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*Zykova N.,[1]*Mendykulova G.,[1]Amralinova B.,[1]Sarkambayeva Sh.[1]*

[1]Kazakh Scientific Research Technical University named after K.I.Satbayev, Almaty, Kazakhstan

COMPARATIVE ANALYSIS OF CURRENT APPROACHES TO ADVANCED TRAINING OF ENGINEERING FACULTY

Abstract

The article examines current issues and strategies for improving the professional competence of engineering faculty in the context of recent requirements of educational standards, considering the UN Sustainable Development Goals. The authors of the article analyze modern approaches to the system of lifelong education and consider means and methods aimed at effective training and professional development.

The article highlights the importance of innovative approaches, including the use of modern technologies and pedagogical techniques, to ensure a successful professional development process. The results of the study provide useful recommendations for the development of professional development programs that promote the effective fusion of theoretical knowledge and practical skills in the field of engineering and pedagogy, taking into account sustainable development goals. The study includes an overview of current trends in education and their impact on the need to improve the qualifications of engineering teachers. This is due to changes in the technological production process, the introduction of new teaching methodologies and labor market requirements. The role of modern technologies in advanced training is emphasized, including online learning, virtual laboratories, simulations and other innovative methods that promote effective learning, as well as understanding and taking into account the characteristics of the psychology of adults in the learning process.

Keywords: qualification, lifelong learning, engineering education, educational standards, educational trends, technology in education.

Н.М.Зыкова, [1] Г.М.Меңдіқұлова, [1] Б.Б.Амралинова, [1] Ш.Ғ.Саркамбаева [1]*
[1]Қ.И.Сәтбаев атындағы Қазақ ұлттық зерттеу техникалық университеті,
Алматы қ., Қазақстан

ИНЖЕНЕРІК - ПЕДАГОГ КАДРЛАРДЫҢ БІЛІКТІЛІГІН АРТТЫРУДЫҢ ЗАМАНАУИ ТӘСІЛДЕРІН САЛЫСТЫРМАЛЫ ТАЛДАУ

Аңдатпа

Мақалада білім беру стандарттарының заманауи талаптары контекстінде инженерлік-педагогикалық кадрлардың кәсіби құзыреттілігін арттыру бойынша өзекті мәселелері мен стратегиялары қарастырылады. Мақала авторлары үздіксіз білім беру жүйесінің алдына қойылған мақсаттарды талдап, кадрларды тиімді оқыту мен дамытуға бағытталған құралдар мен тәсілдерді қарастырады. Мақалада біліктілікті арттырудың табысты процесін қамтамасыз ету үшін инновациялық тәсілдердің, соның ішінде заманауи технологиялар мен педагогикалық әдістерді қолданудың маңыздылығы атап өтілген. Зерттеу нәтижелері тұрақты даму мақсаттарын ескере отырып, инженерлік істі оқыту саласындағы теориялық білім мен практикалық дағдыларды тиімді біріктіруге ықпал ететін біліктілікті арттыру бағдарламаларын әзірлеу бойынша пайдалы ұсыныстар береді. Зерттеу білім берудегі қазіргі тенденцияларға шолуды және олардың инженерлік-педагогикалық кадрлардың біліктілігін арттыру қажеттілігіне әсерін қамтиды. Бұл өндірістің технологиялық процесіндегі өзгерістерге, оқытудың жаңа әдістемелерінің енгізілуіне және еңбек нарығының талаптарына байланысты. Біліктілікті арттырудағы заманауи технологиялардың рөлі атап өтіліп, оның ішінде онлайн оқыту, виртуалды зертханалар, модельдеу және тиімді оқытуға ықпал ететін басқа да инновациялық әдістер, сондай-ақ оқу процесінде ересектердің психологиясын түсіну және ескерудің маңыздылығы көрсетілген.

Түйін сөздер: біліктілік, үздіксіз білім беру, инженерлік білім, білім беру стандарттары, білім беру үрдістері, білім берудегі технологиялар.

