his work.

The conclusion of V. Isaacson (author of biographies of S. Jobs, B. Franklin and A. Einstein) who was particularly interested in the creativity that arises when inclinations to the humanities and exact sciences are combined in one strong personality is worth attention. He believed that this (the combination of inclinations to the humanities and exact sciences) would be the key to creating an innovative economy in the twenty-first century.

In search of answers to questions related to the functionality and appearance of future personal computers, S. Jobs, together with his colleagues, visited various exhibitions (for example, the Louis Tiffany glass exhibition at the Metropolitan Museum of Art in Manhattan), conferences (for example, the international design conference in Aspen in 1981), which were sources of inspiration.

In our opinion, it is interesting to single out such a feature as "not believing in limitations, looking for answers".

Steve Jobs' interest in Eastern spirituality, Hinduism, Zen Buddhism and his search for enlightenment led him to believe that the true understanding of things is intuitive. He inspired others with his own intuitive vision of things (desired characteristics of future PCs), thus achieving the impossible. Atkinson (one of S. Jobs' colleagues) said, "I believed in the power of naivety. Since I didn't know exactly how to do it, I was able to do it. It was like self-programming," said Debbie Coleman. "You do the impossible because you don't realize it's impossible."

In contrast to S. Jobs, H. Ford used logical conclusions and principles in his work. One of the principles was: "Do not be afraid of the future and do not bow to the past… Failures are only an excuse to start all over again and act more wisely. The past is useful only when it shows us the ways and means of development."

The respondents identified such an important characteristic for international teams (for example, Huawei (China)) as the ability to global cooperation (cultural adaptability, the ability to adapt and work effectively in various cultural environments; effective communication; the ability to work together in geographically distributed teams). This feature is also becoming important for Ukrainians.

3. Read the text, answer the question:

In marketing, the following groups of customers are distinguished by their susceptibility to new types of goods and services: innovators – risk-averse, they try out new products, taking a little risk; early followers – opinion leaders in their environment, they accept new ideas quite early, although with caution; early majority – people are cautious, they accept innovations earlier than the average person, but they are rarely leaders; late majority – people who are skeptical: they accept a novelty only after the majority has already tried it; laggards – people, bound by traditions, they are suspicious of changes, communicate with other supporters of traditions and accept a novelty only because it has already become a tradition to some extent.

What other characteristics can distinguish susceptibility to the new?

The third of five questions (according to the indicated topic) is aimed at identifying the respondents' opinions regarding the signs of level differentiation of people susceptible to the new?

The most obvious factors of differentiation of people susceptible to the new (which was confirmed by the results of the analysis of the responses of the survey participants) are the following: age, educational level, financial capacity, social group, religious and spiritual beliefs. Since the differentiation of society (in sociology – stratification, in marketing – segmentation) occurs according to the indicated factors, it is logical to predict a similar differentiation among people susceptible to the new. Along with the obviousness, each of the above factors requires a separate study regarding internal differentiation, confirmation by examples, etc. And, thus, is a prospect for further scientific explorations.

While studying the biographies of prominent personalities whose susceptibility to the new is beyond doubt, I noticed ways of accumulating external/internal sensations, impulses, information and transferring them into an active (consciously or unconsciously) state ("method of releasing creative energy", "continuous concentration", "intuition, search for inspiration and examples", "systemic improvement").

Rahul Jandial, a famous neurosurgeon, author of the book "Neurofitness. Recommendations of a neurosurgeon for improving brain function", describes his "method of releasing creative energy" as follows. My method of generating ideas grew out of an old habit of surgical planning. If the next day I have a particularly difficult operation, in the evening I meticulously study the patient's brain scans and the tumor that has settled in them, and when I fall asleep, I scroll through all this again in my head, mentally rotate the neoplasm in all projections, visualize the dangerous zones adjacent

to it. In the morning, I definitely take a few minutes to look at the scans, clarify the shape and position of the tumor contours.

In the course of and to develop this approach, I read articles two evenings a week before going to bed that are directly or indirectly related to the experiment I am working on. Thus, scrolling through the data and conclusions, obtained by others, in my head, while my brain continues to search for answers to its own scientific and practical questions, I discover new connections between what has already been established and the interesting, and sometimes too bold, conclusions that we have reached in the laboratory.

Incidentally, such mental wanderings in the borderland between sleep and wakefulness have proven fruitful. It is quite possible that at the moment of falling asleep (in neurobiology this intermediate state is called hypnagogic) and during the slow transition back to wakefulness (hypnopompic state) portals to the subconscious open for a moment in our consciousness to snatch a creative insight [23].

Bill Gates (co-founder of Microsoft, who played a decisive role in the popularization of computers and the Internet), has repeatedly emphasized throughout his career that the habit of reading and self-isolation became the driving force behind his achievements. B. Gates called his method "continuous concentration". In the 1990s, he spent every year "Week of Reflection" – he secluded himself in an isolated hut in the desert with a pile of books and technical documentation. During this time, he did not check his e-mail and focused on reading, thinking and writing down the ideas that arose. According to Gates, it was these periods of deep concentration that allowed him to create large-scale ideas, including the development of the Internet Explorer browser [24].

Steve Jobs' interest in Eastern spirituality, Hinduism, Zen Buddhism and his search for enlightenment led him to believe that the true understanding of things is intuitive. "Intuition is a very powerful thing, it is, in my opinion, stronger than intelligence. Understanding this had a great influence on my approach to work," S. Jobs testified. He inspired others with his own intuitive vision of things (desired characteristics of future PCs), thus achieving the impossible. It was like self-programming, – recalled Debbie Coleman – You do the impossible because you do not realize that it is impossible [17].

H. Ford's method is called "systemic improvement". This is how H. Ford describes his method in the book "My Life, My Achievements".

We must start from the product itself. First, you need to understand whether it is really as good as it should be, that is, whether the product fully meets its purpose. Then – whether the best materials or the most expensive are used for its production. Can its design be simplified and its weight reduced? And thus bring the product to perfection. Production must start from the product itself – technology, management, sales and financing are adapted to it. This is how the company hones its capabilities and ultimately wins over time. Forced release of a product without proper confidence in it is the hidden cause of many, many disasters.

It took twelve years before the Model T, which is popular today, began to suit me in every way. Until we had finally completed its development, we did not even try to start its production. But later

this model did not undergo any significant changes. I do not miss a single good idea, but I try not to decide right away whether it is good or not. If the idea is really worth it or opens up new possibilities, I am for testing it. But from testing to change is a long way. When most manufacturers are willing to change the product, we change the production methods [16].

As for level differentiation, the most common in pedagogical research is a three-level one, according to the level of quality (low level, medium level, high level).

In marketing, a five-level differentiation of customers is used according to their susceptibility to new types of goods and services: innovators; early followers; early majority; late majority; laggards.

By the number of people who were covered by the proposed innovation: from personal, unique, unrepeatable, (for example, artistic performance of dance, painting, etc.) to mass application (for example, a personal computer).

By the level of recognition: geniuses of the first kind are those who are recognized during life; geniuses of the second kind are those who are recognized after death; geniuses of the third kind are those who can be recognized in a more or less distant future.

The use of theoretical generalization, survey and biographical methods as complementary methods has enriched the author's idea of the differentiation of individuals susceptible to the new. We consider research on the internal differentiation of each factor, the development of diagnostic tools, to be promising.

4. Read the text, answer the questions:

A. Fleming discovered penicillin (which saved and still saves the lives and health of a large number of people); V. Roentgen discovered X-rays or X-Rays; I. Duncan is known for his innovative "free" dance, which is based on own sensations, caused by music; F. Haber is known for his contribution to the synthesis of ammonia, necessary for the production of fertilizers and explosives; Henry Ford invented the "self-propelled cart" and then endlessly improved it (author of 161 US patents), developed a production line (conveyor), and, finally, established the production of a "car for everyone".

What is the difference in the susceptibility to the new of the people, mentioned in the text?

In the fourth of five questions (according to the indicated topic), the answers to the question are analyzed: What is the difference in the susceptibility to the new of A. Fleming, V. Roentgen, I. Duncan, F. Haber, H. Ford? The survey answered that the susceptibility to the new of the specified persons differs in the areas of their activity, starting opportunities, the environment, in which the researcher was raised and lived; motivation for achievements.

Using the method of theoretical generalization, the author singled out classification features, by which susceptibility to the new can be distinguished. It is difficult to calculate the number of possible combinations of the identified features. The author is aware of the possibility of the manifestation of new, previously undetected classification features and the presence of such classification features that are not currently recognized. The author assumes the presence of personal uniqueness (up to absolute).

5. Give examples of those who are susceptible to the new that you know.

The last question (according to the indicated topic) asked to give known examples of those who are susceptible to the new. The answers indicated: the use of new electronic gadgets, household appliances, technologies; problems that require solving and promoting progressive social and political changes; signs of susceptibility to new things (changing jobs, countries of residence, tendency to travel); names of specific Brazilian figures, such as Elke Maravilla, Helena Camargo, Silvio Santos, Pele, Tarcila do Amaral, Nise da Silveira.

CONCLUSIONS

Thus, the sequence and phasing of the study of susceptibility to the new are revealed: the application of the theoretical generalization method (2022–2023, first stage), the biographical method (2023–2024, second stage), the survey method (2024–2025, third stage). The author's experience in applying the potential of an interdisciplinary approach and combining various methods in the study of susceptibility to the new (theoretical generalization method, biographical method and survey method) is summarized. The use of the biographical method has proven its validity and persuasiveness in the study of such a deep process as susceptibility to the new, in particular, for generalizing information regarding the identification of different types of susceptibility to the new according to previously identified classification features.

In particular, the behavioral characteristics of involuntary (unintentional) susceptibility to the new on the example of A. Fleming (based on the book by A. Maurois "The Life of Alexander Fleming") could seem reckless, frivolous and, in the absence of advance planning, such as indicate complete indifference to everything.

The behavior of V. Roentgen (based on K. Benek, "William Conrad Roentgen") is an example of arbitrary, purposeful susceptibility to the new. V. Roentgen was interested in the problem for a long time, followed the current scientific searches of other researchers with great interest. During his own research, he demonstrated a high degree of purposeful concentration, posed new and new questions for himself, determining the perspective.

Biographical information about I. Duncan (according to I. Duncan, "My Life") illustrates the susceptibility to the new, the basis of which is a mix of visual, auditory and muscular sensitivity. The formation of the original manner of I. Duncan's performing style, the "new" choreography, was influenced by the perception of the rhythm of ocean waves, the immediacy, the inspiration of the dance, which was an expression of freedom.

Cognitive-emotional processes, in our opinion, stimulated the manifestation of F. Haber's susceptibility to the new (according to D. Stolzenberg "Fritz Haber: chemist, Nobel Prize winner, German, Jew: biography"). In particular, the example of significant individuals, worldview beliefs (service to the Fatherland, Germany) stimulated the manifestation and formation of susceptibility to the new in everyday life and in professional activities.

H. Ford's susceptibility to the new (according to H. Ford "My Life, My Achievements") was stimulated by a passion for invention, which was aimed at forming a new experience of farm work (to build a light cart with a steam engine that could replace horses as a tractor for extremely heavy plowing) and life.

S. Jobs's susceptibility to the new (according to V. Isaacson "Steve Jobs. Biography of the founder of Apple") was in the nature of forecasting, anticipating a new practical experience (massive use of personal electronic devices). The characteristic features of the design of future electronic gadgets of Apple were formed on the basis of transferring S. Jobs' impressions, received in his father's auto repair shop and from his admiration for Eichler's houses (it is simple and functional to use).

The respondents' answers to the five questions, which were formed in accordance with the author's concept of susceptibility to the new, were analyzed. The questionnaire for the survey was combined with a formalized interview.

After analyzing the data, the results obtained were interpreted in the context of the research problem. In particular, the following components of susceptibility to the new were identified: openness, insight, curiosity, readiness (for example, for communication), sensitivity. A content analysis of the definitions of susceptibility to the new, openness, insight, curiosity, readiness, sensitivity was carried out.

The following features of individuals susceptible to the new were identified. The respondents' answers were grouped by similarity and complementarity:

– self-worth, motivation, responsibility;

– empathy, resilience, enthusiasm, courage of mind, ability to generate creative ideas, flexibility in solving problems;

– education (its level, versatility of knowledge, openness to the acquisition of different knowledge, its use for the development of one's own ideas);

– not to believe in limitations, to look for answers;

– the ability for global cooperation (cultural adaptability; ability to adapt and work effectively in various cultural environments; effective communication; ability to work together in geographically distributed teams). The obtained results were critically evaluated. The biographical method was used as a complementary one.

The survey results enriched the author's idea regarding the differentiation of individuals susceptible to the new. While studying the biographies of outstanding personalities, whose susceptibility to the new is beyond doubt, attention was drawn to the ways of accumulating external/internal sensations, impulses, information and transferring them to an active (consciously or unconsciously) state ("method of releasing creative energy", "continuous concentration", "intuition, search for inspiration and examples", "systemic improvement").

Using the method of theoretical generalization, the author has identified classification features, by which susceptibility to the new can be distinguished. It is difficult to calculate the number of possible combinations of the identified features. The author is aware of the possibility of the

appearance of new, previously undiscovered classification features and the presence of such classification features that are not currently recognized. The author assumes the presence of personal uniqueness (up to absolute).

We see a perspective in the study of the levels of interconnection and correlation of the above definitions; the study of the internal differentiation of each factor, the development of diagnostic tools/compilation of a classification index of different types of susceptibility to the new.

The survey results contribute to the identification of new themes, patterns or trends and the understanding of the data in connection with previous theoretical generalizations, the consideration of alternative explanations and interpretations.

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CHAPTER 5

INTEGRATION OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES INTO THE DIGITAL TRANSFORMATION OF PROFESSIONAL HIGHER EDUCATION IN TECHNICAL FIELDS

ABSTRACT

This chapter explores current trends in the integration of artificial intelligence technologies into the professional training of students in technical higher education institutions. The theoretical section highlights models of digital transformation, the structure of digital competences, the role of AI in adapting educational programs, as well as strategic initiatives implemented at Lviv Polytechnic National University under the leadership of rector N. Shakhovska.

Special attention is given to an empirical study based on a survey of students and instructors in technical fields. The findings identify the most anticipated benefits and barriers to AI adoption in the educational process and reveal correlations between selected advantages and the respondents' level of digital readiness. A series of visualizations is presented, including a digital competence pyramid, network graphs of stakeholder interaction, and a map of multiple associations between AI-driven educational outcomes. The results underscore the need for a systemic approach to fostering AI literacy in technical universities, the importance of digital pedagogical support for instructors, and the development of an ethical culture in the use of intelligent tools in professional education.

KEYWORDS

Artificial intelligence in education, technical higher education, digital transformation, AI literacy, digital competences, educational technologies, professional training, ethical use of AI, instructors' digital readiness, learning innovation.

In the 21st century, professional higher education faces the imperative of transformation under the influence of digital technologies, particularly artificial intelligence (AI). Technical universities, such as Lviv Polytechnic National University, are expected not only to adapt to new conditions but also to become flagships of innovative change. Today, the mission of technical education extends beyond the transfer of specialized knowledge to include the development of digital competences aligned with the demands of a dynamic labor market and contemporary digital reality.

AI functions not only as a subject of study but also as a powerful tool for transforming the educational process. Intelligent systems are already being applied to analyze educational data, personalize learning, create simulations and digital twins, automate knowledge assessment, and support students through virtual tutors and chatbots. At the same time, the implementation of such technologies requires updated teaching methodologies, ethical responsibility, and equitable access to digital solutions for all participants in the educational ecosystem. The theoretical underpinnings of AI in mathematics and education are well articulated in the frameworks reflecting current advances [1–3], emphasizing the importance of descriptive models and system categorizations.

This topic is particularly relevant in the context of the strategic development of Lviv Polytechnic National University, led by Rector Prof. Nataliia Shakhovska, Doctor of Technical Sciences and a leading expert in intelligent information technologies. The university consistently advances a policy of educational digital transformation and the expansion of digital competences among both instructors and students.

The purpose of this study is to provide a theoretical framework and empirical exploration of the integration of artificial intelligence technologies into the educational process of a technical higher education institution. Special emphasis is placed on the analysis of digital and AI-related competences, the expected benefits and challenges of implementation, and the interconnections between key components of digital transformation – as illustrated by the case of Lviv Polytechnic National University.

The object of the study is the process of developing digital and AI competences in the professional higher education system of technical profile.

The subject of the study includes the methods, models, and tools for implementing AI technologies in the educational process of a technical university, as well as the attitudes of key stakeholders toward their use.

Research objectives:

– to analyze the current state of AI implementation in professional education within technical universities;

– to identify the levels of digital and ai-related competences developed among students in technical fields;

– to investigate the expected benefits and challenges associated with integrating ai into the educational process;

– to develop a visual model illustrating the interconnections between key components of digital transformation;

– to propose a structural model for integrating AI into the system of professional higher education in technical institutions.

The methodological framework of the study includes an analysis of scientific literature and strategic documents, a comparative review of educational practices, as well as a quantitative empirical study based on surveys conducted among students and instructors in technical fields. The obtained results are presented through graphical visualizations – including pyramidal models

of digital competence, network diagrams, and histograms – which help interpret the structure of perceived benefits and barriers to AI integration in education.

Structurally, the chapter comprises six thematic blocks, which the chapter combines analytical depth with practical orientation, illustrating the opportunities and prospects for expanding digital competences in modern professional higher education.

Most existing research focuses either on general overviews of IT/AI in higher education or on applications within specific disciplines (e.g., language learning or medical training). In contrast, this study presents a systematic analysis of AI implementation specifically within a technical university, taking into account internal educational policies and practices at Lviv Polytechnic National University.

The proposed original three-level model of digital and AI competences (literacy – professional use – research level) offers a framework for structuring the preparation of technical students for real-world participation in the digital economy.

An associative visualization method is applied to reveal the connections between selected perceived benefits of AI, a technique rarely used in pedagogical studies. This approach allows not only for tracking frequency of responses but also for exploring the cognitive context, identifying which advantages are interconnected in respondents' perceptions.

The study reflects real initiatives implemented at Lviv Polytechnic National University: the digital transformation policy led by Rector Nataliia Shakhovska, cooperation with the IT industry, participation in Jean Monnet and BUP projects, and the development of digital infrastructure. This gives the research a practical dimension and offers a reference model for other technical universities in Ukraine.

The chapter also includes the original survey instrument, which may be reused by other institutions to assess their readiness for AI integration. Additionally, the proposed infographics and network-based models can serve as tools for educational management and strategic planning.

5.1 THEORETICAL FOUNDATIONS FOR THE IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN VOCATIONAL EDUCATION

5.1.1 EVOLUTION OF AIED PARADIGMS (ARTIFICIAL INTELLIGENCE IN EDUCATION)

The idea of applying artificial intelligence in education has a long history, dating back to the 1970s and 1980s when the first concepts of Intelligent Tutoring Systems (ITS) were developed. These systems were based on the assumption that a computer could model individual student needs and adapt educational materials accordingly.