Зыкова Н.М.,[1] Мендикулова Г.М.,[1] Амралинова Б.Б.,[1] Саркамбаева Ш.Г.[1]*
[1]Казахский национальный исследовательский технический университет имени К.И.Сатпаева, г.Алматы, Казахстан

СРАВНИТЕЛЬНЫЙ АНАЛИЗ СОВРЕМЕННЫХ ПОДХОДОВ В ПОВЫШЕНИЕ КВАЛИФИКАЦИИ ИНЖЕНЕРНО-ПЕДАГОГИЧЕСКИХ КАДРОВ

Аннотация

В статье рассматриваются актуальные вопросы и стратегии повышения профессиональной компетентности инженерно-педагогических кадров в контексте современных требований образовательных стандартов с учетом Целей устойчивого развития ООН. Авторы статьи анализируют современные подходы, поставленные перед системой непрерывного образования, и рассматривают средства и методы, направленные на эффективное обучение и развитие кадров. В статье подчеркивается важность инновационных подходов, включая использование современных технологий и педагогических методик, для обеспечения успешного процесса повышения квалификации. Результаты исследования предоставляют полезные рекомендации для разработки программ повышения квалификации, способствующих эффективному слиянию теоретических знаний и практических навыков в инженерно-педагогической области с учетом целей устойчивого развития. Исследование включает обзор современных тенденций в образовании и их влияние на необходимость повышения квалификации инженерно-педагогических кадров. Это связано с изменениями в технологическом процессе производства, внедрение новых методологий обучения и требования рынка труда. Подчеркнута роль современных технологий в повышении квалификации, включая онлайн-обучение, виртуальные лаборатории, симуляции и другие инновационные методы, способствующие эффективному обучению, а также понимание и учет особенностей психологии взрослых людей в процессе обучения.

Ключевые слова: квалификация, непрерывное обучение, инженерное образование, образовательные стандарты, тенденции образования, технологии в образовании.

Introduction. The modern dynamics of technological progress and the educational needs of kazakh society are inseparable from the need for constant updating and development of professional skills of engineering teachers. All this meets the requirements and goals of sustainable development. As is known, the SDGs have 17 key areas, aimed at eliminating poverty and misery,

combating inequality and injustice, as well as protecting the planet and ensuring peace (and prosperity (UN SDGs Our work on the Sustainable Development Goals in Kazakhstan // https://kazakhstan.un.org/ru/sdgs). All this should lead to the sustainable development of the world community and Kazakhstan, in particular.

World and Kazakh experience confirm that certain fundamental changes in the educational system practically cannot take place without the retraining of professional personnel who possess the latest technologies in engineering and pedagogical activities.

In a rapidly changing educational and industrial outlook, advanced training is becoming a key factor in ensuring high levels of educational standards and effective training of specialists.

Against the backdrop of this current issue, this article focuses on the goals and effectiveness of advanced training programs for engineering teachers in the field of lifelong education, bearing in mind the goals of sustainable development. Having analyzed modern challenges in education, we set ourselves the task of identifying the optimal directions that will form the basis for developing a strategy for improving the qualifications of engineering teachers and thereby ensuring high-quality continuous training of specialists engaged in the field of higher education.

The article examines the effectiveness of existing advanced training programs, as well as the relationship between education and labor market requirements. The focus is on modern technologies and adaptive teaching methods, which play a key role in the formation of highly qualified engineering teachers.

Today, the problem of improving the qualifications of engineering teachers in the context of continuing education, considering the goals of sustainable development, attracts considerable attention in the educational sphere and the scientific community. Many studies, publications and projects are devoted to this problem, which indicates its relevance and significance. Various countries and regions are developing their programs and strategies to improve the skills of engineering and pedagogical personnel, taking into account the requirements of sustainable development. However, despite the active study of this problem, a number of challenges and unresolved issues remain. For example, the effectiveness of existing professional development programs, optimal approaches to integrating sustainable development principles into educational courses, motivating professors to participate in continuing learning, and many other aspects that require further research and development (Felder et al., 2011; Rummler, 2014).

Thus, we can say that the problem of improving the qualifications of engineering teachers in the context of sustainable development is being studied, but still requires further improvement and development in Kazakhstan.

The purpose of our research is to provide a comprehensive overview of modern challenges and solutions in the field of advanced training of engineering teachers in the light of the implementation of sustainable development goals in the world, as well as to develop practical recommendations for improving the learning process in continuing education.

Problems of advanced training as one of the structural links of the lifelong education system have been the subject of scientific researches by various authors. Researches note that modern conditions place high demands on pedagogical staff, especially since most of them previously had neither didactic nor pedagogical training to fulfill their pedagogical tasks. The important question facing the scientific community is how to effectively train pedagogical staff, motivate them to participate in continuing learning, and also use innovative teaching formats in their work and actively apply interactive teaching methods? How can a new culture of teaching and learning be successfully integrated?

As noted by Vexler et al. (2014), for the effective functioning of a lifelong education system, it is essential to develop a support model for adult educators throughout all stages of their professional growth. This is particularly relevant in the context of rapid technological advancement and the implementation of innovative learning formats, such as virtual and remote laboratories (Poo et al., 2023; Raman et al., 2022).

Researchers emphasize the importance of fostering motivation among educators to engage in continuous learning. Wlodkowski and Ginsberg (2017) propose motivational strategies based on recognizing the value of adult experience and applying an individualized approach. Groccia (2010) highlights the need to develop institutional mechanisms that support educators in using interactive methods and digital tools.

To implement a new teaching and learning culture, systematic professional development programs are required—programs that encompass both theoretical and practical aspects of pedagogy. In particular, the studies by Rüütmann (2019) and Shageeva et al. (2020) demonstrate successful cases of preparing engineering teaching staff through the integration of engineering pedagogy into professional development. Programs based on the principles of «learning factories» and digital transformation effectively equip instructors with the skills to adapt to new learning environments (Abele et al., 2015; Gualtieri et al., 2018).

An important component of such programs is the individualization of learning content according to the needs of instructors (Pérez-Foguet et al., 2018), which helps build sustainable motivation for professional growth. As Utschig and Schaefer (2008) point out, recognizing and developing educators' professional competencies should be a priority in higher education policy.

The solution to these issues is seen in the development of theoretical and practical pedagogical competencies of engineering teachers. The professional development program should include content tailored to the individual needs of teachers. To improve the qualifications of professors, it is necessary to organize support along the path of a pedagogical career and this will meet the requirements of continuing education.

Basic provisions. Modern requirements necessitate the development of specialized professional development programs for engineering teaching staff. Most instructors in engineering disciplines lack systematic pedagogical training, which calls for targeted professional development initiatives. Such programs should include the development of pedagogical competencies, motivation of instructors, adaptation of content to individual needs, and continuous support throughout the teaching career. It is essential to incorporate tools for integrating the sustainable development goals (SDGs) into the educational process. A multi-level certification system and financial incentives for instructors enhance engagement in professional development programs and ensure long-term quality of teaching within the lifelong learning system.

Materials and Methods. The following approaches and theories have been served as the methodological basis of our research. Sociocultural approach (L.S. Vygotsky, Jean Love and Etienne Wenger, David R. Francis) which emphasizes the importance of sociocultural context in the study of learning and development processes. Constructivist learning theory (L.S. Vygotsky, J. Piaget, Jerome Bruner, David Jones) shows that learning is an active process of constructing knowledge by students based on their own experience and understanding. Within the framework of the study, it is also possible to consider strategies and teaching methods that best correspond to the constructivist approach in improving the qualifications of engineering teachers. The theory of motivation (Raymond Wlodkowski, Malcolm Knowles, Edward Deci, Karol Dwejk) allows us to understand which factors of motivation of adults are the most significant in improving the qualifications of engineering teachers. The theory of sustainable development (Gro Harland Bruntland, Bruno Latour) makes it possible to identify how advanced training of engineering teachers can contribute to achieving sustainable development of educational systems and society as a whole.

The study has applied a theoretical method, including a system review, analysis, synthesis, synthesis of research materials, study of best practices on the issue of advanced training of engineering teachers in continuing education, taking into account sustainable development goals. In particular, a contextual analysis was carried out, i.e., the characteristics and contexts of different countries and regions were summarized when analyzing the data, since approaches to improving the qualifications of engineering teachers can vary significantly depending on cultural and institutional pecularities.

Results and Discussion. Analysis of literary sources used has made it possible to identify the main goals (challenges) or directions that need to be reflected in the strategy of the program for advanced training of engineering teachers. The first thing you need to pay attention to is the content of the educational material for advanced training programs for engineering teachers in the Republic of Kazakhstan.