The main theoretical approaches in this paradigm include:

– the intelligent tutoring paradigm, where AI acts as a mentor: it monitors progress, detects knowledge gaps, and adjusts the learning trajectory;

– the collaborative learning coordination paradigm, which emerged later and focuses on supporting student interactions, task distribution, and enhanced group learning through AI mechanisms [4].

Contemporary AI tools go beyond these early concepts. Generative models such as GPT, Claude, and Copilot not only adapt learning content but actively create new educational material. This requires a fundamentally new understanding of their pedagogical role.

As a result, AIED is transforming from a reproductive environment into one of shared cognitive partnership between humans and digital agents.

5.1.2 HYBRID INTELLIGENCE AS A CONCEPTUAL FRAMEWORK FOR AI INTEGRATION IN EDUCATION

The traditional view of AI as an autonomous system is gradually being replaced by the concept of hybrid intelligence, in which AI does not replace the human but enhances cognitive capabilities. This approach is based on the idea of synergy: human intuition, creativity, and ethical judgment are combined with the computational power, analytical speed, and adaptability of AI.

M. Cukurova notes that human – AI hybrid interaction is one of the key trends in educational technology. They emphasize that effective learning systems should function as extended learning environments in which AI acts not just as a knowledge mediator but as a partner in problem-solving, reflection, and self-directed learning [5].

In the context of vocational and technical education, hybrid intelligence is realized through:

– automated assessment with expert correction;

– interactive learning systems that model behavior and provide feedback;

– joint project development between students and digital agents, e.g., during code creation, diagram design, or data modeling [6].

5.1.3 ETHICAL AND INCLUSIVE DIMENSIONS OF AIED

As the influence of AI in education expands, the issue of ethical responsibility becomes increasingly important. The integration of AI changes both pedagogical approaches and the relationships among teachers, students, and digital agents. Therefore, there is a growing need to establish an ethical framework for AIED use.

According to W. Holmes et al., the main risks associated with AIED include [4]:

– algorithmic opacity and the inability to explain system-generated recommendations;

– hidden bias due to skewed training data;

– privacy violations and irresponsible collection of personal educational data;

– reduced student autonomy, with a risk of turning education into an overly controlled process.

In addition, issues of digital equity are critically important. Studies conducted within our project confirm that not all learners have equal access to modern digital tools and high-speed internet, particularly under war conditions or in socioeconomically disadvantaged regions.

Leading organizations such as UNESCO, IEEE, and the European Commission – recommend adhering to the following principles in AI integration:

– transparency (AI systems should be interpretable to users);
– fairness (avoiding discrimination or exclusion);
– accountability (clear assignment of responsibility for AI actions);
– security (protection of educational data);
– human-centeredness (AI should serve as a support tool, not a control mechanism) [7, 8].

5.1.4 THEORY OF SOCIALLY GENERATIVE SYSTEMS

A novel direction in AI and education research is the concept of socially generative systems, which views AI not as a static tool but as a co-participant in the social learning process.

M. Sharples proposes interpreting generative models (such as ChatGPT, Claude AI, and Copilot) as communication participants capable of supporting, transforming, or even simulating pedagogical interactions. Learning, in this context, becomes a triadic process: teacher – student – Ai [9].

Social generativity is reflected in:

– AI participation in dialogues, where it not only answers but also asks clarifying questions or provides counterarguments;

– co-construction of knowledge, where students "discuss" ideas with AI, refine arguments, and train logical thinking;

– shaping learning behavior through AI-generated recommendations that influence time planning or learning strategies.

This theory helps explain why perceived benefits of AI among teachers and students are interrelated. In our research, a network structure of perceived benefits was identified, where effects such as personalization, motivation, and innovation are interconnected. This is a manifestation of social generativity.

Thus, treating AI as a social agent allows us to expand traditional educational models and align them with 21st-century learning concepts – co-creation, partnership, and multidirectional interaction [10, 11].

5.1.5 DIGITALIZATION AS A DRIVER OF PROFESSIONAL COMPETENCE DEVELOPMENT

Digital transformation affects not only educational tools but also the structure of professional competencies formed in students of technical disciplines. The focus is shifting from traditional

knowledge and skills to integrated digital abilities, the capacity to adapt to emerging technologies, and the ability to collaborate effectively within digital environments.

A recent framework for vocational and technical education argues that developing digital competencies effectively requires a whole-institution approach – engaging institutional leaders, teachers, and learners together in co-creating the digital learning environment.

Systematic reviews in higher education point out that digital transformation demands not only technical fluency but also pedagogical skillsets: critical media literacy, ethical awareness, and methodological innovation are highlighted as essential capabilities for both students and educators.

A study on graduates' employability reveals significant skills gaps: employers increasingly require data literacy, online research competence, digital communication, and basic cybersecurity.

According to research conducted within our project (**Section 5.3**), both students and instructors acknowledge that the use of AI services contributes significantly to the development of key professional competencies (**Fig.5.1**), including:

– analytical thinking, developed through working with large datasets, querying AI, and interpreting results;

– digital literacy, enhanced through hands-on interaction with modern tools such as GitHub Copilot, Notion AI, and similar platforms [6, 11];

– adaptability and flexibility, fostered by navigating the unpredictability of generative AI responses;

– project-oriented thinking, supported by new formats such as learning case studies, hackathons, and collaborative work environments [12, 13].

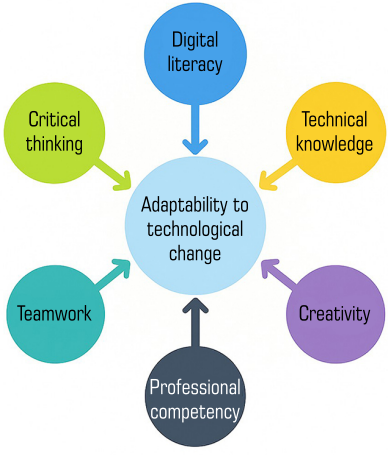

Fig. 5.1 Structure of the relationship between digital skills and components of professional competence

In the context of technical and vocational education, these competencies are especially important. Future professionals are expected not only to operate AI tools, but also to understand their architecture, ethical limitations, and practical relevance to their field of expertise [14, 15].

5.1.6 THE LIFELONG LEARNING PARADIGM IN THE DIGITAL SOCIETY

In the 21st century, the concept of lifelong learning has evolved from an abstract ideal into a practical necessity. The rapid advancement of digital technologies, particularly artificial intelligence, is reshaping the labor market, altering the qualifications expected from professionals, and shortening the life cycle of knowledge. In this context, higher education institutions are no longer limited to delivering foundational knowledge but are increasingly responsible for developing skills in self-directed learning, re-skilling, and critical adaptation (**Fig.5.2**).

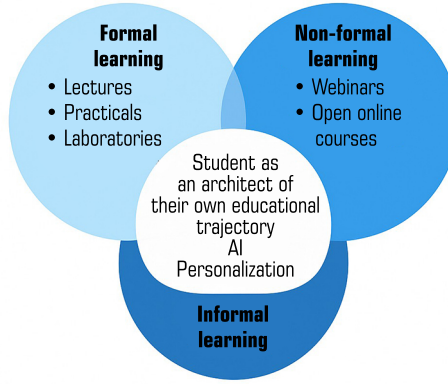

Fig. 5.2 Cross-structure of formal, non-formal, and informal learning in the digital society

New expectations for graduates of technical universities include:
– the ability to quickly update professional knowledge;
– readiness to master new digital tools independently, without external assistance;
– self-assessment skills for tracking one's educational progress;
– intrinsic motivation for continuous learning, especially in online environments [16, 17].
Artificial intelligence plays a key role in supporting lifelong learning through:
– adaptive learning systems, which adjust content and pace based on learner performance;
– personalized learning pathways, aligned with learner goals and current competencies;

– AI-based assistants that provide suggestions, generate explanations, or administer diagnostic tests (e.g., Copilot, recommender systems used by platforms like Coursera);

– knowledge verification tools based on intelligent testing algorithms [18].

This shift requires a rethinking of both educational content and methodologies. Educators are now expected to cultivate learning-to-learn strategies, enabling students to function effectively in dynamic, digital knowledge environments.

5.1.7 TRANSFORMATION OF THE EDUCATIONAL ENVIRONMENT IN THE CONTEXT OF DIGITAL TRANSITION

As digital technologies continue to expand, the educational environment of technical universities is transforming into a multi-dimensional ecosystem that combines physical, virtual, blended, and simulated learning spaces. Within this evolving context, artificial intelligence functions as a modulator of educational flows, enabling the customization of learning processes to meet the individual needs of each participant.

Key characteristics of the modern educational environment include:

– hybrid learning formats, combining offline instruction, online learning, asynchronous modules, and simulation-based experiences;

– digital mobility, where students access content via mobile apps, cloud platforms, and virtual laboratories;

– integration of intelligent systems, such as AI-powered scheduling tools, progress tracking dashboards, and personalized recommendation engines;

– continuous feedback loops, supported by learning management systems (LMS), chatbots, and educational analytics platforms [4, 5].

Examples of integrated solutions:

– Moodle with AI modules – for participation analytics and automatic generation of personalized assignments;

– MS Teams with Copilot – assisting instructors in creating quizzes, answering student questions, and managing course materials;

– Open edX with adaptive pathways – delivering differentiated instruction based on learner performance and preferences.

This transformation redefines the educational space from a static location into a dy-namic learning ecosystem, responsive to changes in learner behavior and technological advan-cements.

The **Fig. 5.3** illustrates how core elements of the digital environment – administrative platforms, learning platforms, cloud services, simulators, and AI modules – interact through a central educational analytics hub.

This hub collects data on user activity, performance, and learning dynamics to generate individualized educational scenarios.

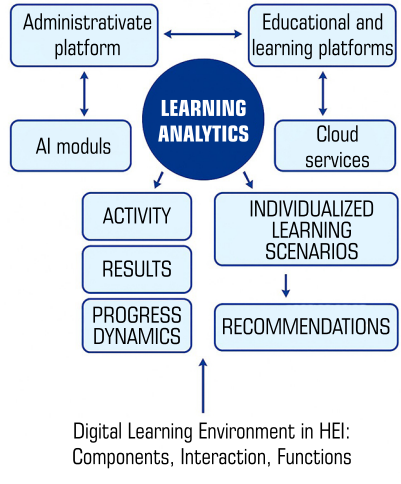

Fig. 5.3 Digital learning environment of a technical university: components, interactions, and functions

5.1.8 ADAPTING THE REGULATORY FRAMEWORK FOR AI INTEGRATION IN EDUCATION

The growing integration of artificial intelligence into educational processes requires not only technical modernization but also the updating of regulatory frameworks governing the operation of technical higher education institutions. At both national and institutional levels, the lack of clearly defined policies regarding the use of generative AI, student data analysis, and automated assessment systems creates legal uncertainty and raises concerns over academic integrity.

The model (**Fig. 5.4**) outlines regulatory alignment at three interconnected levels: national policy (macro), institutional governance (meso), and classroom practices (micro). It reflects how top-down and bottom-up regulatory dynamics shape ethical, transparent, and effective use of AI in education.

Key areas for regulatory adaptation include:

– institutional AI policies: formalizing guidelines for the permitted use of AI tools in student projects, theses, laboratory reports, and other academic work;

– revised assessment procedures: incorporating open formats, elements of oral verification, and hybrid assessment models to ensure authenticity of learning outcomes;

– ethical code of AI usage: requiring proper attribution for AI-assisted content (similar to academic citations), and prohibiting the use of AI for cheating, manipulation, or data fabrication.

Student data protection: aligning institutional practices with GDPR principles, even for internal data platforms used for educational analytics [19, 20].

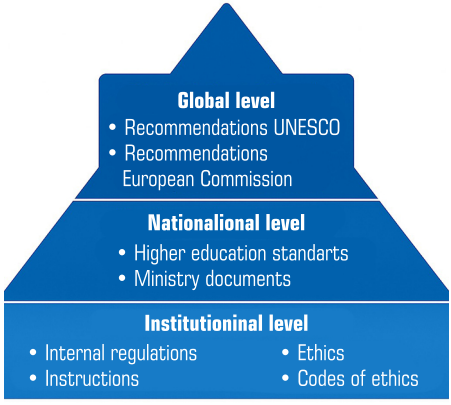

Fig. 5.4 Three-tier model of regulatory adaptation for AI integration into educational processes

Updating regulatory instruments is essential to ensuring ethical, transparent, and responsible integration of AI in higher education and maintaining trust among students, educators, and institutions.

5.1.9 DEVELOPING A DIGITAL TEACHING CULTURE IN THE AGE OF ARTIFICIAL INTELLIGENCE

The digital transformation of education is rapidly reshaping the role of educators. In the age of artificial intelligence (AI), teachers are no longer the sole providers of knowledge; they now act as mediators between learners and complex digital ecosystems, including AI-driven tools and platforms. This transition requires not only mastery of new technologies but also a profound shift in the professional identity of the teacher.

Key elements of this evolving identity include:

– critical reflection on AI capabilities: understanding the limitations and risks of automated assessment, as well as the impact of AI on learner autonomy and decision-making;

– eEthical awareness: recognizing the teacher's responsibility in shaping student attitudes toward responsible AI use and data ethics;

– readiness for co-creation: using AI as a tool for generating ideas, analyzing sources, and encouraging interdisciplinary thinking and collaboration.

Markers of a mature digital teaching culture include:

– the ability to blend AI tools with traditional pedagogical practices effectively;

– open dialogue with students about acceptable and ethical AI use in academic contexts;

– the development of original, AI-integrated course content tailored to discipline-specific needs;

– promotion of digital inclusivity, ensuring that AI-enhanced learning accommodates diverse learner needs.

In this context, fostering a digital teaching culture is not merely about acquiring technical skills; it is about reshaping educational values, empowering lifelong learning, and positioning educators as ethical leaders in a technology-rich academic environment.

The **Fig. 5.5** illustrates five progressive levels of digital maturity, from the most basic ("Digital Resistance") to the most advanced ("AI-Innovation Leadership"). It emphasizes that full integration of AI in education is only possible when institutions shift from mere technical adaptation to deep pedagogical rethinking.

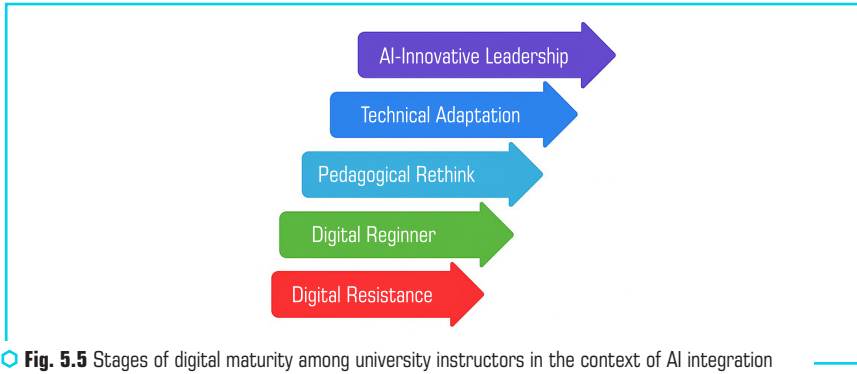

Fig. 5.5 Stages of digital maturity among university instructors in the context of AI integration

5.1.10 COMMUNITIES OF PRACTICE AND COLLECTIVE LEARNING AMONG INSTRUCTORS IN THE FIELD OF AI

The successful integration of artificial intelligence into education relies not only on individual digital competencies but also on the presence of collaborative professional ecosystems. These ecosystems enable instructors to acquire new knowledge, exchange experiences, critically reflect on pedagogical strategies, and co-develop innovative solutions. In this regard, communities of practice (CoPs) play a main role.

The **Fig. 5.6** presents a networked structure of collaboration among instructors, mentor hubs (mo-derators), external experts (industry representatives), and digital platforms. This configuration supports continuous collective learning and shared professional development in the field of AI in education.

Key characteristics of communities of practice and collective learning among instructors in the field of AI include:

– voluntary participation and horizontal collaboration rather than top-down mandates;

– a shared focus on the practical application of AI tools in teaching, research, and curriculum design;

– a safe environment for experimentation, dialogue, and learning from mistakes;

– development of a meta-perspective, where technologies are examined in broader educational, ethical, and social contexts.

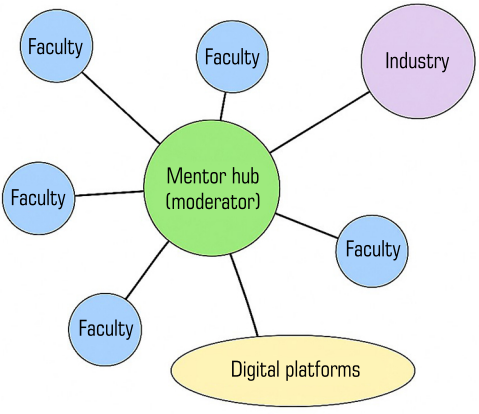

Fig. 5.6 Community of practice: interaction architecture for instructors in an AI-enhanced educational environment

Faculty at technical universities who engage in CoPs tend to adopt new tools more rapidly, adapt teaching materials, and generate AI-driven innovations in instruction [21].

Examples from Lviv Polytechnic National University include:

– cross-departmental workshops on ChatGPT, GitHub Copilot, and Midjourney;

– topic-specific groups in Microsoft Teams and Slack for exchanging AI teaching scenarios;

– summer schools on digital pedagogy, including micro-projects using generative AI;

– collaborative development of open educational resources (OERs) that incorporate AI components.

These initiatives foster a culture of continuous improvement and innovation, helping instructors transition from AI users to AI co-creators in their educational practice.

CONCLUSIONS TO SECTION 5.1

In modern technical universities, the integration of artificial intelligence (AI) requires not only digital modernization but a systemic transformation of the entire educational ecosystem. As shown in this chapter, the effective use of AI in higher education depends on several interconnected factors:

– multi-level support for the digital competence of instructors, encompassing both formal (professional development courses) and informal (communities of practice) learning;

– implementation of personalized professional development pathways, tailored to each educator's level of digital literacy, subject specialization, and teaching experience;

– creation of pedagogical autonomy spaces, where instructors are encouraged to experiment, share practices, and collaboratively adapt AI tools for diverse educational contexts;

– administrative support and local infrastructure, enabling rapid testing and scaling of educational innovations;

– integration of AI across all domains of academic activity, including content development, assessment, student guidance, and scientific research.

Ultimately, the educator is the key driver of transformation. Their experience, adaptability, and capacity for interdisciplinary collaboration are the foundation for sustainable digital evolution in technical higher education institutions.

5.2 ARTIFICIAL INTELLIGENCE AS A COMPONENT OF MODERN PROFESSIONAL TRAINING

In today's educational environment, AI is viewed not only as a subject of academic study but also as a tool that transforms professional training in higher education. This is particularly important for technical universities, where the integration of cutting-edge digital technologies is essential for maintaining the quality of academic programs.