The analysis of works on this issue has shown that it is important to include information about modern theories of learning and teaching, personal and cognitive theories, and educational technologies (project-based, problem-based and team learning) in the content of the program. In order to make professors to design their course, knowledge of course design is required, which provides a taxonomy of objectives that helps formulate student outcomes and competencies. It is important for professors to know and understand student motivation, as well as what technologies can be used to increase it. Any course ends with an assessment, so it is important to have information about formative assessment. The teaching process is always associated with the interaction between professor and student, so any professor needs to know how to solve problems associated with students and what teaching styles and approaches can be applied, taking into account gender and ethical diversity in the teaching process [1, p.89]

Considering the content of the program for advanced training of engineering and teaching staff, the researchers also emphasize that when selecting the content of a system of educational materials, it is important to rely on the integrated approach. The integrated approach involves taking into account the demands put forward by market relations and the characteristics of the region, adapting the model of the content of adult education to the development of the labor market. It is important to pay attention to the fact that in world practice the problem of modeling effective education of adults remains [2, p.1].

When planning the educational process for adults, it is necessary to take into account the state and regional orders of the customer and, accordingly, the formation of educational and work programs that reflect the requirements of the state educational standard.

The authors of the article drew attention to a point related to the education of adults, namely motivation. Adults begin their education fully aware of its necessity to achieve the following goals: the acquisition of new knowledge, know-how, expanding the professional capabilities of a specialist, increases his demand and indispensability in modern production tasks, and therefore increases his qualifications in the eyes of universities and employers. The feature of motivation can be considered the employee’s desire to increase his salary after completing retraining or advanced training courses. Developing new skills and acquiring new knowledge increases your chances of becoming more in demand in the labor market. Personal enrichment and interest in obtaining fresh information on favorite and interesting topics. The authors emphasize that the educational process of adults should be determined by the economic and social needs of the territory of residence of a person, namely the regional aspect of residence.

The professional development program can be implemented in various formats, such as workshops (seminars), seminar series, and discussion sessions, consulting, mentoring, partnerships, and learning communities.

The developed programs must be assessed by the program participants themselves, thereby determining the degree of satisfaction with the program, how it influenced their pedagogical knowledge and skills and the learning process [1, p. 92].

As we know, modern society is gradually moving towards sustainable development, and higher education institutions play a key role in training specialists and decision-makers in the environmental, social, and political spheres (Lozano et al., 2013). Sustainable progress towards development goals is impossible without active and critically thinking citizens. In 1987, the United Nations World Commission on Environment and Development has defined sustainable development (SD) as follows: “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p. 42). The principles of sustainable development can be integrated into the educational

process through the reorientation of educational programs to address issues of sustainable development, through the integration of sustainable development programs into educational programs, and through the introduction of pedagogical innovations, such as institutional-wide approaches to sustainable development goals (UNESCO, 2014).

It is widely recognized that engineering is a key discipline for addressing sustainability issues and promoting a sustainable future (Davidson et al., 2010; Karatzoglou, 2013). Future engineers must have skills and attitudes that meet global needs (Boni et al., 2015). Many researchers have noted the lack of understanding of sustainability principles among engineering students (Azapagic et al., 2005; Byrne et al., 2013; Segalàs et al., 2009), so it is important to increase awareness and knowledge of sustainable development among university professors [3, p.4286].

Modern conditions have shown that despite understanding the importance of introducing the goals and principles of sustainable development into the educational process, this process still turns out to be difficult for various reasons. On the one hand, these changes largely depend on scientists and their ability and willingness to support transformative processes. On the other hand, various studies have identified a number of barriers to change that persist and hinder sustained faculty participation (Lozano, 2006, Velazquez et al., 2006, Verhulst and Lambrechts, 2014). There is limited research on workforce development programs in the field of SD, especially in the field of engineering (Holmberg et al., 2008, Lozano and Lozano, 2014, Lozano García et al., 2008, Pérez-Voget et al., 2005, Svanström et al., 2012).

Scientists believe (Le Noue et al., 2011, Wang et al., 2014, Azeiteiro et al., 2014) that Internet initiatives, namely online learning, are attractive for continuing education in SD. Through online learning, it is possible to involve a large number of scientists in the process of continuous professional development. The study [3, p. 4286] was based on an analysis of the learning process of a group of scientists participating in online courses implemented within the framework of the European initiative “Global Dimension in Engineering Education” (GDEE, 2015a). The main goal of SD professional development programs for scientists is to promote the development of professors’ competencies in order to change their teaching practice and integrate SD principles into everyday educational activities. The results of the study have shown that participants perceived the content and curricula of online courses, developed jointly by academics and practitioners, as relevant and useful for integrating sustainability principles into teaching. The authors of this study believe that there is a need to explore the possibility of integrating online courses aimed at faculty into university policies and strategies as a way to promote professional development and academic engagement in sustainability issues.