Preparing professionals who can both apply and critically assess AI technologies requires embedding artificial intelligence into curricula, developing new courses, and using AI-based tools to optimize the educational process.

According to many researchers, one of the core competencies of the 21st century is AI literacy – a basic understanding of how AI systems function, their application areas, ethical concerns, and their ability to automate engineering, management, analytical, and creative tasks.

Common applications of AI in technical universities include:

– adaptive learning: platforms like Coursera and Khan Academy that incorporate AI-supported adaptive modules can tailor content delivery to each student's knowledge level [22];

– automated assessment: AI tools can automatically verify solutions in programming code, engineering problem-solving, and even open-ended questions [23];

– generative AI tools: ChatGPT, GitHub Copilot, and Claude AI are now widely used by students for generating examples, testing ideas, and checking hypotheses [24];

– virtual laboratories: the integration of AI and digital twins allows simulation of processes, especially in fields like Mechatronics, Automation, and Civil Engineering [25];

– intelligent tutors: AI agents assist students 24/7 by answering questions, providing feedback, and adjusting learning paths [26].

However, successful AI integration depends not only on technical infrastructure but also on teachers' willingness to rethink pedagogy and redefine their role in an automated educational setting. The teacher must act as a facilitator of human competencies such as critical thinking, ethical reasoning, and creativity, which complement the functions of Ai [27].

Therefore, artificial intelligence does not replace professional education but enhances it with new forms, greater flexibility, and effective tools. Its integration into the educational process enables technical education not only to respond to contemporary challenges but to set new standards for quality and practice-oriented learning [28].

According to the survey results, the most important digital competency identified by respondents as essential for an effective educational process is proficiency in using digital tools (rank – 4.56). The next priorities include personal data protection (4.25) and cybersecurity (4.10). Lower scores were assigned to competencies such as digital content creation (3.76) and providing online consultations (3.47), which indicates the need for greater attention to these areas in educational programs (**Fig. 5.7**).

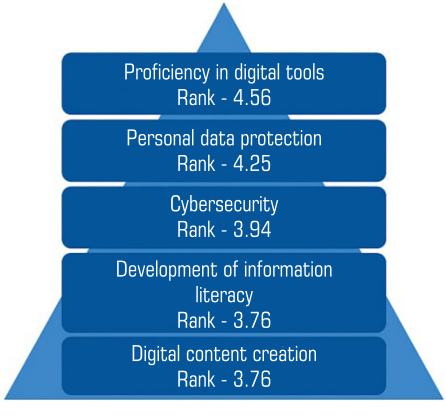

Fig. 5.7 Average ranks of digital competencies for professional education

The highest self-assessment among students was observed in the use of generative AI tools (such as ChatGPT and Copilot), with an average score of 4.8, reflecting strong practical interest and easy access to these technologies. In contrast, the lowest score was given to the understanding of AI ethics – only 3.2 points – indicating limited awareness of the normative and ethical aspects of AI use in education. This highlights the need to strengthen interdisciplinary courses on digital ethics and promote critical thinking in the application of intelligent systems (**Fig. 5.8**).

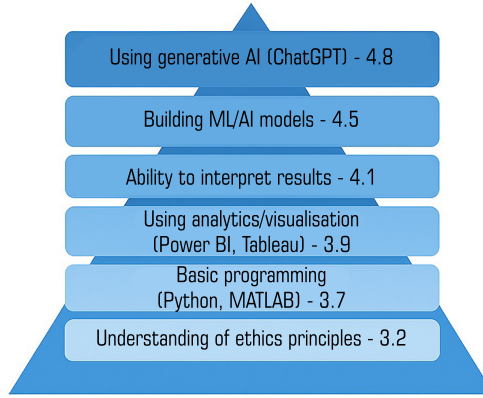

Fig. 5.8 Levels of digital and AI competencies among students in technical fields

CONCLUSION TO SECTION 5.2

Artificial intelligence is no longer a future concept but a present-day necessity in professional training. As this section has shown, AI serves not only as a subject of academic study but also as a transformative tool that redefines learning processes, roles of educators, and student engagement. In technical universities, where adaptability and innovation are key, the integration of AI enables more personalized, efficient, and relevant education. However, its successful adoption requires more than infrastructure – it demands a shift in mindset, pedagogical strategies, and ethical awareness. By embedding AI into the educational ecosystem, institutions prepare future professionals to operate responsibly and effectively in a rapidly evolving digital world.

5.3 PRACTICES OF AI INTEGRATION INTO THE EDUCATIONAL PROCESS AT LVIV POLYTECHNIC

Lviv Polytechnic National University is one of Ukraine's leading technical higher education institutions, actively promoting the digital transformation of education [29]. Under the leadership of Rector Nataliia Shakhovska – a recognized expert in the field of intelligent information technologies – the university has taken decisive steps to integrate artificial intelligence into its educational process, research activities, and interdisciplinary projects [30–33].

Lviv Polytechnic National University has expanded its AI-oriented initiatives through deep collaboration with major IT companies in the region. For example, partnerships with SoftServe, EPAM, ELEKS, GlobalLogic, N-iX, Intellias and others – many of which are headquartered or maintain

significant offices in Lviv – have been central to this effort. These alliances have shaped curriculum and lab offerings: SoftServe and peers actively contributed to developing new AI, data science, cybersecurity, and IoT programs through the Lviv IT Cluster, with support for educational tracks and access to industry-grade tools.

Events like the Lviv IT Cluster's "IT Future Conf" with SoftServe as gold partner regularly assemble leading firms (including EPAM, N-iX, Avenga, Intellias) for lectures, workshops, and student recruitment. Beyond education, companies like SoftServe have launched real-world AI pilot programs such as integrating generative AI into development workflows, boosting productivity up to 45% creating internship and research opportunities for students at Lviv Polytechnic .

Additionally, joint spaces like the SmartIndustry conference and the IoT lab, supported by both the IT Cluster and companies like SoftServe and GlobalLogic, foster continuous collaboration among academia, business, and students. This engagement enables the university to co-create applied AI solutions, while students benefit from hands-on projects, industry mentoring, and direct paths to employment.

The key stakeholder groups – students, instructors, administration, IT departments, and external partners (IT companies, EdTech developers) – and the directions of their interaction during digital transformation are presented in **Fig 5.9**.

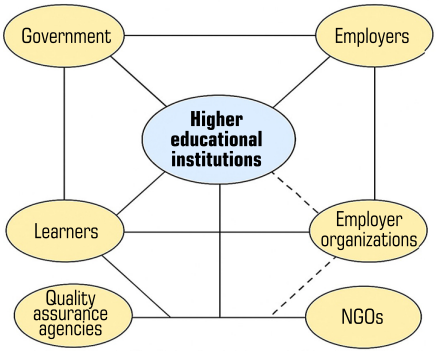

Fig. 5.9 Network structure of stakeholder interaction in the process of AI integration into technical higher education

Instructors serve as intermediaries between the administration and students, while also collaborating with IT companies in the development of educational content. Students interact not only with instructors, but also indirectly – through LMS interfaces – with technical services.

This network structure highlights that successful AI implementation in education is not merely a technological shift, but an organizational one, where coordination among all educational environment participants plays a crucial role.

5.3.1 INTEGRATION OF AI INTO ACADEMIC COURSES

The development of digital and AI-related competences is supported through a set of dedicated courses introduced into the academic curriculum, such as:

1. Artificial Intelligence, Machine Learning, and Intelligent Data Analysis – offered to students in programs like Computer Science (122), Software Engineering (121), Applied Mathematics (113), and Information Systems (126).

2. Foundations of AI and Digital Transformation – available as an elective for students from non-technical fields.

3. Decision Support Systems, Python Programming, and Neural Networks and Computational Intelligence – included in master's programs.

Some courses are co-designed in collaboration with leading IT companies such as SoftServe and EPAM [34]. This partnership facilitates the inclusion of industry-oriented content and enables students to work with real-life case studies.

5.3.2 DIGITAL LEARNING ENVIRONMENTS ENHANCED BY AI TOOLS

Lviv Polytechnic National University actively employs blended learning platforms, particularly Moodle, which is integrated with analytics modules and predictive algorithms [35]. In pilot settings, the university has introduced:

– automated code assessment systems;

– pattern recognition in student responses;

– generation of personalized assignments using generative AI.

Tools such as ChatGPT, GitHub Copilot, and Notion AI are increasingly used by students to assist in study preparation, solution modeling, writing reflections, and preparing presentations.

Personalized learning systems using neural networks have demonstrated success in adapting individual study plans for technical students [36]. Furthermore, the use of sentiment analysis and neural-network quality-management tools in education and healthcare has been validated in similar educational settings [37–39].

According to the survey results [**Fig. 5.10**], the most widely recognized benefit associated with the use of AI in professional education is personalized learning (84%). This indicates a strong demand for individual learning paths supported by intelligent systems.

Other significant factors include improved quality of education (75%) and the development of digital skills (66%).

Less than half of the respondents identified assessment optimization (39%) as a key benefit, which may reflect a lack of awareness about the technical capabilities of AI in knowledge evaluation.

In response, instructors have developed new assessment formats – including analytical reports, mini-projects, and case studies – aimed at fostering critical thinking and promoting deeper learning.

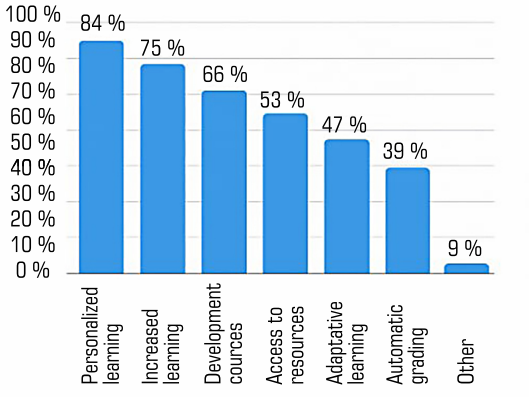

Fig. 5.10 Survey results on the perceived benefits of using artificial intelligence in professional education

The **Fig. 5.11** illustrates how many AI-related benefits each respondent selected. Most respondents identified five to seven key advantages, indicating a broad perception of AI's value within the student community. This distribution reflects a high level of awareness among participants regarding the diverse potential of AI in education, particularly in areas such as adaptive learning, AI ethics, and big data analytics.

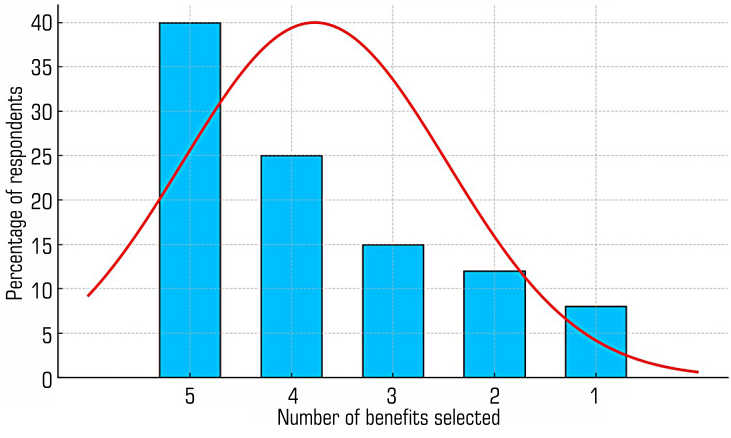

Fig. 5.11 Distribution of the number of AI benefits selected by respondents

5.3.3 STUDENT INITIATIVES AND RESEARCH PROJECTS

Lviv Polytechnic National University actively supports youth-led research initiatives related to artificial intelligence. University-organized AI hackathons, startup competitions, and cross-faculty innovation hubs engage students in developing projects in areas such as:

– smart city technologies;
– energy efficiency;
– digital assistants;
– educational platforms with adaptive learning features.

Some student theses and master's projects already implement ML algorithms using tools such as TensorFlow, scikit-learn, and OpenCV, demonstrating the gradual integration of AI into students' professional skill sets during their studies [40].

At the same time, pedagogical research at Lviv Polytechnic National University highlights the role of educational coaching and interdisciplinary learning in enhancing student motivation and cognitive engagement. Studies show that activating students' learning potential through coaching methods and integrating foreign language instruction within professional education contributes to higher autonomy and readiness for digital learning environments.

5.3.4 INTERNATIONAL PROJECTS AND COLLABORATIONS

Lviv Polytechnic National University actively participates in a range of international educational initiatives that support the integration of artificial intelligence and digital transformation into higher education. Among them are the Erasmus+ Jean Monnet projects focused on the digitalization of governance and education in Ukraine, as well as the Baltic University Programme, which promotes sustainable development modeling using analytical and AI-based tools.

Additionally, the university is involved in specialized Erasmus+ Key Action 2 (KA2) consortia, such as:

– "Effectiveness of Medicine E-learning Distance Courses", an international collaborative project co-led by Prof. N. Shakhovska in partnership with the University Lumière Lyon 2 (France), the Polytechnic University of Valencia (Spain), Linnaeus University (Sweden), and others. This project focuses on the application of AI-based adaptive learning systems in medical education and digital pedagogy;

– "iCare4Next" emphasizes inclusive digital learning, accessibility, and digital support mechanisms for students with disabilities and veterans. AI is used in this context to develop intelligent tutoring and support systems that adapt to users' cognitive and emotional states;

– "SmallAIM (AI in Medicine)", coordinated under the Eurizone initiative, explores the application of explainable AI models in medical diagnostics and e-learning systems, integrating ethical considerations and transparency.

These international collaborations not only raise awareness about the potential of artificial intelligence among students and faculty but also enable the transfer of innovative instructional

approaches into the Ukrainian educational context. Through such projects, Lviv Polytechnic National University contributes to the formation of a shared European educational space based on digital inclusion, sustainability, and data-driven pedagogy.

5.3.5 INDUSTRY-SUPPORTED EDUCATIONAL PROGRAMS: THE CASE OF LVIV IT CLUSTER

In response to the growing demand for industry-relevant competencies, Lviv Polytechnic National University has partnered with the Lviv IT Cluster to modernize its bachelor's degree programs.

This collaboration resulted in the creation and implementation of cutting-edge curricula across multiple disciplines, reflecting the latest trends in artificial intelligence, digital systems, and data analytics.

The updated programs include:

– Robotics (G6 Information-Measuring Technologies) – targeting applications in medicine, defense, and space;

– Internet of Things (F3 Computer Sciences, Systems Engineering) – training specialists to design smart, internet-connected systems;

– Cybersecurity (F5 Cybersecurity and Information Protection) – preparing experts to protect digital infrastructure;

– Artificial Intelligence (F3 Computer Sciences, AI Systems) – focusing on developing AI-based technologies and applications;

– DevOps & Data Engineering (F6 Information Systems and Technologies) – teaching students how to manage complex digital ecosystems;

– Business Analysis & Data Science (F4 System Analysis) – equipping future professionals with analytical and decision-making skills;

– IT Sales Management (F4 System Analysis, IT Product Management) – training students in product management and market strategies;

– UI/UX Design (G20 Publishing and Polygraphy) – merging technology with aesthetics to create user-centered interfaces.

These programs are developed with the active participation of IT professionals and regularly updated to reflect the needs of the digital labor market. Thanks to this initiative, students gain access not only to up-to-date theoretical knowledge but also to real-world practices and internships with partner companies.

CONCLUSION TO SECTION 5.3

The implementation of artificial intelligence at Lviv Polytechnic National University exemplifies a strategic and comprehensive approach to educational innovation. Through the integration of

AI-related courses, the use of intelligent digital learning environments, and active engagement in international projects, the university has established itself as a leader in fostering AI competencies among both students and faculty.

Importantly, these initiatives go beyond technology adoption – they reshape the pedagogical culture, stimulate interdisciplinary collaboration, and align educational outcomes with the demands of the digital economy. The ongoing institutional commitment to AI-driven transformation reflects not only current global trends but also a proactive vision for the future of technical education.

5.4 CHALLENGES AND ETHICAL ASPECTS OF USING AI IN THE EDUCATIONAL PROCESS

Despite the numerous benefits that artificial intelligence technologies bring to professional higher education, their implementation is accompanied by a range of challenges: technical, pedagogical, and ethical. In technical universities, where AI is used not only as a learning tool but also as a component of professional practice, the issue of responsible AI use becomes particularly important.

5.4.1 ACADEMIC INTEGRITY IN THE AGE OF GENERATIVE AI

One of the most debated challenges is the use of generative AI models (such as ChatGPT, Claude, and GitHub Copilot) by students to produce texts, answers, code, or reports. In the absence of clearly defined policies on AI usage in higher education, several risks arise:

– academic plagiarism;
– loss of independent critical thinking skills;
– automation of tasks without real understanding of the content.

In response to these risks, instructors at Lviv Polytechnic are developing new assessment formats: analytical tasks with personalized elements, open-ended discussions, and mini-projects that require students to justify their thought processes. There is also ongoing debate around acceptable AI usage, aiming to distinguish between responsible assistance and inappropriate substitution of human work.

5.4.2 SURVEY RESULTS ON BARRIERS TO AI ADOPTION

To identify barriers to the effective integration of AI into professional education, a survey was conducted among students and faculty of technical disciplines. The results are presented in **Fig. 5.12**.

The most significant barrier, according to respondents, is the lack of appropriate user skills (65%), highlighting the urgent need for systematic training of both students and instructors. A considerable percentage also emphasized ethical risks (53%) and technical infrastructure limitations (49%).

Other barriers, such as lack of funding (45%) and legal constraints (18%), point to the importance of external support and regulatory frameworks for the integration of digital innovations in education.

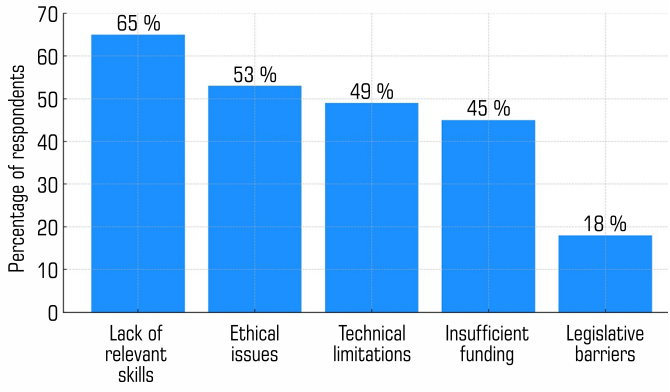

Fig. 5.12 Survey results on barriers to the use of artificial intelligence in the educational process

5.4.3 PERCEPTION OF PROBLEM COMPLEXITY: HOW MANY BARRIERS DO RESPONDENTS IDENTIFY?

The **Fig. 5.13** illustrates how many barriers each respondent marked as significant. This allows us to assess whether the problem of AI integration in education is perceived narrowly or broadly by stakeholders.