Thus, when developing the content of advanced training programs for engineering and teaching staff, it is important to include information related to the integration of sustainable development goals into the taught disciplines. Online learning is an effective form for the continuous professional development of engineering teachers.

When setting goals for advanced training programs for engineering teachers, it is necessary to take into account that engineering teachers have received engineering qualifications in the relevant field, but do not have pedagogical knowledge and competencies. Pedagogical activities are mainly carried out on the basis of intuition and trial and error. In this regard, it becomes important in advanced training programs to provide for an area related to the formation of pedagogical competencies. Many authors emphasize the importance of developing pedagogical competencies among engineering and teaching staff [4, p.125].

Engineering pedagogy serves as an effective basis for pedagogical continuous education of engineering teachers. Within the framework of engineering pedagogy, the didactic pentagram EPS was developed [5, p.123].

The didactic pentagram includes learning objectives, student psychology, instructor competencies, course content, and social structure. It also covers teaching technologies (media, e-learning), teaching methods and strategies (active learning, project-based learning), assessment and feedback methods. The core elements—professor, students, and course content—are combined with self-directed learning and classroom management components.

The detailed analysis of the didactic pentagram has shown that it actually reflects the pedagogical competencies that are necessary for an engineering professor, taking into account modern requirements. This is the ability to use the Internet in teaching, analyze the learning process, master the tools of coaching and mentoring, audience management, knowledge of modern methodology, the use of active learning methods, collaboration skills, creativity and critical thinking, the basics of motivational theories, skills of rhetoric, ethics, scientific writing for composing effective teaching aids and materials.

The important variable, which is also reflected in the didactic pentagram, is pedagogical design, which includes the ability to develop a curriculum, plan, course, lecture. The entire process begins with the design of learning outcomes, and here existing learning objective taxonomy models can be used. Further, it is important to take into account the individual characteristics of students when designing (learning styles, mental differences, prior knowledge, motivation). Then comes the development of course content, selection of teaching technology, learning environment, learning model (deduction or induction, interactive teaching methods, flipped classroom model, interactive lectures, discussions, engineering design, etc.). Assessment and feedback technology. The final stage of design is analysis and reflection.

Thus, the quality of engineering education depends on knowledge of engineering pedagogy, which involves the use of appropriate and relevant didactic models to ensure effective learning.

Consequently, in the program for advanced training of engineering teachers, it is necessary to provide a direction related to the formation of pedagogical competencies.

In order for advanced training programs for pedagogical staff to be effective, one need to pay attention to the fact that they are designed for adults. Accordingly, it is necessary to intensify the motivation of an adult to learn. An analysis of the psychophysical characteristics of adults receiving higher education is reflected in the materials of P.T. von Hippel and J.L. Lynch (2014), the problem of modeling the adult education system in Lithuania Dromantiene & Zemaitaityte (2014), the features of the adult education system in Portugal are considered by P. Guimarães, N. Alves, C. Cavaco and M. Marques (2014), experimental studies have been published on the education of adults of different ethnic, national, cultural backgrounds in Turkey (S.S. Gul, H.E. Kaya and A.).

The basis for a professional development program for engineering teachers can be based on the criteria proposed in Raymond Wlodkowski's theory of adult motivation - professor experience, relevance of content, choice of application, practice (action plus reflection) and group work. The first factor of motivation is the expertise of the one who teaches. He must be an expert in the material, know the interests, needs, and problems of his audience. The second factor is the relevance of the content - i.e., it is important that the material is personally meaningful and meets the professional needs of the student. The third factor is the possibility of choice i.e., there are no “universal recipes”. The fourth factor is action plus reflection - i.e., it is important to try out the methods being studied on your own, and then reflect and generalize the results. The fifth factor is group work – i.e. adults derive pleasure and benefit from sharing their knowledge and experience with colleagues [6].

Typically, professor participation in advanced training programs is low, except in those countries where it is mandatory [7, p.13]. This state of affairs is due to the fact that professors have no incentives and no rewards for improving their teaching. This problem can be addressed through a certification program that recognizes and rewards professors who have completed a specific course of study. Certification certifies a person's qualifications to teach at a basic or advanced level. Certification programs exist in many countries. An international certification program dedicated to engineering education, called ING-PAED (IGP, 2010), is administered in 72 countries by the International Society for Engineering Education, based in Austria. It consists of a number of core modules (engineering pedagogy and laboratory methodology), theoretical modules (psychology, sociology, ethics and intercultural competence) and practical modules (oral communication, technical writing, project work and educational technology) and is open to professors with teaching experience no less than one year. Those who complete it are certified as International Engineering Educators.