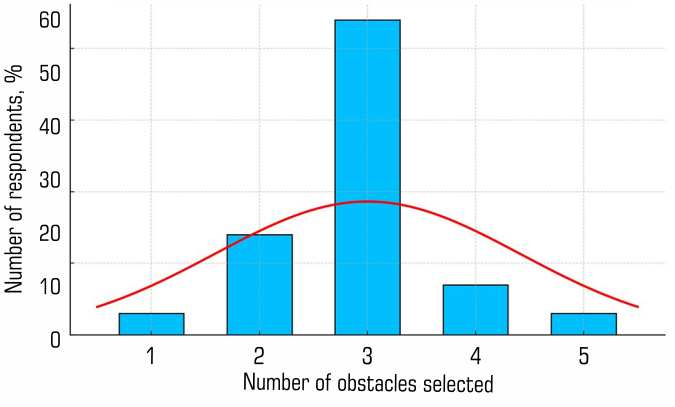

Fig. 5.13 Distribution of the number of AI-related barriers identified by respondents

The data suggest a near-normal distribution: most respondents selected three key barriers, indicating a balanced and comprehensive perception of the issue. A small portion identified only one or as many as five barriers, reflecting varying levels of awareness or personal experience with AI integration in education. This distribution underscores the need for a differentiated approach to addressing these challenges – from basic training to institution-wide support policies.

5.4.4 DIGITAL ACCESS INEQUALITY

Not all learners have equal access to modern digital tools or stable internet connections – particularly under wartime conditions or in blended/remote learning settings. This raises concerns that the integration of AI technologies may deepen educational inequality.

In this context, it is crucial for universities to provide:

– open-access resources and local servers with AI capabilities (within internal infrastructure);

– baseline digital literacy training for all students regardless of major;

– onboarding sessions on using AI tools (e.g., Notion AI, Copilot, OpenCV, RapidMiner) at the beginning of the academic year.

5.4.5 INSTRUCTOR TRAINING AND SUPPORT

The successful integration of AI requires not only technical upgrades but also a shift in the role of instructors. Not all educators possess sufficient experience with digital tools, which can lead to:

– anxiety about new technologies;

– challenges in managing the learning process;

– resistance to change due to lack of support or increased workload.

Lviv Polytechnic gradually implements professional development programs in EdTech, digital pedagogy, and AI tools. These include training workshops, summer schools, and involvement of faculty in cross-departmental digitalization projects.

5.4.6 ETHICAL USE OF AI IN EDUCATION

There is growing global attention to AI ethics. Key principles that educational institutions should adhere to include:

– algorithmic transparency (understanding how AI systems make decisions);

– non-discrimination (eliminating bias in data or models);

– data protection (especially when analyzing student performance or handling personal data);

– respect for human autonomy (AI as an assistive tool, not a replacement for human input).

Universities adopting AI should develop their own ethical guidelines for digital tools, clearly defining boundaries, accountability, confidentiality, and openness.

CONCLUSION TO SECTION 5.4

The integration of artificial intelligence into the educational process of technical universities brings both transformative opportunities and critical challenges. While AI can significantly enhance learning personalization, content generation, and data-driven decision-making, its implementation must be approached with caution and responsibility. The findings indicate that insufficient user skills, ethical concerns, and infrastructure limitations remain key barriers to effective AI adoption. Moreover, unequal digital access, lack of instructor preparedness, and the potential erosion of academic integrity due to misuse of generative AI tools highlight the need for institutional strategies that combine technical, pedagogical, and ethical safeguards. Universities must therefore not only invest in digital infrastructure and professional development but also establish transparent and inclusive policies to guide the responsible use of AI. By addressing these challenges through a holistic and equity-focused approach, higher education institutions can ensure that the integration of AI strengthens rather than undermines the quality and integrity of academic processes.

5.5 A MODEL FOR IMPLEMENTING AI IN PROFESSIONAL EDUCATION AT A TECHNICAL UNIVERSITY

Successful digital transformation of the educational process at technical higher education institutions requires not a fragmented adoption of individual digital tools, but a systematic model for integrating artificial intelligence (AI) into all stages of professional training. Such a model should be based on an interdisciplinary approach, practical orientation, adherence to ethical principles, and the development of both student and faculty digital competencies.

5.5.1 IMPLEMENTATION LEVELS

The model can be represented as a three-level structure:

a) Level 1 – AI literacy: development of basic knowledge about the principles of AI, machine learning, algorithms, and their societal impact. This level should be accessible to all students, regardless of their field of study.

Implementation methods: integrated lectures, online courses, and seminars;

b) Level 2 – professional application of AI: using AI as a tool within the framework of a specific discipline: for example, forecasting in economics, digital twins in mechanical engineering, data analysis in the energy sector, code generation and verification in IT.

Implementation: through specialized courses, laboratory work, and practical training;

c) Level 3 – research and innovation Level: engaging students in interdisciplinary research projects, hackathons, and thesis projects using AI technologies. Active collaboration with IT companies, participation in international educational initiatives, and submitting startup ideas to innovation competitions.

5.5.2 KEY COMPONENTS OF THE MODEL

Institutional Policy:
– defining a clear strategy for digital transformation;
– developing an ethical code for the use of AI in education;
– supporting educational initiatives at the rectorate level.
Educational Programs and Standards:
– updating academic programs to include AI-oriented components;
– designing interdisciplinary courses;
– implementing micro-qualifications and certification modules (e.g., AI for Engineers, AI for Teachers).
Faculty Development:
– offering professional development courses in AI/EdTech;
– facilitating experience exchange among departments and faculties;
– providing mentorship for junior faculty in working with digital tools.
Infrastructure:
– access to open resources (Google Colab, Hugging Face, Kaggle);
– availability of AI laboratories and GPU-supported servers;
– equipping classrooms for hybrid and simulation-based learning.
Integration with the Labor Market:
– collaboration with IT companies in program development;
– student internships in AI-focused teams;
– organization of workshops, guest lectures, and certifications involving industry professionals.

5.5.3 VISUALIZATION OF THE BENEFITS OF AI INTEGRATION

The multiple interconnections between the benefits of AI use in education are shown in **Fig. 5.14**.

The nodes with the highest number of associative connections are personalized learning, access to resources, and preparation for the digital labor market. This indicates that these components form the core perception of AI effectiveness in professional education. The Other node is linked by only a single edge, reflecting its limited significance. The thickness of the connecting lines represents the frequency with which respondents selected the connected benefits simultaneously.

These central nodes not only reflect user perceptions but also align with current academic and policy research. For instance, research in corporate technical training shows that digital transformation increasingly requires instructional designers to integrate digital tools within pedagogical design emphasizing adaptability, continuous improvement, and agile methodologies. Furthermore, the European VET agenda recognizes vocational education's leading role in bridging education and industry through the development of workplace-ready digital competences.

The 3D model clearly reveals clustering among the identified benefits (**Fig. 5.15**). For example, personalization, motivation, and teacher time optimization form a logical segment related to pedagogical impact. In contrast, access to resources and preparation for the labor market lean more toward functional and career-related advantages. The spatial structure highlights central nodes of influence and potential leverage points to amplify the effects of AI implementation through interconnected factors.

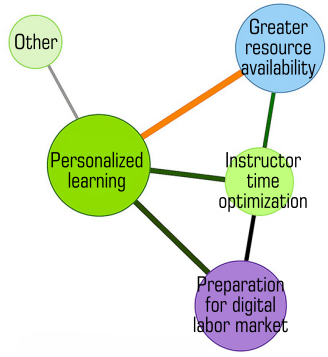

Fig. 5.14 Visualization of multiple interconnections between the benefits of AI use in education (2D)

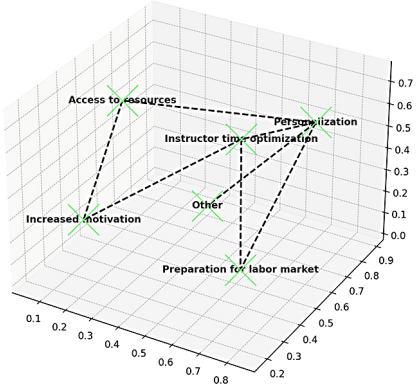

Fig. 5.15 Spatial visualization of associations between the benefits of AI use in education (3D graph)

5.5.4 EXPECTED OUTCOMES OF THE MODEL

The following results are expected from the proposed model:
– increased competitiveness of graduates in the global labor market;
– reduced gap between theoretical knowledge and practical application;
– development of a culture of ethical and responsible AI use;
– strengthening the university's role as a center for digital innovation;
– establishment of sustainable infrastructure to support AI-enhanced learning.

CONCLUSIONS TO SECTION 5.5

The proposed model for integrating artificial intelligence into professional education at a technical university highlights the need for a comprehensive, multi-level approach to digital transformation. It encompasses foundational AI literacy for all students, specialized professional applications, and innovative research activities. By addressing key components – institutional policy, curriculum modernization, faculty training, technical infrastructure, and integration with the labor market – the model supports the development of a resilient educational ecosystem. The visualization of AI-related benefits confirms that the most valued aspects include personalized learning, access to resources, and enhanced readiness for the digital labor market. The expected outcomes demonstrate the model's potential as a strategic tool for advancing the role of the technical university as a center of digital innovation.

CONCLUSIONS

The integration of artificial intelligence technologies into the professional training of students in higher technical education is not only a demand of the times but also a strategic necessity for ensuring quality, flexibility, and innovation in the educational process. Modern technical univer-sities – in particular, Lviv Polytechnic National University – demonstrate their readiness to act as drivers of digital transformation by combining academic tradition with technological advancement.

Under the leadership of Rector Nataliia Shakhovska, Lviv Polytechnic National University has been implemen-ting a consistent policy of digitalization. This policy is grounded in the expansion of digital competencies among students and faculty, the inclusion of AI components in educational programs, the development of an open digital infrastructure, and participation in international projects and partnerships with the business sector. This chapter has proposed a model for implementing artificial intelligence in technical higher education, which takes into account multilevel training, ethical challenges, institutional frame-works, and infrastructural conditions. The approach, based on a combination of AI literacy, practical application, and research engagement, enables the formation

of not only competitive professionals but also responsible citizens capable of interacting effectively and ethically with emerging digital realities.

Future development prospects lie in enhancing teacher training systems for AI integration, adapting academic integrity policies to the new conditions, and designing interdisciplinary learning tracks that merge technical expertise, social competencies, and digital ethics.

APPENDIX A.

SURVEY QUESTIONNAIRE: ARTIFICIAL INTELLIGENCE IN HIGHER EDUCATION

This appendix contains the survey form developed specifically for students and academic staff of Lviv Polytechnic National University, aimed at studying their experience and perspectives on the integration of artificial intelligence (AI) into the educational process. While the questionnaire was initially tailored for the institutional context of Lviv Polytechnic, it is also applicable for use in other technical higher education institutions across Ukraine.

The questionnaire was designed to:

– identify the current level of AI adoption in academic activities;

– explore students' and lecturers' usage of AI tools in learning and teaching;

– assess perceived advantages and concerns regarding AI implementation;

– and determine the need for additional training or support related to AI technologies.

The structure of the survey includes both closed-ended questions for statistical analysis and open-ended responses for collecting individual insights and reflections. The results were used to inform the analysis and argumentation in **Sections 5.3.1**, **5.3.2**, and **5.3.5** of the monograph, contributing to a deeper understanding of the human dimension of digital transformation in technical education.

SURVEY ON THE USE OF ARTIFICIAL INTELLIGENCE IN VOCATIONAL AND HIGHER EDUCATION

1. Gender

- ☐ Female
- ☐ Male
- ☐ Other
- ☐ Prefer not to say

2. Age

- ☐ Under 18
- ☐ 18–24
- ☐ 25–34

- ☐ 35–44
- ☐ 45 and older

3. Status

- ☐ Vocational education student
- ☐ University student
- ☐ Teacher
- ☐ Administrator
- ☐ Other: _____

4. Have you ever used artificial intelligence (AI) tools in your learning or teaching process?

- ☐ Yes
- ☐ No
- ☐ Not sure

5. If yes, which AI tools have you used? *(multiple choices allowed)*

- ☐ ChatGPT
- ☐ Grammarly
- ☐ Duolingo
- ☐ Khan Academy (AI tutor)
- ☐ AI-based learning platforms (e.g., Coursera, EdApp)
- ☐ AI-integrated LMS (e.g., Moodle with AI plug-ins)
- ☐ Other (please specify): _____

6. What benefits of AI in education do you find most important? *(select up to 7)*

- ☐ Personalized learning
- ☐ Increased learning outcomes
- ☐ Development of courses and materials
- ☐ Access to high-quality resources
- ☐ Adaptive learning paths
- ☐ Automatic grading and feedback
- ☐ Assistance with disabilities
- ☐ Motivation and gamification features
- ☐ Support for self-paced learning
- ☐ Improvement of digital skills
- ☐ Other (please specify): _____

7. How many AI-related benefits do you personally consider relevant in your experience?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

- ☐ 6
- ☐ 7

8. What obstacles do you think hinder the implementation of AI in the educational process? *(multiple choices allowed)*

- ☐ Lack of relevant digital skills
- ☐ Ethical issues (e.g., plagiarism, fairness)
- ☐ Technical infrastructure limitations
- ☐ Insufficient funding
- ☐ Legal or regulatory barriers
- ☐ Lack of interest from faculty or administration
- ☐ Resistance to change
- ☐ Other (please specify): _____

9. How many obstacles do you personally see in the implementation of AI in the educational process?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

COMMENTS (OPTIONAL)

_____

If you have your own thoughts, suggestions, or ideas about the implementation of AI in higher education, please share them below:

_____

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CHAPTER 6

CHAPTER 6

PHILOSOPHICAL AND METHODOLOGICAL DIMENSION OF VOCATIONAL PSYCHOLOGICAL AND PEDAGOGICAL TRAINING OF FUTURE SPECIALISTS IN THE FIELD OF TECHNOLOGY AND DESIGN IN UKRAINE

ABSTRACT

The article presents the conceptual foundations of psychological and pedagogical training of a competitive specialist in the field of technology and design. The philosophical and methodological aspect of vocational psychological and pedagogical training of future specialists in general and in the field of technology and design has been determined. The essence and components of the basic concepts, trends in the psychological and pedagogical training of a specialist in the field of technology and design have been determined. The concept of "innovative potential of a personality" and the essence of philosophical imperatives in terms of vocational-focused psychological and pedagogical training of future specialists in the field of technology and design in Ukraine have been revealed. The essence of a new methodological approach to the innovative transformation of the teacher's life in the educational environment in the era of digitalization is analyzed. The relevance of the research topic and the main theoretical and methodological approaches to the study are substantiated. It is noted that the problem of transformation of human dimensions in the post-non-classical era in the philosophical and methodological aspect of measuring the quality of vocational psychological and pedagogical education of future specialists of Ukraine, the relationship of educational policy with the socio-economic development of the country, should now be considered in the context of the state policy of innovative development as one of the urgent strategic issues of national security. The focus is on the fact that universal and nation-building value orientations, as a special social basis of the philosophical and cultural worldview, should be extrapolated into the global function of modern education. The essence of the phenomenon (as a phenomenon and concept) "psychometric environments/systems" (PS) is specified from the standpoint of psychosynergetics; it is proven that the psychometricity of social reality plays an important role in understanding social and socio-cultural processes, crisis states of their subjects, which are caused by psychometricity, against the background of crisis states of society itself as a social reality. In addition, the study considers social reality both from the position of its existence in the form of a social environment, culture, external to a person, and in the form of an internal psychic/intrapersonal, neuropsychic environment. It is emphasized that to date, both forms contain manifestations of the digital environment in its proportion, which is rapidly increasing in relation to human and psychometricity. The

main approaches to the content of psychological and pedagogical training of a competitive specialist in conditions of uncertainty have been systematized and developed. On the basis of the identified and analyzed methodological approaches and methods, philosophical and contextual basis of psychological and pedagogical training of future specialists, the main trends in the implementation of holistic human-centered and nation-building approaches in the psychological and pedagogical training of future specialists in the field of technology and design in the conditions of war and post-war reconstruction of Ukraine have been outlined. The author's own aspects of the philosophical and methodological approach and active means of training future specialists in the field of technology and design are presented, and the ways of their implementation in the pedagogical process at Kyiv National University of Technology and Design (KNUTD) have been outlined.

KEYWORDS

Professional competence, psychological and pedagogical training, human dimension, psychometrics, pedagogical skills, concept of pedagogy of the good, universal and nation-building value orientations, future specialist in the field of technology and design.

The education system in general, and the vocational education of technology and design specialists in particular, at all its stages, faces the task of focusing on the formation and development of skills and competencies necessary for innovation. An indicator of the ability to innovate is a high level of *innovative potential* of an individual, i.e., an integral systemic characteristic of a person that determines their ability to, firstly, generate new forms of behaviour and activity, using the opportunities that open up to them in the complex dynamics of the value and meaning dimensions of their life space, and, secondly, ensure a mode of self-development [1]. A complex and contradictory world requires the formation of a person of freedom, spirituality, and deep humanity who is aware of their responsibility for every step of their own choice. The existential value of personal freedom (creative, civic, professional) is combined with its *ethical responsibility* [2]. It forms *a critically thinking, civically courageous, competently capable person* who humanises the world, enriching it with intelligence, reverence and nobility. A general, somewhat idealised view of a person, whose qualitative characteristics should be shaped by education, is the basis for imagining what education, its philosophy and content should be [3, 4].

The philosophical and methodological aspect of the vocational psychological and pedagogical training of future specialists in general and in the field of technology and design [5] is determined by the ideas of the cohesion of the world and the transdisciplinary unity of scientific knowledge; theories of paradigm functioning and philosophical theories of imperative; provisions on the general connection and integrity of phenomena and processes of society development; works of scientists, which present theories of studying personality as an open, self-developing system; synergistic approach based on the ideas of integrity of perception of the world, nonlinearity, deep interconnec-

tion of chaos and order, randomness and necessity; humanistic pedagogy, self-development of the individual in the process of professional activity [6].

The idea is from the standpoint of the principles of managing the quality of vocational training of future specialists, the development of the subjectivity of the spiritual and intellectual personality that the essence of the new methodological approach "*Innovative Transformation of the Teacher's Life in the Educational Environment in the Age of Digitalisation*" is considered, which defines pedagogical interaction as human life, which is provided at three levels: physiological, mental and social, and holistically unites the emotional, intellectual and volitional spheres of the individual, in the context of transformations of the modern educational environment/space of the system of pedagogic education in Ukraine, is considered in the planes of real and virtual education in their synergistic combination in the era of digitalisation [7, 8]. The researchers formulated the essence of the new principles of this approach:

– *human dimension of the quality of modern education in the era of digitalisation,* which means that strategies and mechanisms for improving the quality of education are developed and implemented with the provision of open reflective interaction between all participants in the educational process, while maintaining the integrity of the characteristics of formation of the subjectivity of each person (cognitive, emotional and volitional), in the use of digital technologies, which become a tool for the harmonious development of a person in the educational environment, a technological tool for enriching the value experience and cultures of a future specialist.

– *participatory management of higher education*, which is interpreted in the aspect of a wide interconnected and integrated use of digital technologies in managing the quality of future teacher training in pedagogical universities with specification of the originality of organisational and methodological principles, revealing the deep meaning and origins of the idea of partes-based approach (coherence and unity, harmonisation of actions of management subjects that should be implemented simultaneously to achieve a common goal) [7].

Thus, the problem of transformation of human dimensions in the post-non-classical era in the philosophical and methodological aspect of measuring the quality of vocational psychological and pedagogical education of future specialists of Ukraine, the relationship of educational policy with the socio-economic development of the country, should now be considered in the context of the state policy of innovative development as one of the urgent strategic issues of national security.

6.1. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

The main issue in defining the essence of philosophical imperatives in the context of vocational psychological and pedagogical training of future specialists in the field of technology and design in Ukraine has become the clarification of the imperative of educational paradigms – which holds the highest value for learners and determines their successful future prospects. Immanuel Kant, in his work Critique of Pure Reason [9], explained that an imperative is a universally significant ethical

directive, as opposed to a personal principle (a maxim). This statement is vividly complemented by Kant's expression: "Act in such a way that your conduct could be an example." From this point of view, ***the personal and professional paradigm*** is a system of views and ideas, within which a person perceives the world around, is aware of himself/herself in society and anticipates future changes, which has specific logically related and interrelated components: *ontological* – imperative and *epistemological* – innovation, self-improvement, forecasting, and is characterised by functionality, prevalence, adaptability, dynamism, multivariance and controllability [10].

According to research [11], in the 1960s and 1970s, scientific reflections on the problem of the relationship between human, science and humanistic values were actualised. The works of Ivan Tymofiiovych Frolov (1929–1999), a philosopher, academician, researcher of the theory of knowledge, philosophy of natural science, who devoted his life to the comprehensive study of human, social, ethical and humanistic issues of science and technology, philosophy and history of biology and genetics, and the problems of the meaning of life and death, were of particular importance for the establishment of the problem of ***human dimension*** in Ukrainian philosophical thought of that period. The scientist formulated the idea of the unity of science and humanism, as a result of which science appears as a humanised doctrine that "contains" a person in its inputs and outcomes, which determines the study of human and their development in close relationship with social practice. This idea is a guideline for scientific education, i.e., a goal and an ideal that points to the prospect of a "new humanism" that does not oppose science but serves as a spiritual basis for the scientific and technological progress of mankind. It is especially important to note the presence of a ***value dimension*** in science. The fact that educational cognitive activity is axiologically oriented does not manifest itself in knowledge as something that deprives it of the attribute of objectivity. The value orientation of science and education is objectively motivated, because it also becomes the result of scientific knowledge, and not something extraneous that can only distort the truth [12].

J. Habermas, known for his works on social philosophy related to communicative action, discourse, and rationality, noted that society is based on communicative interactions, in which rational arguments are formulated and rejected. Habermas distinguished between two forms of communication: communicative action, which aims at exchanging information, and discourse, which helps to reach agreement, discursive understanding through justification [13]. Concepts of communicative reason and human interests are at the centre of Habermas's philosophical reflections of that period. The patterns of learning were a central issue for J. Habermas. In his opinion, it is not the process of learning, but the absence of this process, i.e., "not learning", is a phenomenon requiring explanation. The scientist studied adult learning in the context of the processes of establishing a democratic society. He called this relationship the *adult learning project* and associated democracy with free and continuous *communication*. Postulating a crisis of adult learning in his contemporary society, the researcher argued that adults are not sufficiently prepared for a democratic society, in particular to participate in *public discourse*.

It should be noted that Habermas's view that adults should be active citizens is at odds with the uncritical version of lifelong learning, where the lack of basic skills, combined with employment

is the central problem of adult education, which aims to "fulfil their role as active citizens participating in democracy" [13].

Therefore, it is quite positive that Habermas's transformation of social philosophy based on the theory of communicative action, his ethics of discourse and political studies have had a significant impact on the development of Ukrainian philosophy in the post-Soviet period. It also helped to create a theoretical framework for the formation of civil society and a political nation in Ukraine. In recent decades, Ukraine has consistently followed the path of democratisation of society, creation of modern institutions, moral and spiritual renewal of Ukrainian society [14].

We cannot endorse Habermas's "Heuristic of Fear", because Ukrainians not only resist, but also, owing to the world's support, make efforts to defeat the imperial insidious, bloody enemy. *We share and fully support the current and deeply reasoned position* of A. Yermolenko, Ukrainian scientist, philosopher, Doctor of Philosophy, professor, corresponding member of the National Academy of Sciences of Ukraine, director of the Institute of Philosophy of the National Academy of Sciences of Ukraine and *author of the publication "We must not negotiate, but resist":*

We all need a common victory over evil, and the world must unite for this! Today, Russia is carrying out a full-scale aggression against Ukraine not because the West has somehow "provoked" it – it is aggressing because it is the only way for the current Russian Federation to exist, and imperial expansion is the only way for it to stay together" – these are the true interests of Russia… [15].

After all, this article is a response to Jürgen Habermas's publication "War and Resentment" of April 28, 2022 [13], for whom "*Ukraine's defeat is no worse than the escalation of the conflict. He does not understand that Putin is targeting the West, whose freedom is being desperately defended in Ukraine."* Following A. M. Yermolenko, we also believe that there is no dilemma, as outlined by J. Habermas in his article, because the **two evils** that J. Habermas describes and which form a dilemma for him are actually one single evil.

It is from this perspective that the author, explaining the concept of the pedagogy of the **Good**, thoroughly reveals the flaw in the idea of the "impartiality" of the teacher. I. Ziaziun argued that it is educators who are able to influence future history, saying that education is an open-ended "scientific formation", since human existence is conditioned but not determined by its circumstances. Finally, since teachers are also students, they are not independent of social processes. In professional activities that are directly related to a person, there are two equivalent subjects in terms of their content – Human and Human. They should create a sense of Peace, Balance, Well-being and Happiness for each other… These life-giving principles and the final results of human life are in the hands of the Teacher… The Teacher is a master on a par with the student, constantly participating in the creation of new knowledge, mastering the valuable experience. A teacher-coach, like a teacher-master, teaches unobtrusively, non-trendy, spontaneously. He/she teaches by his/her Behaviour, his/her Status, his/her Knowledge, his/her Humanity, his/her Freedom, his/her Love, his/her Happiness, his/her Talent [16].

Numerous studies focus on the idea of "life well-being", which is a multidimensional phenomenon that includes physical, psychological, social and spiritual health. It is a holistic approach to the

development of educational standards and practices that allows us to ensure long-term life satisfaction, which is part of the system of values of modern human dignity. According to the concept of "life-oriented education", personal happiness is not just a subjective state of satisfaction, but the result of the holistic development of the human personality, supported by educational practices, focused on emotional competence and ethical maturity. In particular, it involves the development of critical thinking, self-awareness, empathy and inner harmony [17]. At the level of practice, it is realised through an individualised approach to pedagogic activities that takes into account the motivational and psychological characteristics of each student, creates an emotionally supportive environment, promotes the formation of positive life values, and provides moral support, which is important for the prevention of anxiety, depression and emotional burnout [18].

A core idea of pedagogical mastery is the recognition that, beyond all else, the system of teacher education represents a "profoundly affective and sensory-driven practice of envisioning and planning the future world of humanity". It embodies an integral synthesis of three inseparable dimensions of human dimension – "*affect, intellect, and will*", united in their holistic coherence: cognitive, emotional and conative. We share the position of scientists [19] that, in general, the current priority areas of the state educational policy in Ukraine should be: *focus* on the *individual* and preservation and transmission of *national* and *universal values* to the younger generation; creation of equal opportunities in education; continuous *improvement of the quality* of education, updating the content and forms of organisation of the educational process; introduction of appropriate *innovations* and information technologies; raising the social status and *professionalism* of educators, strengthening their state and public support; *development of education as an open* state-social *system; integration* of domestic higher education into the European higher education system [20]. The interpretation of universal values as a *value-based holistic approach to learning* that provides meaning to human life and activity is recorded in historically specific forms of culture and theoretically substantiates the importance of measuring the quality of higher education from the standpoint of human dimension in general and vocational psychological and pedagogical training of future specialists in the field of technology and design in particular.

It is in this context that I. Bekh, an active member of the National Academy of Pedagogical Sciences of Ukraine, Doctor of Psychology, Professor, Director of the Institute of Educational Problems of the National Academy of Pedagogical Sciences of Ukraine, properly and timely noted in his speech "The Problem of Life Success of a Personality in the Social and Educational Dimension":

...The national situation, the challenges to preserve the integrity and statehood of Ukraine, and the conditions of war have sharply intensified the problem of meaningful life values, especially national values, both at the state and individual levels. National independence, identity, patriotism, will, devotion, national identification, national centrism, statehood are becoming effective symbols that unite the nation around fateful actions, aimed at establishing, preserving and defending our Ukraine..." [21].

Since "PERSON" = "PERSONALITY" + "INDIVIDUAL", it is impossible to comprehend the social role of an individual without analyzing his/her psychology (moral and value orientations, motives of activity, abilities and character, and in some cases – the features of his/her bodily organization,

for example, the type of nervous activity) due to the fact that the structure of a person's mental activity is a complex, multifaceted and dynamic system that is capable of self-development [3].

At the same time, it is impossible to specify the content of the personal dimension of the strategic development of higher education without a general scientific philosophical and methodological reflection on the processes of integration as a phenomenon of social transformations that meet the requirements of the time. After all, the basis of integration is the intersystem interaction of socio-political, socio-economic, scientific-technological, socio-cultural spheres of social life, which, on the one hand, strive for national self-preservation, and on the other, feeling external dependence, have a tendency to self-destruction. At the same time, intersystem interaction is considered in two planes: internal and external. Such interaction determines the state's ability to new interstate formations and is formed on the basis of the interaction of the main levels of social development – personal, political, economic, social and cultural. The unity and stability of this interaction provides society with the ability to self-organize, adapt to the conditions of the external environment, and actively participate in the processes of international relations, while maintaining national identity. Otherwise, integration processes will lead to the absorption of the state and throw it to the periphery of the globalization space [22].

Instead, the issues of strategic modernization of higher education, its philosophy and psychology, and universal human values in the context of the personal dimension of the quality of education in Ukraine are currently quite scattered and far from always clearly outlined and formulated [23]. Therefore, the authors of the article consider it necessary, first of all, to dwell on one of the most important and fundamental, from our point of view, aspects of them – the methodological one, which corresponds to the current vector of scientific development.

The modern post-nonclassical stage of science indicates that the solution to this problem lies in such an integration of scientific approaches, which requires a single scientific analysis from the standpoint of psychometric complexity, as the internal unity of phenomena that previously seemed completely unrelated to each other. In the methodological aspect, this is manifested in the development of trans- and interdisciplinary connections, the implementation of the conceptual model of psychosynergetics "whole in whole". The above applies not only to processes within the natural or human sciences, but also between the humanities and natural science blocks in the aspect of the post-disciplinary classification of sciences, which considers them on the basis of dimensionality (cosmo-, natural-/geo-, human-/socio- and psychometric) [24]. Along with this, post-nonclassical reveals the deficiency of the generalizing role of philosophical knowledge, the need to develop applied philosophy as an organizational and systematized form of modern scientific research.

Therefore, if to strive for a future society that is focused on Man as a Personality and, accordingly, on universal human values, then prognostic construction should also take into account the "human face" of the subject of the socio-educational space both in Ukraine and in Europe. In other words, the management parameter should be psychometric.

However, the current reality demonstrates a tendency that the person of the future will encounter more aggressive conditions of existence, both physical, mental, and social. Therefore, it is

necessary to take into account that the minimum requirement for a person should be competence in terms of his/her physical, mental, intellectual, and social survival. In this case, it is important to focus on the macro level of both what is happening and what is planned.

Along with the macro level, it is also necessary to take into account the set of phase states of systems/processes operating within the psychometric environment of an individual (intra-personal, intra-cognitive scale), in the social-educational-cognitive space (interpersonal scale) and, finally, in the scale of the culture of different countries and peoples (macroscale, as the spectrum of the considered integration of higher education of Ukraine into the European educational space).

The implementation of the unity of nonlinear synthesis of knowledge in the aspect of the methodology of the personal dimension of higher education on the basis of the psychosynergetic approach will allow a manager of any level to build around one common one many more lateral trajectories – educational development routes, which will allow showing the nature of the probability of processes, the variety of possibilities of ways to increase the efficiency of the functioning of educational systems and methods of managing them. From such positions, within the framework of the post-nonclassical psychosynergetic methodology of science, it is possible to make an attempt to specify the content of the personal dimension of higher education regarding human life in modern conditions (S_1 – subject – person), which is represented by higher education in Ukraine (S_2 – subject – higher education system) and explain its constructive prognosis.

Psychosynergetic understanding is manifested in the recognition of the pervasive presence of self-organization at the level of the psychic, which leads to a change in the model – a transition from the admissibility of a qualitative leap only between the boundary levels of matter to the assumption of the possibility of such a leap in the "jumping" mode to any of the potentially possible levels for a certain psychometric environment.

The transition to the "whole-in-a-whole" position becomes a conceptual-model (categorical) identification of why a person can be more complex than society or the human psyche is more complex than the person him/herself. The place of the "whole" in such a model does not determine the level of its complexity: the "whole" that is inside another "whole" can completely be more complex than it, and the level of complexity of the system in this case is defined as the ability to create something that is more complex than the system itself [25].

The nonlinear nature of processes and relationships in such a conceptual model/system as "whole-in-whole" leads to an understanding of qualitatively different results in the behavior and states of these systems and their relationships [26].

In combination with the "whole-in-whole" position, the categories proposed by psychosynergetics direct the level of research beyond the "part-whole" dichotomy, shifting the emphasis to the level of "whole-in-whole" as "nonlinear whole-in-nonlinear whole". Since this implies the manifestation of complex holistic environments within each other, such as: the system of the psyche, the system of the inner world of the individual, the system of the human organism and the system of the person him/herself, the system of society, the system of nature.

Therefore, from the standpoint of psychosynergetics, both man (A) and society (B) are considered as a nonlinear whole, the relations of which are formed as the relationships of wholes (A B). Therefore, a macro-goal (C) is distinguished – the product of these relations (between wholes A and B), which affects the behavior of each whole.

If a third whole is introduced into the model, for example, nature (D), then the existence of a mega-whole (E) becomes obvious - the product of relations between the macro-goal (C, C_1, …, C_n) and between wholes (A, B, D). The study of the «nonlinear whole-in-a-nonlinear whole» requires analysis within the category of «field of development paths», needing to take into account the levels and nature of the neighborhoods of points/processes of bifurcations.

Since the neighborhoods can overlap, they can fundamentally change the conditions and, accordingly, the nature of the processes of transformations/transitions, structures/environments from one state to another under the influence of mega-level control parameters of type E.

In the methodological aspect for the subject of our study:

S_1 – subject - person – psycho-bio-social or psychometric environment/system of a certain class;

S_2 – subject - higher education system – socio-educational or psychometric environment/system of the same class.

After all, it is to psychometric environments, by definition, that S_1 and S_2 belong. Let's note that for S_1, the "psycho-bio-social" environment/system is put in first place, and for S_2 – the "socio-educational" environmen/system because this is exactly what happens in real social reality today. But for scientific reflection, these environments/systems must be brought to uniformity, that is, to make the socio-educational environment psycho-social-educational or psycho-educational-social, in other words, priority psychometric. The point is that these environments must necessarily be methodologically equivalent not only to each other (because this is actually a micro-level for the entire model of the relationship S_1 and S_2), but both (each and together) must be relevant to the uncertain future that awaits the subjects of the educational space in Ukraine, Europe, and the world in general in the distant future in 10–15–30 years.

Let's denote such an uncertain future N, respectively N10, N20, N30. This is the time of active social realization of oneself by those subjects who today and in the next 5 years will receive higher education. So, it is possible to see the priority and obviousness of the characteristics of psychometrics in the answer to the question – what should be a person with higher education who will enter the social space in 5–10–15–20 years for the model of the personal dimension of higher education.

Then the question of what exactly this space will be becomes relevant. It should be one that takes into account and is subordinate to social values, goals and norms or only psychometric – that is, one that takes into account and is subordinate to the psychometric values, goals and norms of a person as an individual. Education, in a broad sense, correlates with both of them – both with the individual and with society. The construction of a methodological predictive triangle – a macromodel is formed. Accordingly, its peak, which is possible to put in the first place, will determine the nature

of the process. The basis for this conclusion is the mechanism of the nonlinear control parameter in the behavior of psychometric environments.

Investigating the personal dimension of higher education in Ukraine as an open nonlinear system capable of self-organization, it is possible to focus on the aspect of improvement and self-development of such systems that are able to accumulate and use past experience. Considering the above-mentioned issues in this methodological perspective, it is possible to focus on two essential points.

The first is the "non-specific influence", which characterizes the inner mental world of a person within certain conditions – the environment of higher education in the future. Such influence is explained by the fact that modern information and socio-economic, socio-educational, information conditions form a qualitatively new mental, cognitive load on a person and his/her psyche (the system of mental reality). In these conditions, it is important not to lose the contours of a person's future in the environment/system of higher education in Ukraine and the image of higher education itself in this future. The fact is that in conditions of prolonged unprecedented psycho-emotional "stress" load, as studies show, a person can immerse him/herself in the current situation, isolating him/herself today ("here and now"), ignoring his/her future ("withdrawal into sudden problems"). Otherwise, a person may strive to level his/her presence in society ("become invisible"). Such an orientation of the personality, psyche, and brain leads to the organism expanding the scope of its implementation. For example, at first, there is a decrease in the mnemonic function and the ineffectiveness of tutoring efforts, then motor and muscular functions decrease, intelligence "extinguishes", and volitional and value motives do not work.

The second is the rapidly growing chaos at all levels of human existence, which is an integral stage of self-organization and dissipation [27]. Chaotization of the internal-psychic-personal (informational, value, emotional) world of a person when he/she crosses the critical threshold for the nervous system, brain and cognitive activity can lead, according to existing experimental scenarios, to the destruction of the system/environment itself to one degree or another. Since this is the internal-psychic-personal world of a person (emotional, informational, value) – the aspect of his/her mental, intellectual and axiological health is actualized. Thus, it becomes important to consider the degree of destruction: partial (recoverable destruction), or significant (remains the ability to still maintain the obviousness of the existence of the system/environment as a subject), or complete (the system/environment disappears, having collapsed «to the ground»). An essential feature that is important to pay attention to in these scenarios is to find out what exactly is damaged from the beginning: the brain substrate and the function of the brain, the psyche, or is there a diffuse deterioration of the appropriate degree.