Thus, when developing a program for advanced training of engineering teachers, it is important to take into account the motivational features of adults, since it is necessary that education be continuous and that engineering teachers be interested in improving their qualifications, for example, through financial rewards or a developed certification system [8, p.16].

The next area that, in our opinion, should be present within the framework of the advanced training program for engineering teachers is support for a teaching career, i.e. continuous learning. The system of advanced training should be oriented to the long term. This direction can be implemented through the certification of engineering teachers [9, p.18].

Since 1996, ZEWK has been providing advanced training courses for researchers at the Technical University of Berlin. Upon completion of the course, the professor receives a certificate. There are three levels of certification. There is a final certificate; to obtain it you need to complete 5 training modules. Next comes the professional certificate, which includes three levels. First level is 60 hours «Teaching for the best universities». The second level is 100 hours, you need to select and complete 5 of 18 training modules. The third level is participation in the seminar «Teaching Portfolio - the concept and philosophy of teaching», development of your own portfolio and two coaching sessions (total 50 hours).

So, to obtain a professional certificate, teaching staff undergo 210 hours of training. Competencies include special methods of teaching engineering subjects that are interdisciplinary and intercultural, research management, scientific communication, analysis of learning situations and learning processes, learning planning, learning sequences and learning modules, planning and «staging» learning situations, consultation on learning objectives, learning strategies, instructional planning, examinations and assessment.

The work [8] analyzed the current opportunities and problems that exist in the United States regarding the development of professors related to professional education. They proposed the structure of a program for advanced training of engineering and teaching staff. The programs require completion of various levels of certification. The first level of certification (60 hours) is aimed at mastering the theory of learning, i.e. mastering the fundamentals of teaching and learning. This level involves mastering the skills of course development, curriculum development, the use of active learning to involve students in the educational process, assessment, and the use of various technologies. The second level of certification (100 hours) focuses on the process of developing and understanding your own «mental model» of teaching and learning in your personal context. The third level of certification (50 hours) involves developing a teaching portfolio. Such portfolios document various facts about the participant's personal development and progress related to various aspects of teaching and learning [10].

Since programs require certification of teachers, they must be supported at the level of a national academy or national community.

It should also be noted that within the framework of the international project ENTER (Engineering educators pedagogical training), developed within the framework of the European Union Erasmus+ program from 2018 to 2021, a certification model was also proposed. The international project ENTER is a consortium that included 13 organizations from five countries. It includes universities and professional public associations from the countries of the European Union, Russia, and Kazakhstan. The developed certification model included three modules.

Short-term module 1 (iPET-1) discipline: «Innovations in engineering education», «Time management» and «Effective interaction».

Module 2 (iPET-2), included «Interactive learning», «System analysis in education», «Educational psychology and communication», «Interaction with employers», «Sustainable development».

Module 3 (iPET-3), disciplines: «Digital learning», «Modern educational technologies (problem-based, project-based, practice-oriented learning) », «Evaluation of learning outcomes», «Design of an academic discipline», «Innovations in engineering»; Upon completion of training, a final pedagogical project is completed and defended.

Completing all three modules makes it possible to obtain an internationally recognized certificate [11, p.65].

The next area that, in our opinion, needs to be reflected in advanced training programs for engineering teachers is technologies that meet the current requirements. Therefore, when developing advanced training programs, it is important to take into account the needs and requirements of Industry 4.0 in order to ensure the training of specialists who can effectively use modern technologies in the educational process [12, p.1111]. According to Industry 4.0, training can take place in training enterprises.

The studies describe the results that were obtained during special training and educational activities on advanced automation in the Smart Mini Factory laboratory of the Free University of Bolzano. Experience has shown that such a laboratory is a multifunctional innovative structure, thanks to which it is possible to study and simulate modern advanced technologies of production systems in the field of Industry 4.0. The laboratory is actually a platform for connecting education and industry. The SMF is a hands-on training facility for students who participate in laboratory exercises and simulations. Students can develop their study projects as well as their final dissertations and thus gain valuable experience using modern Industry 4.0 systems.