If the brain substrate is damaged, and as a result, the brain function that provides higher mental activity – intellectual, the structure of the personality is damaged, for example, in conditions of a new type of high-speed trauma with a diffuse nature of the damage (cognitive overload in simulation programs, psychological personal-value trauma, road accidents, plane crashes, strokes, contusions or even physical death) and the substrate is no longer restored in a substantially complete

volume, then it is not possible to assert that this is the same subject who is capable of performing the same cognitive activity with the same quality.

The theory of social self-organization provides a new vision of the processes of social transformations and changes, since it reveals the most important role of chaos in establishing a new social order, which is a complication and development of the social system at the structural level. However, the priority of psychometrics of the social and socio-educational environment and the criticality of the current situation in this aspect, poses the need to correct the methodological foundations in the direction of psychosynergetics in order to find adequate solutions to the problems of the personal dimension of higher education.

When studying the psychometric environment, it is obvious that an extremely non-equilibrium state plays the most important role in the existence of the environment. In a nonlinear regime far from equilibrium, such a general principle of determining the state of the system is absent. Therefore, in psychosynergetics, the states of environments far from equilibrium can be unstable and move to new organized states as a result of their own influence on themselves within themselves. Moreover, this can manifest itself both in one of the parameters or measurements of the psychometric environment, and in many of them, both locally and at the macro level "as a whole". Finally, the regime of «nonlinear whole-in-nonlinear whole» is possible.

For example, let's assume that at time t_1 the environment is in state C_1, and at time t_2 – in state C_2. Therefore, the change in the state of the environment ($\Delta C = C_2 - C_1$) over time ($\Delta t = t_2 - t_1$) is equal to: $C(t) = \lim_{\Delta t \to 0} \frac{\Delta C}{\Delta t} = \frac{dC}{dt}$ – a quantity characterizing the change in the state of the environment over time. Each C_i characterizes some information state of the psychometric environment. The deviation from information equilibrium is characterized by the parameter Δi. When $\Delta i = 0$, the psychometric environment is in a state of information equilibrium. When $\Delta i \to 0$, that is, it is insignificant, the psychometric environment is near information equilibrium, approaching it. This family of states, which expresses the continuous expansion of the equilibrium state for thermodynamic systems, was called the thermodynamic branch.

By analogy, the family of states, which express the continuous expansion of the equilibrium information state of psychosynergistic environments (PS), will be called the information-dynamic branch of PS. For such states, autocatalytic reactions become possible (a reaction in which one of its elements acts as a catalyst-accelerator, where the reaction rate first increases and then fades away). Then, by definition, in some PS, such as intra-psychic reactions of the type of autocatalytic information level (when Δi reaches a critical value), the states belonging to the information-dynamic branch become unstable. In this case, the PS switches to a new branch, which may already correspond to an organized structure.

Similar structures (or organization of structures) can be prepared in advance and the PS only leads to them. When the condition $\Delta i = 0$ is violated, the information-dynamic branch can become unstable. If it becomes unstable, the PS can move to another branch, which in general terms is

already an organized structure or was such in memory, experience, values ... or a new branch is artificially created to lead the PS to a different development route relative to the possible spectrum of paths that are available in the PS's memory. In the aspect of our research, for example, this may be an unconscious process of change/deformation by the human subject, for example, of his/her personal identity.

It should be noted that G. Haken used the concept of "critical divergence", and I. Prigozhin used the concept of "critical threshold", "critical value". In both cases, it is about a certain criticality as a certain forced distance, a certain turning point/situation that systems reach in their states, which are characterized/determined/described by selected indicators. In such an interpretation, it is the threshold criticality or divergence – that is, the achievement of this point by the system – that leads to a qualitative leap in the state or behavior of the system. Indicators can be, for example, "temperature" in the categories of thermodynamics of I. Prigozhin, "wave" in the synergetic of G. Haken. In the aspect of our study of psychosynergistic environments, this is a personal assessment and, as a result, a need; or value position and, as a result, inconsistency with this need (for example, in changes that are closer to the choice of a system of fluctuations: tradition in culture, emotion in actions; changes in the speed parameters of the capacity-structural cognitive characteristics of information processing).

Now, obviously, a fundamentally new scientific picture of the world is being formed. It does not raise the question of a model of Nature. In this picture of the world, Nature is absent just as Man and Society are absent. A fundamentally qualitatively different component has rapidly entered the new scientific picture of the world – "Number", symbolizing the inanimate, non-biological. It is symbolic that, as is known, the word "number", which comes from the Arabic "sifr", means "empty", "nothing", "zero". (Latin – "*Cifra*"). In this context, the word "digitization" can be interpreted as "zeroing", "desolation".

Having found ourselves in the vicinity of digitalization, humanity can no longer assume "that we are on the path to a new synthesis, a new concept of nature". Because "digit" is not only "inanimate", but generally "unnatural". Since the new "picture of the world of numbers" is, in fact, a picture of the world that assumes in the future "life" only numbers "separately from nature" and "separately from man", which will exist "after nature", "after man and society", "after the union of man's nature" and "after the dialogue of man with nature", which symbolized until recently the post-nonclassical picture of the world – "The zone after post-nonclassical".

Within the framework of the etymology of the origin and understanding of the word "digit", let's also interpret the meaning of the context of the word "digitization" – this is the zone of zeroing the previous one. Perhaps this is a new form of civilization that "zeroes man". Its subject is a "digit", digital information that materializes in a certain medium (not necessarily biological), which at a certain moment becomes a self-sufficient, acting independent subject – a "digital subject". Judging by the IT transformations that are rapidly taking place in all spheres of life today, we are facing the emergence of an independent form of existence – the existence of a "digital subject". It is believed that information arises when someone or something perceives it. There is no

perception (fixation) – there is no information. In order for information to appear in digital form, it must be perceived either by a person or by a "digital subject" endowed with appropriate intellectual abilities. In fact, this is what developers of artificial intelligence (AI) strive for. However, our human interpretation of intelligence, firstly, contains emotional intelligence, and secondly, proceeds from a person and his/her abilities as a carrier of intelligence. It is clear that the «subject – number» does not have a bio-carrier, does not have «Spirit and Faith» in the Hegelian sense, intelligence in the human sense [28].

The fundamental difference of the new picture of the world, in our opinion, is that Man is a natural being and Society is a product of man. It is obvious that these "holistic" components "Man – Nature – Society" have no analogies-similarities. Let's explain this statement: Nature is unemotional (passionless) to Man, fundamentally ontological "in itself" and does not take Man into account. It does not contain emotionality a priori, it does not have values in the human sense. Man is emotional, that is, by nature he/she is inherent in the presence of emotions, consciousness, emotional intelligence, spirituality, etc. Man is technological, intellectual, psychometric, neuro- and physiological. He/she is radically, qualitatively different from Nature, despite the fact that he/she is considered a natural being, a product of the "internal evolution of the Universe". Man tries to take nature into account, depends on it. All this also explains the idea of the anthropocentricity of the cultural-historical sphere, which is opposed to the stable material world of nature, which is considered atemporal. Society, society, state, power, as it is not surprising, are almost apathetic to a specific person, pursue their goals, although they are created and consist of people. More precisely, it is about a structure that is inhumane in its essence and, actually leveling the individuality of a person, tries to take it into account in the same way as nature. Society is unemotional, «indifferent». For example, banking and similar systems that were created by man. In any case, organizationally they contradict man, their structure does not correspond to the dimensionality of man., because its goal is to preserve itself as a construction, its given order.

A priori, a figure is unemotional to man, to society, and to nature, that is, fundamentally dispassionate, although the figure was created by man and is a product of his/her intellect. Similarly, the "relationship" of numbers to society and nature was not foreseen from the very beginning of the existence of numbers. A feature of the current stage of the functioning of numbers is that today numbers actually write their own "world of numbers" independent of anyone and anything: be it the activity of a robot-bot in social networks, or programs like "Big Data".

Thus, scientific reflection leads to a conclusion regarding the interpretation of a new picture of the world. There is no single picture of the world in the traditional sense – there are: a separate picture of the world containing Nature and Man, and a separate picture of the world of Numbers. Or two separate pictures of two separate worlds by type are possible – "Nature – Man" and a picture of the world "Number". In the aspect of the above, the primary picture of the world can be conditionally expressed by the model "Nature – Man – Society". Its clarifying variants are possible, for example, "Universe – Nature – Man (brain, psyche, consciousness) – Society – Culture – Technique (technology)", etc.

Three hundred years after the scientific substantiation of the construction of the classical methodology of science, Ilya Prigozhin will write that "there is no Man in the classical scientific picture of the world". Indeed, there is strength, form, weight, color, etc. in it, but there is no man as a natural force or a man in him/herself with his/her emotions, values, "human factor", human time, for example, the "human factor" is not provided for in the structure of banks, therefore it is taken into account only for the purpose of zeroing. Today, the new picture of the world takes on the following form – "nature – man – number (zero, empty)" or "nature – man (brain, consciousness, society ...) – number (zero, empty, society ...)". Such a picture of the world cannot be considered within the established classification of the methodology of scientific knowledge of S. Stepin "classical – non-classical – post-non-classical". Since it no longer fits into the framework of the classical, non-classical and post-non-classical stages of the development of science.

In fact, the Number is the final form of that "non-human dimension", which until now has characterized only a nature apathetic to man. In the case of the "number" – it is the zero of human dimension (zero cycle). True, to a large extent, society is also characterized by indifference to man, a veil for its interests, for example, organizational, public, ideological, banking – that is, in the organizational aspect – the preservation of its own structure, value orientation towards profit. The "Era of the Number" is understood by us not simply as the "next stage of civilization development", which includes all the previous ones. On the contrary – it is an era that leaves them outside its "civilization". The new "picture of the world of the number" is characterized by "NON-natural dimension", "Non-sociometricity" and even more so "Non-human dimension". All of them are nullified, at some point of self-sufficiency of the number and remain outside its boundaries. "The number is a number and it is in itself".

Therefore, it can be argued that the concept, conceptual model, picture of the world has fundamentally changed. It was: "one follows from the other, generates the next, then attracts it to itself and they coexist in a new, different mode". It became: "lack of involvement and coexistence", "what has arisen now and is available by itself", "what has arisen and improves itself". The last characteristic, the non- and extra-human dimension of digitalization, the "era of the digital" has a fundamentally new fundamental specificity. First of all, this is the specificity of the relationship "Man" – "Digital". There is nothing human in digital. In the conditions of digitalization, a person at a certain moment is simply taken beyond the limits of presence, participation in digital processes, disappears from the circle of digital participants (this is not the same as a digital participant). As a result, a digital «civilization» emerges, which is qualitatively fundamentally new and parallel in the direct and figurative sense to all previous types of civilizations that contained Man in one form or another and to a certain extent.

One of the applied aspects, in our opinion, is the effect of "zeroing" any psychospheric "horror stories" of the historical list – the creation and introduction of technologies harmful to humans and nature, weapons, etc.

What is happening now, in our opinion, demonstrates the movement of the Number towards its insensitivity to all aspects that are related to human activity, its creativity and values, to the

mental or biological specificity of human life. It is logical that it is not possible to call what the "digital subject" uses ("subject – number"), with the same words that were created in connection with and/or to describe a person – brain, creativity, intelligence or affect, intellect, will.

Nowadays, a person is pushed out, or absorbed or dissolved by the "number" by means of "zeroing" – ignoring the emotional, value components. The idea of creating a subject of action by building a connection "human brain – electrodes – computer processor" is just one of the examples and methods that lead to such "zeroing". In conditions of sufficiently developed digitalization, a person together turns out to be unnecessary, superfluous with his/her psycho- and human dimension, human factor, human values.

Today, a "transitional digital society" is actually being created so far, in which "digits" are already able to serve themselves, inventing and implementing the necessary new computer equipment and its parts, and in the future they strive to do without human participation (which is already happening in some places). "It" can itself make the necessary replacements in itself and others like it, support itself and others like it in the necessary form and activity, finally, "it" becomes able to improve itself, create the necessary new things, including programs, language, using existing skills and programs. There comes a moment (and it has already come) when a person does not know either the language or the plans of "digits – computer", "digits – robot". If only "it" were only busy with itself! But it seeks to take everything possible from a person, ignoring both immediately and in the future his self, human dimension. And then, in the best case, both a person and a "digit" will receive their own allocated space for each.

It is obvious that digitalization leads to the emergence of a "society" of robots "next to", and not "together" with human society. At the same time, a person's irritation from the inhumanity of the voice of an electronic announcer is growing – this is where human emotionality manifests itself. The feeling of hopelessness is also increasing due to other manifestations that appear due to increasing digitalization as inhumanity, unemotionality of the "digital society". The dialogue mode is disappearing, the spectrum of the message mode is expanding, when an electronic voice or author reports something, offers to choose one of several options for action (let's recall the telephone automatic directory). In this mode, there is no human dialogue, and, even more so, sensuality, empathy, as there are no human shortcomings. Let's give another example: conducting so-called «educational online trainings» for developers of educational programs of higher education institutions, when participants who cannot see and hear each other (the organizers have programmatically eliminated the possibility of turning on cameras and microphones by participants) are prohibited not only from communicating in writing in the chat, but also from generally finding out the names of fellow participants of the event, and all that is allowed at such an event is to choose one of several options for the proposed answers in anonymous online testing… But it is precisely the violation of symmetry, ideality, as is known, that leads to the emergence of masterpieces in creativity. Let's begin to feel a deficit in the exchange of emotions, feelings, of what is inherent in living things in general and living people in particular. In our opinion, in the not-so-distant future this may lead to the disappearance (fading of the population) of humanity in a new non-trivial way, i.e. not the usual

way of wars, arms races, intelligence struggles, etc. Yes, there will be stages, such as combining the brain with electrodes, i.e. absorption or synthesis. But in the end, this may still lead to the disappearance of the human, since the human dimension in such a synthesized subject becomes less and less. A person, in fact, is already learning to "not be human", not to show his/her human dimension – emotions, learning not to expect a corresponding sensory reaction from an electronic interlocutor. There is no point in waiting for "feelings of life" from an electronic interlocutor. And when a living subject of communication appears, a person no longer switches. The perception of reality as a computer game begins.

Of course, there is a parallel line of human creation of artificial intelligence (AI) as a kind of simulacrum that imitates personality, intonations, facial expressions, reactions. The authors of this direction do this on the basis of a simplified model - the structure of the brain, consisting of nodes, and not of neural networks, as in the real human nervous system. In particular, in the program "The Era Of Artificial Intelligence" with Robert Downey Jr. (YouTube Originals) Series 1: "Where is the point of no return?" using the example of creating a «digital child» capable of human-like emotional reactions – a device that can analyze music and improvise, as well as cyber limbs for musicians and a custom-made digital double, the following questions are raised: How to create a copy of a person, a stunt double that would look realistic, a copy that in real time will behave like a living original? The authors of the project emphasize that they want to achieve the feeling that you are talking to a real Will, and not to a digital Will – his/her virtual version. Let's note that we are not talking about cloning.

How far will it take to create a living, truly independent personality? This directs scientific research to fundamental philosophical questions. For example, about the nature of free will. And how, in general, to create/teach to raise an independent personality? What is free will and how to develop/teach willpower? "Someday I will be gone, but he/she will remain" – this motto inspires scientists for further development of AI, encourages them to expand their creative capabilities. Humanity has been trying to solve this problem for thousands of years: from the times of Aristotle, Descartes, the creators of the Golem to this day, this "battle of a thousand years" continues. Is it possible, in principle, to create a machine capable of thinking independently? Let's say, a copy of a specific person, independent and autonomous. Impossible. But people have achieved a lot through joint work. So far, its goal is defined as follows: AI is a virtual assistant that provides the opportunity to devote more time to creativity and social activities and other activities. – this is the range of issues raised so far.

As a result, something else is replacing nature and man, expressed so far by the concepts of digitalization and virtualization. We are witnesses and creators of a new picture, a model of the world – "nature – man – number" ("nature – man/brain/society – digital subject"), in which very soon only the "DIGITAL SUBJECT" may remain, because a number in the "DS" status does not need either nature or man. This does not mean that such a subject will necessarily be aggressive. Presumably, there will also be a "fork" – separately "nature – man" ("nature – man/brain/psyche/society") and separately "digital subject" as two parallel worlds.

Psychointegrative, from the point of view of I. Zyazyun, acts as a general scientific transdisciplinary research methodology, where the initial anthropometric ideas and their paradigmatic models are in the imperative of human life. In this aspect, pedagogical action aimed at the development of the individual becomes possible when it is based on eternal universal human spiritual values: «... it is necessary to build a holistic process of acquiring knowledge adequate to life, to build an organic complex of humanitarian-social-historical, natural-scientific and artistic disciplines, united by the unity of humanistic meanings and spiritual and moral goals» [25]. One of the prerequisites for solving this extremely important and complex task is the acquisition by teachers of higher (especially technical) schools of thorough psychological and pedagogical knowledge, skills, abilities, and attitudes.

The interpretation of universal human values as value-oriented sensory knowledge that provides the meaning of life and human activity is fixed in historically specific forms of culture and theoretically substantiates our psychosynergistic approach to the problem of the personal dimension of higher education from the standpoint of human dimension. Perhaps one of the most negative consequences of total digitalization may be the devaluation of universal human values in the actions and behavior of the individual. To overcome and prevent this, it is necessary to take into account the cultural and historical dynamics of changing paradigms of education as the axiological basis of social interaction that globalizes the world. Such an analysis allows to reveal the essence of the trends in changes in value orientations, as a special social basis on which to expound the philosophical and cultural worldview that should determine the global function of modern scientific knowledge; to reveal its social force that expresses the progress and modernization of education in different historical eras.

The common thing here is the need to translate the achievements of science and culture, best practices into the consciousness of the Society, achievements against the background of this knowledge and attitudes, awareness of new priorities of the personal dimension of education. The special thing is to reflect the connection of the cultural, sensory experience of humanity with education, as well as the contradictions that are inherent in each model of the picture of the World [26]. Naturally, under such circumstances, the educational systems of different countries are faced with the task of spiritual renewal of humanity as a whole and the younger generation in particular, the preservation and reproduction of universal human values.

Today's world goes beyond the theoretical boundaries of classical theories, since it is characterized by instability, variability, multi- and multidimensionality, a complex topology of social space and the heterogeneity of historical time. Thus, polyparadigmality and transdisciplinarity become important characteristics of modern scientific knowledge. Currently, a transformation trend is being formed in the structure of a holistic picture of the world: "Nature – Man" (with all the variations that involve specifying the component "Man" – "man/brain/society"). It is turning into a picture of the world "Nature – Man – Digitalization" (where the digit is connected to the person – exoskeleton, electronic eye, etc.). On the other hand, there is a tendency to form two separate (parallel) pictures of the world: "Nature – Man/Digitalization" and "Number".

The above indicates that humanity, in general, and education, in particular, are experiencing an "absolutely new process." Its qualitative novelty can be expressed in the fact that "digital subjects" will no longer exist as "separate subjects," but will begin to "oscillate coherently." As a result, the "digital subject" field itself will no longer consist of separate uncorrelated "wave trains," but will transform "into one practically infinitely long sinusoid." Which, with great probability, may allow it to separate into an independent form of an unnatural and inhuman kind – the "civilization of the digital subject."