Real factory equipment and models allow contextualization of activities, as well as activation of the learner through direct application of knowledge. Problem solving skills, motivation, collectivization, alternation of practical stages with classical stages of training are all achieved during various exercises and course hours [13, p.1].

The introduction of «learning factories» is an example of the implementation of a practice-oriented approach to training and is an important component of engineering education; the possibility of combining science and practice is realized.

Up to-date technologies include the use of virtual and remote laboratories [14, p.1110].

Admittedly, virtual and remote laboratories will certainly not replace the hands-on experience of physical laboratories, but they provide promising opportunities for improving learning in the face of the disruption of face-to-face learning.

Sustainability education teaches an understanding of the relationships between ecology, society and the economy in order to promote sustainable and ethical practices.

Laboratory teaching activities allow students to apply theoretical knowledge practically, bridging the gap between classroom learning and real-world problem solving. In the lab, they can use their knowledge to analyze data, conduct experiments, and create innovative solutions. An engineering education provides students with the technical skills to design, build and maintain efficient and sustainable systems, while a sustainability education broadens their horizons. This helps engineers consider the environmental, social and economic impacts of their projects, contributing to the development of more sustainable solutions [15, p.4744].

Remote laboratories allow experiments and laboratory tasks to be carried out over the Internet without being near the equipment [16]. The implementation and use of scientific ideas is the result of an iterative learning process that requires frequent experimentation in the laboratory. Thus, classical experimental laboratories are sometimes insufficient to achieve the desired impact on student learning [17, p.11055].

Virtual and remote laboratories have several advantages over traditional experimental laboratories, including a secure learning environment, high availability, reduced costs, flexibility and time savings for self-learning, and are easily scalable to larger numbers of students. They also provide students with an engaging, interactive 3D learning environment that promotes engagement and interactivity. However, they may be limited in providing sensory feedback, which reduces the depth of hands-on experience.

Remote labs provide a realistic experience by allowing students to work with real equipment and improve their hands-on skills, but may be limited by the availability of equipment and trained instructors.

Both forms of labs promote active learning and can be used effectively for sustainability education. Virtual labs allow students to explore scientific phenomena in a safe and controlled environment and teach complex sustainability concepts such as environmental monitoring and resource management.

The next technology that meets the current challenges is working in project teams. A number of studies note that modern project teams are increasingly used to solve problems at the intersection of many disciplines and areas dedicated to Industry 4.0. [18, p. 803]. The way of performing and monitoring tasks related to project management is changing, as projects become more complex, innovative and implemented at the intersection of many areas [19, p.92], [20, p.96].

Industry 4.0 is also a socio-technical concept that can support the entire society and industry in achieving sustainable development. The study has noted that the core skills that can best impact the context of Sustainable Industry 4.0 are based on three groups of skills: cognitive skills, interpersonal skills and strategic skills. The authors of have identified two sets of leadership skills required in Sustainable Industry 4.0: one related to human relations, and the other related to knowledge about the use of technology. Essential leadership skills are listening, teamwork, stakeholder relations, relationships with team members, use of digital tools and the ability to cope with change.

Due to the fact that projects within the framework of sustainable Industry 4.0 are most often interdisciplinary, therefore, the importance of the stage of collecting and identifying information increases. The new project management function appears in the field of time management - monitoring project execution in real time and eliminating gaps in progress reports; in team management - the widespread use of virtual teams and collective intelligence; in communications management - acceleration of communication processes within projects, abandonment of physical communications and increased online connectivity. Important soft skills emerge, such as: communication skills, authority, team management, unexpected event management and negotiation skills.

Working in interdisciplinary teams requires new skills. These skills include interdisciplinary thinking, problem solving, flexibility and creativity. Interdisciplinary thinking is a consequence of the high complexity of knowledge, both explicit and tacit, in companies. In this context, also emphasizes that the training of team members should be adapted to new models of teaching and learning, which are aimed at developing interdisciplinary competencies and increasing the ability of employees to solve problems arising from the 4th industrial revolution. Each team member, representing a different specialization of knowledge, comes to the team with a different «world of thought» and understands problems, critical elements and solution steps differently than other team members. It is important that every interdisciplinary team includes leaders who, through their integration skills, support interaction and discussion among team members to create the trust and shared understanding necessary for knowledge integration.