Nowadays, psychosynergetic ideas of pedagogical mastery should be a beacon for all concerned with solving problems of the quality of higher education, for all those for whom Science and Education are the meaning of life and a conscious value, for those who are able to faithfully serve Man and feel the needs and realities of the state. Changes in modern Ukrainian higher education have become feasible. This has been achieved for many years, but the people whose leaders deceive them materially and spiritually suffer a tragic fate. Enriching advanced philosophical and methodological experience with research that would contribute to the creative implementation of the ideas of Ukrainian scientific schools into modern practice is currently necessary, based on our own conditions, culture, politics, mentality, in the context of the pan-European and global development of independent Ukraine.

Summing up the above, we note that universal and nation-building value orientations, as a special social basis of the philosophical and cultural worldview, should be extrapolated into the global function of modern education, which should determine and implement its social power, characterising civilisational development in different historical epochs.

6.2 RESEARCH DESIGN AND METHODS

To solve this problem, we used a set of interrelated scientific research methods based on the application of a systematic approach as a methodology for combining philosophical, psychological, pedagogical, sociological, aesthetic, historical, cultural, and project knowledge.

Let us explain them:

1. Theoretical methods (analysis, synthesis, comparison, classification and systematisation of research results; analysis of periodicals, documents, factual and statistical information, dissertations, etc.) – to study the state of research on the problem, determine the specifics of methodological approaches; substantiation and clarification of definitions of key concepts, ensuring the objectivity of determining strategic prospects and the possibility of making comparisons with any target group; the literary and analytical method was used to systematise and summarise scientific and literary sources; the application of historical and typological, analytical, semantic and pragmatic approaches allowed to identify the characteristic features of the typology of the historical dynamics of civilisational changes and to summarise the transformations in the project concepts of scientists of the 20th and 21st centuries.

2. Empirical methods (observation, surveys, modelling and forecasting from the initial registration/description of circumstances and facts/phenomena and behaviour to understanding the needs of respondents) – to substantiate the trends, concepts and originality of the philosophical and methodological dimension of vocational psychological and pedagogical training of future specialists in the field of technology and design in Ukraine.

To summarise, we would like to emphasise that on the basis of the identified and analysed methodological approaches and methods, philosophical and contextual basis of psychological and pedagogical training of future specialists, the main trends in the implementation of holistic human-centred and nation-building approaches in the psychological and pedagogical training of future specialists in the field of technology and design in the conditions of war and post-war reconstruction of Ukraine have been outlined.

6.3. RESULTS

It should be noted that, as it's well known, universal and nation-building value orientations, as a special social basis of the philosophical and cultural worldview, should be extrapolated into the global function of modern education, which should determine and implement its social power, characterising civilisational development in different historical epochs. Therefore, in practical terms, education turns into a cultural and philosophical space where values, identity, thinking ability and responsibility to society are formed. From this perspective, Kyiv National University of Technology and Design (KNUTD) in its educational strategy reflects a worldview that is closely linked to the philosophical and cultural context. This approach demonstrates the deep integration of humanitarian knowledge into technological and design education. After all, Kyiv National University of Technology and Design is a multidisciplinary educational, research and innovation institution with a developed infrastructure and modern material and technical facilities that provides multi-level training of qualified specialists in various fields. The university is a flagship in the training of specialised personnel in the fields of light industry, clothing, business, art and technical modelling, design, art, pedagogy, psychology, economics and consumer services, medicine and pharmacy, law, etc. It is also one of the oldest technical higher education institutions in the country. The university is engaged in scientific and innovative activities and is recognised both in Ukraine and abroad. Its position in national and international rankings demonstrates its competitiveness. Currently, the highest achievement of KNUTD is its inclusion in one of the most influential international university rankings – QS World University Rankings: EECA – a regional ranking of universities in Eastern Europe and Central Asia. The QS ranking evaluates the educational and research activities of universities based on the results of a survey of more than 140,000 experts, academics, employers, as well as indicators of scientific, international and educational activities. In the QS World University Rankings: Europe 2024, the university is ranked 551–600 among 688 universities in Europe, 81st in Eastern Europe, 13th among 33 universities in Ukraine and 5th among universities in Kyiv.

In addition, in 2023, for the first time in the history of the ranking by the most prestigious international rating of higher education institutions QS WORLD UNIVERSITY RANKINGS, our university was included in the world ranking by educational programme: "Art and Design" of the QS World University Rankings by Subject 2023 and was qualified in this segment from 201 to 240 positions in the world, while taking the first and only place in Ukraine. It is worth noting that in the history of the ranking, no other Ukrainian university has been awarded such a high rating. In addition to academic and research activities, students are actively involved in the social and cultural life of the university. Many students participate in artistic groups and creative workshops. They compete in the startup project competition "Innovation in Education, Science, Business: Challenges and Opportunities", the International Competition of Young Designers "DIGITAL FASHION", the All-Ukrainian Competition for Web Page Development "WEB-technologist", the International Competition of One Image and New Year and Christmas Decor "Chestnut Constellation", the All-Ukrainian Competition of Student Research Papers, foreign language weeks, as well as in sports tournaments, competitions, etc.

The traditional Pechersk Chestnuts International Contest is a real extravaganza of ideas by talented young designers that even well-known experts can envy.

The process of professional training of specialists in the field of technology and design, in particular in the fashion industry, is extremely complex and multifaceted, as it involves not only the mind, knowledge, skills and abilities of the artist-student, but also his or her internal emotional and aesthetic feelings, observations and memory. This process consists and is explained by the logic of a number of defined stages of professional activity – from the designer's idea-concept, through setting tasks, forming a concept and choosing design techniques, methods, tools and techniques, combined in a different sequence to the implementation of the idea [30]. Therefore, the process of educational professional training of future specialists in the field of technology and design at Kyiv National University of Technology and Design involves the mandatory implementation of real creative projects, including the creation of fundamentally new forms and types of modern costume, based on the use of knowledge about various cultures and art movements, bionic objects and innovative materials.

In the process of project implementation (development of collections of clothing, footwear, accessories), students develop the ability to collect information, analyse and put forward creative hypotheses, identify the problem and objectives of research using project-based and heuristic methods. It is extremely important to develop the communication skills of future professionals, the ability to work in a team, discuss and optimise the expected results. In the process of project work, students create not only new types of clothing, but also form a holistic iconic image that contains various additions, accessories, hair and make-up, all the necessary components of a creative style and image [31]. It is in the process of implementing, preparing and subsequently presenting the results of these real projects that future specialists in the field of technology and design develop their professional competencies and "soft skills", and learn to advertise and present within the framework of the aforementioned All-Ukrainian Competition for Young Designers "Chestnut Constellation" and the traditional International Competition "Pechersk Chestnuts".

National and patriotic education at the university is implemented through educational events, exhibitions, presentations, and the distribution of information materials on significant events in Ukrainian history. Also, scientific and practical meetings and events are organised to develop patriotic, labour, language, ethical, environmental, energy saving and physical education.

For example, a collective exhibition of teachers and students of KNUTD "Sunflower is a symbol of Ukraine!" was held at KNUTD. The exposition of the exhibition covers a wide range of artistic techniques, combining traditional and modern methods of execution, which makes it possible to create bright, emotionally rich images that impress with their expressiveness and subtlety. The exhibition demonstrates not only the high level of skill of the authors, but also their creative approach to the embodiment of the sunflower as a symbol of Ukraine in contemporary art. The majority of the exhibition's works were presented at the All-Ukrainian exhibitions "Where there is a Sunflower – there is sunshine!" and "Sunflower is the Sun's Look", where the National Register of Records of Ukraine documented a record for the exhibition with the largest number of paintings depicting sunflowers, specifically 258. Participation in the exhibition "Sunflower is a symbol of Ukraine!" provided an opportunity for each artist to express their vision of this unique flower symbol, apply the latest techniques and experiment with materials. For KNUTD students, this is an opportunity not only to demonstrate their talents, but also to join a great mission – to preserve cultural heritage by rethinking it in a modern context. It's a chance to show yourself, to pay attention to new ideas and views, and to become part of an artistic community where every voice counts. The sunflower, as part of our cultural heritage, is a bridge between the past and the future, and students are the ones who will create this new art that combines tradition with innovation.

The harmonisation of the inner world of the participants of the educational process, the development of skills of self-awareness, self-reflection and self-analysis, the ability to cope with fears that arise in the process of change and recognise them at the university is implemented through educational activities for students: a training session for first (bachelor's) level students on the topic "The road is made by the walker: how to start moving when you are scared", during the training students had the opportunity to get to know themselves better, received practical tools to combat the fear of uncertainty, changed their attitude to it, developed skills to maintain their own psychological balance; an educational event on the topic "Why are you afraid of horror films?", which aimed to identify the positive aspects of fear, teach students to be aware of and analyse their behaviour in situations that cause fear; a preventive event on the topic "Recovering lost energy: Emotional Burnout" was held to inform students about the phenomenon of emotional burnout, its causes and consequences; to identify ways to prevent and overcome it.

Students and teachers of Kyiv National University of Technology and Design are doing their best to bring victory closer and are constantly involved in volunteering. One of such actions was participation in the project to collect aid for the military staff "Together to Victory!". In April 2025, students and teachers, the staff union and student government of KNUTD organised a collection of supplies for the military staff: tea, coffee, sweets, hygiene products, underwear, etc. – things that will make life easier for the defenders of Ukraine during their military service.

The university continues to implement the educational, scientific and cultural project "Paths of Outstanding Fellow Scientists". The first two expeditions took place along the routes of Zhytomyr region, where the prominent founder of cytogenetics Hryhorii Levytskyi was born, and Kyiv, where he studied, worked, and sparked the interest in genetics of then young entomologist T. Dobzhansky. As part of this project, a scientific seminar "DNA Day 2025" was held. The event was conducted to celebrate the anniversary of the outstanding figure of world science, Theodosius Dobzhansky, the most famous co-author of the synthetic theory of evolution, and to promote the role and contribution of Ukrainian scientists in the context of the formation of genetics.

In order to promote a healthy lifestyle among students, the Futsal Tournament among students of higher education institutions of the Pechersk district of Kyiv was held on the day of the All-Ukrainian Football in cooperation with the student self-government of Kyiv National University of Technology and Design and with the support of the Department of Physical Education and Health of the University. The tournament was a great opportunity for the participants to demonstrate their skills, endurance, team spirit and thirst for victory. In addition to sporting excitement, this tournament became a symbol of student initiative and support, and the cohesion of teams and spectators made it a real celebration of student sport.

Much attention is paid to the formation of academic culture and integrity, as well as to holding thematic literary evenings, creative and intellectual competitions. Thus, on the initiative of the student activists, the Quiz "Hryhorii Skovoroda is a Philosopher of Freedom" was held, which continued the implementation of the information, artistic and educational project of KNUTD "We are being examined by H. Skovoroda", dedicated to the honouring and comprehension of the intellectual heritage of H. Skovoroda. The Quiz was opened with an interactive information page, which tells about the work and interesting facts from the life of the great philosopher, who is recognised as one of the five greatest sages of the world alongside Socrates, Confucius, Spinoza and Mahatma Gandhi. The emphasis in the information drew the participants' attention to the sources, manifestations of freedom and individuality in the life and work of H. Skovoroda.

The University implements in practice a *philosophical and cultural model of education* that meets the challenges of the twenty-first century. It recognises education not only as a tool for training specialists, but above all as a source of shaping a person's worldview, cultural and social maturity. Its civilisational mission is to create not only professionals, but also global citizens capable of being agents of change, while maintaining their identity and responsibility to society.

6.4 DISCUSSION

A spiritual core of tradition *for our society, and at the same time an impetus to unite all people who want a fair life in and around Ukraine* – the Ukrainian national idea, which emerges as the leading ideological dominant of state-building [32]. It is the leading one both in the education system in general and in the vocational psychological and pedagogical training of future specialists

in the field of technology and design in Ukraine in particular. Since ***design, as a socio-cultural phenomenon***, should play the role of creating aesthetically expressive things that are an integral element of culture, the main field of aesthetic subject-forming activity responsible for harmonising human relations with the world of things.

That is why a philosophical and cultural study of the training of future design professionals, taken in the unity of the design, formal and semantic aspects, is also relevant. This allows us to create an idea of design not only as a system of creating things, but also to perform an intermediary function between large-scale industrial production and the needs of a particular person for a harmonious object environment. After all, the general function of design as a system and method of creating things is to harmonise the object world and human existence to meet the needs of human culture (vital, existential, spiritual and social) [33] to create conditions for the development of a safe living environment as the basis for security in Ukraine, as well as a modern internal security system as a factor in countering Russian aggression.

Self-organization is an integral element of the categorical-conceptual field of the post-nonclassical social humanitarian sphere (synergetics), which reflects the evolution of scientific ideas about self-organized complex environments and anthro-sociocultural systems. It has become a means of defining social systems/environments in the modern scientific picture of the socio-cultural world and acts as a mechanism for regulating human actions in society. Investigating the issue of psychometricity of today's social reality, let's borrow the idea given in the work of D. Kozobrodova [34], which is that the modern understanding of this issue lacks correspondence between the ideas of modern science, namely:

1) about the mechanisms, characteristics and behavior of the phenomenon of self-organization – on the one hand;

2) about its role in social behavior, social activity, the state of man and society, the formation of social reality as self-organized environments/systems – on the other hand [35];

3) about the role of psychometrics and integrity in understanding the features of the interaction of the aforementioned environments/systems in the context of the behavior of the macro- and hyper-object of research formed by them.

The possibility of such a question regarding the study of social reality and its psychometrics is currently provided by such post-non-classical cognitive means as the conceptual model (philosophical category, principle) «whole in whole», which includes integrity [24]; hyperparadigm (concept) "brain – psyche – mind/consciousness" [36]; finally, the idea of the human psyche and its personality, society and organism, brain and thinking, perception and creativity, living, non-living and virtual on a single synergistic basis.

In the broadest sense, from the point of view of the theory of self-organization, society (social reality) appears as a nonlinear complex system of a special type, in which stability is ensured by interaction with the external and internal environment. As is known, the basic concepts of the synergistic approach include the term "bifurcation". Getting to the point of social bifurcation means that social reality within the studied aspect will no longer be able to return to its previous state,

and one should expect the emergence of various options for a new social order in society. In a sense, this is a point of no return for social reality, since the former system of order and stability undergoes a radical disruption. It is here that an important point for our study arises, namely, that the social order is not always for a person his/her social reality as such, that is, the one on which he/she is guided in his/her behavior, decisions, actions, goals, choices. This is what it is possible to call the «psychometricity of social reality».

It is necessary to pay attention to this aspect (phenomenon) in the context of the behavior of society as a social reality, as well as the people who make up this society – those who have their own, subjective (personally oriented) social reality. It is possible to emphasize that when considering these phenomena from the standpoint of a synergistic approach, it is precisely this difference between the social realities of the individual and society, having reached a critical level, can trigger a crisis in the dimension of "person", "his/her social behavior" – that is, human dimension, psychodimensionality. This can also occur in the dimension of «the state of the social environment/system (society)» – that is, sociodimensionality. In such a perspective, the fact that the state of social reality significantly depends on human actions, and they, in turn, on the psychodimensionality of the social reality of the individual (subject), its internal state, becomes of particular importance. In the analyzed situation, the presence (manifestation) of the psychodimensionality of the social reality of society itself is traced.

Consideration of dimensions – psycho-, socio-, human- in the post-nonclassical macroclassification of sciences, was introduced to implement the transdisciplinarity of scientific research of the 21st century [37]. According to L. Bevzenko, this is precisely the essence of instability in its true meaning, since during this period, self-organization mechanisms begin to operate in society, which determine the further course of the system's movement towards a new order. "Myth, game, crowd, spontaneity, randomness – the main concepts that can theoretically encompass this process. Social structures, which seem to arise by themselves, are based on a common mythological space or on general rules of the game that attract members of society into their sphere of attraction" [38]. At the same time, at the macro level of society, there is a rupture of social ties, habitual everyday practices, radical changes in the previous lifestyle. The researcher emphasizes that the chaos itself, into which society is ultimately immersed, becomes an environment that gives rise to a new social order. It has not yet appeared and has not been established, it exists only in the form of possible options, therefore unpredictability is a characteristic feature of such a state of instability. In such a state, the role and significance of communication between members of society, their activity and ability to establish connections and relationships are especially increasing. Therefore, an individual (personality, subject), who is accustomed to a stable state of society, to rational decision-making in the conditions of a slowly changing social environment, to clear forecasting of further development paths, will feel insecure – unadapted to the new conditions of instability: "In the whirlpool of modern social processes, a modern person cannot feel adequate" [38].

The most vividly and obviously described processes and changes were felt by residents of many countries during the quarantine period during the COVID-19 epidemic – the theory turned

into a bitter illustration. Social reality is collapsing, "…and with it – the social order as a universal mechanism of identification of individuals and society". In this context, the concept of "psychometricity" or "psychometric environment" [36, 39], proposed in psychosynergetics, deserves attention. Attention to man and anthropometric manifestations in social activity in this concept makes it possible to consider social reality as a psychometric environment. This means that it is formed, develops and transforms (self-organizes, becomes chaotic, collapses, changes, "hangs" in the "plateau" state, etc.) as a result and in the process of the mental (psychometric) activity of a person, a group, a community of people at different scales of space and time, as well as at the scales of individual cultures and civilizations.

It is necessary to emphasize: without mental (psychometric) activity, human-dimensional social activity cannot exist, and the internal mental, internal personal activity of the human subject, his/her system of mental reality significantly affects the character, state and processes of social reality. It is the idea of it that a person uses in his/her thinking, perception, social behavior, in actions.

A new aspect in this issue is the concept and phenomenon of "digit-subject". Thus, it is about the fact that social reality is psychometric, and each person or group (community) proceeds from their own psychometric ideas about social reality, as well as about their own actions in it, goals, consequences, behavior. Accordingly, let's consider social reality as one that arises, transforms and exists in a person's own imagination as a result of their perception, awareness or unconsciousness, activity, behavior, relationships and connections with other people and social structures, in particular those that are increasingly automated and robotic in our time. In fact, it is about a certain subjective version of social reality, which a person forms in their thinking, imagination, memory. Another question is whether a person has an objective version? After all, the phenomenon of social reality itself arises and exists only insofar as there is a person him/herself, who perceives the world around him/her and the world within him/her. However, recent changes, which researchers define as the emergence of a "digital subject" [35] – that is, a work that has an independent way of existence, its own "digital subject" environment (society) without the participation of people and uses a speech system created by it, – lead to the need to distinguish another type of social reality – "digital subject". This type can exist in three variants:

1. "Digital subject social reality", which is observed by a person in the behavior of a digital subject.
2. Social reality that exists in the memory of the digital subject itself.
3. Social reality that is formed in the process of their communication (person – digital subject).

From these positions, self-organizing structures and extreme non-equilibrium states can become parameters of a new order in social reality in the aspect of its psychometricity – on the one hand, as a representation in the thinking of the subject, and on the other – as the basis of his/her social actions. Based on the theoretical research conducted in the mentioned work, it is proposed to use the conceptual model of the psychometric environment of I. Yershova-Babenko in relation to social reality and introduce a new term – "psychometricity of the social environment". The concept of "psychometricity of social reality" and the related conceptual model of I. Yershova-Babenko

"psychometric environments". The definition of "psychometricity" in the considered aspect was introduced by the Ukrainian philosopher, methodologist and psychologist I. Yershova-Babenko [24]. This term is also associated with such concepts as "psychometric environments/systems" (PS), which characterize a person and his/her activities: mental, cognitive, cerebral, social, etc. These concepts in the context of "dimensionality" (i.e., dimensionality, scale) belong to the new post-non-classical macroclassification of sciences developed by the same author [24]. In the work "Psychometric environments in the context of psychosynergetics and their role in the post-nonclassical understanding of society – "nonlinear whole-in-a-nonlinear whole" [35], it is emphasized that the concept of "psychometric environments/systems" (PS) is used in combination with the conceptual model (philosophical category, principle) "whole in a whole" and is a component of psychosynergetics. It should be emphasized that the definition of "psychometricity" also includes such concepts as: "psychometric environments/systems" (PS), which characterize a person and his/her activities: mental, cognitive, cerebral, social, etc. This allows to go beyond the "part-whole" dichotomy when analyzing psychometric environments and their behavior (including macrostrategies) and shift the emphasis to the level of interaction of wholes or wholes, in particular nonlinear ones. According to the author, this involves the interpenetration of complex nonlinear wholes, such as:

– the system of the psyche;
– the system of the inner world of the individual;
– the system of the human organism;
– the system of the person him/herself;
– the system of society;
– the system of nature;
– the system of the Cosmos [35].

The author further notes that the transition to the position of "whole as a whole" or "whole-in-a-whole" becomes a model expression of why a person can be more complex than society, and the human psyche – more complex than him/herself. The place of the "whole" in the structure does not determine the level of its complexity. The "whole" that is inside another "whole" may well be more complex than it. The level of complexity of a system is determined by the ability to create something that is more complex than itself. The nonlinear nature of processes and relationships in such a model/system – "whole as a whole" – allows to rethink the behavior, states and interactions of these systems, which are qualitatively different in terms of results [24]. The level of analysis "nonlinear whole-in-a-nonlinear whole" in the sense of the concept of "psychometric environments/systems", according to I. Yershova-Babenko, brings closer to a new logic – "post-postclassical logic". This logic involves at least four types of operations:

analysis → synthesis → nonlinear synthesis → synergysm (the unit becomes «synergeme»).

Their combination leads to the level of analysis within the category of "field of development paths", which requires taking into account the levels and nature of the neighborhoods of the bifur-

cation point, since these neighborhoods can overlap and thereby radically change the conditions, and therefore the nature of the flow of processes, transformations/transitional states of structures/environments from one state to another [25]. At the same time, the very process of formation and temporary existence of the listed nonlinear wholes – processes/structures/environments/systems of human activity (nonlinear whole), the human psyche (hypersystem of synergistic order), its inner world (informational-emotional environment of synergistic order), as well as society (self-organizing environment, nonlinear whole) – together with the single whole formed by them in various combinations as a result of a certain type of nonlinear synthesis, is equated to "integrity as the unity of diversity" [40]. In this case, it is about a psyche that is multidirectional in time, space and other dimensions, which in different phases has different, sometimes opposite properties, direction, speed and scale. The author emphasizes that in such a context, the subject of research becomes fundamental integrity, the conditions of its disintegration/transformation/emergence, as well as its phase and stadiality.

The phenomenon (as a phenomenon and concept) of "psychometric environments/systems" has been considered in psychosynergetic from the very beginning and for almost three decades now. Moreover, it is obvious that it is the psychometric nature of social reality that plays an increasingly important role in modern social and socio-cultural processes, leading them to crisis states of participants, conditioned by psychometric nature, against the background of crisis states of society itself as a social reality, formed, in particular, by chance, by social organizations. In the author's psychosynergetic understanding of the psychometric environment, a determining, fundamental role is played by self-organizing structures and strongly (maximum-limit) non-equilibrium states, which can become and are becoming a parameter of order, a system- and transition-forming factor [28]. This reflects the positions of the post-non-classical stage of the development of science. It was this aspect that allowed the work [36] to show the limitations of the traditional concept of understanding the psyche (theory of reflection), as well as the relevance of the formation of a new scientific field – psychosynergetics and noology, and later alphalogy.

Psychometric environments are influenced by flows of information, energy/emotions, matter/exchange, time, etc., which come not only from outside, but are primarily produced by these systems/environments themselves within themselves in relation to themselves, to their own intrapsychic – intrapersonal markers. If the environment is a group of people, a collective, a party, etc., these are intragroup, cultural, ideological and similar markers)" [25]. The essence of the specified characteristics of psychometric environments I. Ershova-Babenko explains that the internal psychic influence of the specified flows on themselves can, under certain conditions/factors, be accompanied by the action of nonlinear positive feedback (NPF), which is expressed in the possibility of the flows strengthening themselves and each other through the products they produce (according to the internal psychic markers that become attractors)" [35].

Thus, psychometric environments are interpreted as a whole, which is a "supercomplex open nonlinear self-organized (ONS) environment that exists and was formed in another ONS (or has the ability to enter it already in a formed form)". Actually, the specified phenomenon is a "whole

in a whole" or "nonlinear whole in a nonlinear whole" (containing integrity) implemented in the psychometric environment.

As a reflection of the inner world of a person, such an environment is specified in the works as an "internal psychometric environment" (IPE), an internally personal or internally psychic, informational-mental-spiritual-emotional environment – IMSEE, abbreviated IEE – informational-emotional environment. By definition, it is a supercomplex ONS [36]. For example, the degree of concentration of information, time, energy/emotions in units of measurement, the speed of receipt, transformation of information, meaning, the degree of coherence, scale, etc. From such positions, the psychometric environment (as the environment of the subject) "carries out the choice of the necessary intensity of the surge, in particular due to resonance". As substantiated in the work of I. Yershova-Babenko "Psychosynergetics and its place in post-nonclassical"[25], studies of similar modes and states of the human psychic system prove the possibility of violating the principle of superposition. In this case, the corresponding role is taken by the "coincidence"/superposition of emotional outbursts. In certain cases, this leads to a "breakdown" [35]. In general, the above made it possible to assert that these conceptual positions and research methodology extend to those practical areas where there are different forms and degrees of manifestation of psychometric environments [34]. Such a statement of the question, in our opinion, allows to introduce into the sphere of scientific methodology, in particular, within the framework of research into the phenomenon of social reality, such a characteristic of it as psychometricity from the standpoint of psychosynergetics and psychometric environments/systems which behavior is manifested in the social reality of society. This context combines:

– psychometricity of socio-humanitarian processes and the synergistic methodology for studying psychometricity, psychometric environments/systems;

– commonality of approach in the research – synergetic, psychosynergetic and alphalogical, respectively, the study of the components of the concept of the same name and the hyperwhole itself in the status of "synergetic object", "system/environment of synergetic order";

– the behavior of the concept "brain-psyche (mind/consciousness, …)" [25], of the theory of the same name, from the positions of the hyperwhole in the meaning of the constant or hyperwhole in the meaning of what becomes (alphalogy);

– the relationships between the components of the concept "brain-psyche (mind/consciousness, …)", as relationships between wholes or wholenesses based on and within the framework of the conceptual model "The Whole – in – The Whole" [35, 37]. Thus, summarizing the above, it becomes possible to trace the relationship of the correspondence of ideas about the mechanisms, characteristics and behavior of the phenomenon of self-organization in the conditions of the activity of the hyperwhole or hyperintegrity, presented, on the one hand, in the mentioned hypertheory, and on the other in human life; in the psychodimensionality of socio-humanitarian processes, in particular, in the personally oriented social reality and in the social reality of society. Thus, special attention should be paid to the imbalance of socio-humanitarian processes in the context of the hypertheory "brain – psyche (mind/consciousness, …)" in the aspect of social reality and its

behavior, which is influenced by its psychodimensionality. After all, the special role of the state of psychodimensionality of the social reality of the individual is manifested in the nature of the behavior of the social environment itself.

At the present stage of its development, humanity has encountered a macro- and multi-scale manifestation of a new phenomenon within the framework of the self-organization effect as a phenomenon of critical difference. This scientific concept, like many others, has entered the categorical-conceptual apparatus of philosophy and methodology of socio-humanitarian research on the theory of self-organization. As is known, two directions of self-organization have historically emerged: the theory of dissipative structures, non-equilibrium thermodynamics (created by the Belgian scientist I. Prigozhin in the period 1947–2003) and synergetics (initiated by the German theoretical physicist G. Haken in the period 1973–2024). Such structures of the new order are represented in the behavior of environments/systems of various nature that are self-organizing. They are characterized by irreversibility, which is a condition for the emergence of self-organization, chaos and a new order. Based on the ideas of these scientific directions, psychosynergetics, a methodology for studying the human psyche, psychodimensional environments/systems/processes, including the neuropsychic, cultural macrolevel, as synergistic objects of research, as well as alphalogy for the hyperlevel, is being developed.

The phenomenon of critical difference manifests itself in the present existence of humanity in various forms and in various spheres of human life: its mental and social reality (SR)/activity. Its manifestations are associated with the macroscale nature of the digitalization process. Let's show this with the example of the emergence of the phenomenon/effect of the critical difference between the psychodimensionality of a person and the degree/speed of digitalization of society.

The fundamental difference between environments characterized by psycho- and human dimensionality is their value-semantic, associative and intellectual-emotional basis. Its absence is fixed in the digital (digital). For example, a manifestation of neurophysiological specificity is the individual variability of the vascular network and blood flow rate in a person, to which he/she unconsciously reacts when perceiving another person. But the question is that this specificity is not present in the "digital object"/"subject". The human body and psyche are waiting for them in a communication situation. If there is no communication with a living organism, then the effect of a critical difference in methodological terminology is triggered, and in the aspect of reality a "failure" occurs, since the release of energy by one organism-interlocutor took place (activity of the vascular network and blood flow rate), because it prepared for the release of energy in response from the human interlocutor and its perception, that is, an energy exchange should take place at this level. In fact, the human interlocutor is exhausted during his/her communication with AI, AGI, ChatGPT, since there is no similar response.

The psychodimensionality of a person, his/her individual and social, socio-cultural activity and activity, in this context is understood as his/her quality, characteristics, determined by the emotional-intellectual, value-semantic and associative components of "b-p(m/s, …)", spheres of personality that do not obey "machine" logic. This is perceived from the standpoint of integrity.

The term "psychodimensionality" emphasizes that, for example, the expression "bright future" is understandable to a person, unlike SH I, AGI, GhatGPT, despite many explanations. The indicated and will remain only an imitation of human and psychodimensionality of a person, and upon reaching its high level, it is about a new entity and already "inhuman".

In fact, this is a qualitatively new type of SR – digital SR (with signs of Asperger syndrome) of different scale/level, which is realized in time and space, in the spatio-temporal continuum of individual, group: family, etc. origin. And if to talk about the psychometric dimension of SR, which is produced by a person, and not by a number, then it is considered, in historical and cultural aspects, as a product of the concept of "b-p(m/c, …)" of people who lived – the authors of a certain form of society, family culture, their values, which is perceived by the concept of a living person. SR continues to exist in time in a certain form in which it is preserved in civilization and perceived by living people. Form: theater, cinema, paintings, sculptures, myths and fairy tales, fiction, journalism, science, etc. due to this, it becomes a source of individual experience of those who live and, accordingly, their internal psychic and internal personal (as they grow older) SR. Such SR is characterized by psychometricity (the concept of psychometricity of social reality in the work of D. Kozobrodova [34]), since it was generated with the participation of the concept "b-p (m/c, …)" of those who lived and is perceived by those who live also with the participation of their concept "b-p (m/c, …)". It is transformed in the memory of a living person in the mode of predominance of the activity of the mental component of the concept "b-p (m/c, …)" – emotional-intellectual, value-semantic and associative.

So, it is obvious that in both meanings, the result is about the living. With digital authorship, SR changes its qualities, becoming non-human, non-psychometric (in the meaning of this context). Due to the war between a living person who lives and the psychometric SR made by him/her, and the digital reality perceived by him/her, a conflict (inconsistency, incoherence) arises at the qualitative level (at least, these are the three above-mentioned parameters). Its increase occurs in the mode of self-organization and leads to the manifestation of the effect of «critical difference».

In psychosynergetics, the idea of existence of a macrophenomenon is specified – the unity of the brain and psyche, brain and psychic activities, which are methodologically related to the recognition of the synergistic similarity of everyone's behavior and their unity. Conceptually, this position at the hyperlevel is presented in alphalogy.

For the conceptual designation of such a macrophenomenon at the hyperlevel, the concept «b-p (m/s, …)» was introduced – «brain-psyche (mind/consciousness and other components of the psyche, distinguished by science)». This concept assumes that the brain and mental activity of a person is a kind of unity of the material (brain) and the "immaterial" (psyche). In a similar quality, it is given to a person by nature, he/she is born with it and uses it all his life. In this interpretation, the concept of "b-p(m/s, …)" in the intravital phase of the hypersystem of the psyche in such a theory of the psyche is consistent with the concept of "alive".

Let's note that the famous physicist Ya. Frenkel formulated the main difference between living and inanimate nature as follows: "The normal state of any dead system is a state of stable

equilibrium, while the normal state of any living system, from whatever point of view it is considered (mechanical or chemical), is a state of unstable equilibrium, in the maintenance of which life consists". Therefore, in this perspective it becomes possible to formulate a new, global problem that humanity has faced. This problem is associated with the phenomenon of critical difference of what was described in mathematics and natural science in the second half of the twentieth century. for self-developing environments/systems of various nature. This phenomenon in modern conditions of rapid digitalization takes place in psychometric processes and in the SR of a person. The above appears as a threat, a danger to the very essence of a person – his/her value-semantic, emotional-intellectual, associative, that is, his/her unique human dimension. Under the influence of the digitalization process, there is a movement "from psychometricity" of the human environment and activity in the direction "towards numbers, machine logic". This leads to the "impoverishment" of human dimension, and in the future, it is possible to nullify it, replacing it with a "digital subject" with machine logic.

Thus, the legal framework of education that is being created should be developed on its direct basis, along with integration with general civilisational spiritual guidelines and fundamental human values. These spiritual origins, synthesised into a single whole, create a unique ideological basis for the formation of the legal framework of education as a democratic, integrated into the European and world educational space, open and tolerant system based on national traditions and universal fundamental values, which meets the conditions of today and the urgent needs of practice [10].

Naturally, in such circumstances, educational systems were faced with the task of spiritual and value renewal and consolidation. This, in turn, determined the guidelines for the practical implementation of the constructive *concept of the value dimension of the experience of subjects of pedagogical action* [26] in the educational space of higher education institutions. It should be noted that the *leading idea* of the concept of the value dimension of the experience of the subjects of pedagogical action is the provision that ***value experience*** is an *integral reflective and regulatory characteristic* of Human interaction with the World. The combination of *internal* and *external* functions of value experience (each of which in general forms a monolithic *affective, intellectual and volitional* component structure) represents an *integral* open and nonlinear *synergistic* system consisting of seven centres-functions (1. Experience of survival relations ("*rights and obligations*"). 2. Experience of complementary relations ("*partnership*"). 3. Experience of operational ("*business*") relations. 4. Experience of identity relations ("*love and empathy*"). 5. Experience of formative ("*creative*") relationships. 6. Experience of learning relationships ("*knowledge and skills*"). 7. Experience of ideological ("*value-oriented*")) relations that ensure the existence of the individual as an independent autonomous functional element/subsystem of the system of the natural and social World. As a single systemic whole, such experience, on the one hand, *manifests* the systemic integrity of the regulatory aspect of the *reflection of social practice*, and on the other hand, acts as a factor of integrity – a "s*ystemic regulatory force*" that *determines* this integrity. Awareness of the system's content reveals the systemic cultural and historical dynamics of changes in education paradigms, the meaning of which is specified in its two global *meanings*: cultural

and ideological and social power, the nature of which permeates all educational paradigms [26]. This has led to the need to identify new relevant content, main directions, mechanisms for forecasting, developing and implementing the philosophical and methodological dimension of vocational psychological and pedagogical training of future specialists in the field of technology and design in Ukraine, which would meet both the needs of the present and the future sustainable development of the state. After all, education is a strategic resource for the socio-economic, scientific and technological development of society, ensuring the improvement of human welfare, national security and interests, strengthening the authority and competitiveness of the state in the international arena.

Therefore, we see practical ***tasks*** in terms of further prospects in the implementation of "Programmes for Improving Teaching with Preservation of Ukrainian National Centricity", which should begin with:

1) searching for talented teachers on a nationwide scale who are capable of teaching in the area of pedagogical excellence development;

2) development of special methods of diagnostics for the selection of teacher-coaches for in-service training of university teachers;

3) creation of a competitive situation for the selection of teacher-coaches; testing and evaluation of the "Emotional, sensory and cognitive-volitional spheres of the teacher's personality" and its use in the development of the teacher-coache's pedagogical abilities.

CONCLUSION

We believe that a promising direction is to expand the scope of research on the pedagogical skills of teachers for higher education institutions in a human-dimensional holistic unity: cognitive, emotional and conative components. After all, it is the implementation of a scientifically and politically balanced educational policy that determines the degree of desire of university graduates for dynamic civilisational changes, their spiritual, moral and patriotic education, and their ability to serve the Motherland productively, to create life and to fulfil themselves in the society of the twenty-first century [19]. The main goal of such research work should be aimed at [10]:

– organising and conducting fundamental and applied research to solve topical methodological, theoretical, analytical and practical problems of ensuring the quality of education in terms of interaction in the "Human – Human" system;

– popularisation and implementation of research results, improvement of educational content and organisation of the educational process in order to develop personal pedagogical skills as an integral system of personal and professional development of teachers;

– promoting political, legal, spiritual, cultural, and socio-economic development of society by developing and implementing appropriate scientific, methodological, psychological and pedagogical support in educational practice;

– providing consultancy and scientific and expert support in the field of quality of learning and teaching to higher education institutions, conducting training and professional development for heads of structural units of higher education institutions;

– disseminating the experience of the Ukrainian Scientific School of Pedagogical Excellence in the field of quality of professional education in higher education institutions by improving the pedagogical and managerial qualifications of scientific, scientific-pedagogical, pedagogical staff and other academic staff; organising conditions for the formation, development and self-development of pedagogical skills of specialists, fulfilment of their intellectual, spiritual and cultural potential in the field of scientific and educational activities.

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