The study identified 15 competencies required for the implementation of interdisciplinary Industry 4.0 projects. 9 competencies apply to the entire project team (strategic perspective, communication skills, willingness to compromise, creativity, digital skills, active learning, active listening, integrity and persuasiveness) and 6 competencies are assigned to the team leader (ability to coordinate, work, resolve conflicts, decision making, motivation, empowerment and resource management).

The next technology that meets the challenges of our time is collaborative learning. Collaborative learning strategies involve the active involvement of students in the process of acquiring knowledge. This is achieved through a variety of activities, including group projects, case studies and simulations, flipped classrooms, university computer conferences, digital self-assessment tools, small group learning, etc. The studies provide an explanation of the theoretical foundations, practical applications, and results associated with collaborative learning methodologies.

The strategy for the professional development of engineering and pedagogical personnel should reflect key areas such as pedagogical competencies, instructor motivation, sustainable development goals, teaching technologies, and continuous development (Table 1).

Table 1. Main strategic directions for the professional development of engineering teaching faculty

Direction	*Description*
Pedagogical competencies	Engineering pedagogy, active learning methods, course design
Teacher motivation	Wlodkowski's motivation theory, certification, incentives
Sustainable development goals	Integration of SDGs into courses, online learning, curriculum reorientation
Educational technologies	Virtual/remote labs, learning factories, digital tools
Lifelong professional development	Career support, multi-level certification, teaching portfolio

Conclusion. So, the literature review conducted has allowed us to draw the following conclusions. The main goals (challenges) or, one might say, the directions that need to be reflected in the strategy of the advanced training program for engineering teachers in terms of continuing education, taking into account the goals of sustainable development, are the content of the educational material of advanced training programs, the formation of pedagogical competencies, considering the motivation and needs of engineering and teaching staff in advanced training, support for a teaching career (continuous learning), mastery of technologies that meet the challenges of our time.

When selecting the content of educational material for advanced training programs for engineering and teaching staff in the RoK, it is necessary to rely on the requirements of Industry 4.0 and the goals and principles of sustainable development. The advanced training program should be comprehensive, taking into account both modern theories and practices of training, as well as regional characteristics. As a result, this will make it possible to obtain educational material adapted to regional needs. Engineering teachers will have the knowledge and skills necessary for effective functioning in their region. Including sustainable development issues in educational programs will provide an opportunity to train specialists capable of solving modern environmental, social and economic problems. Awareness and knowledge in this area will help professors to integrate the principles of sustainable development into the teaching process. Analysis of the regional labor market and the inclusion of its results in the content of training materials will ensure the training of personnel capable of working effectively in a particular region, meeting the needs of the local labor market. The training material required for a continuing education program should be structured and include aspects related to fundamental knowledge of modern theories of learning, personal and cognitive development, course design, inclusion of a variety of teaching methods such as collaborative, project-based, team and problem-based learning, and strategies for motivating students. Formative assessment that promotes continuous adjustment of the educational process and improvement of learning outcomes. Taking into account individual differences and solving learning problems makes the process more flexible and student-centered.

Successful development of engineering teachers requires the development of a variety of competencies among teachers, including cognitive skills, interpersonal skills, strategic and leadership skills, interdisciplinary thinking and competencies. This will ensure more flexible and effective interaction in the educational environment.

Incorporating competencies related to the SDGs helps professors to develop an understanding of the importance of sustainable development and the ability to integrate these principles into their teaching practice. This includes the development of critical thinking, the ability to work in interdisciplinary teams and to lead learning processes that take into account the environmental, social and economic aspects of sustainable development.

The professional development program will only be successful if the individual and professional needs of professors are activated. Key motivational factors include: professor experience, relevance of content, choice of application, practice, group work. The development of motivation and reward systems tailored to the needs of professors can significantly increase their interest and active participation in these programs, which in turn will improve the quality of education and training.

The professional development system should be long-term oriented, ensuring continuous professional development of professors. This helps maintain the relevance and quality of teaching in an environment of constantly changing educational standards and technologies. Multilevel professor certification programs around the world demonstrate the effectiveness of a systematic and consistent approach to training. The division into levels allows you to gradually deepen knowledge and skills, from basic theoretical foundations to practical applications and scientific work. International certificates will give professors access to international professional communities and career opportunities.

The inclusion of modern educational technologies and methods in advanced training programs for engineering teachers meets the challenges of our time and helps prepare students for work in the conditions of digital transformation. Interactive and flexible educational technologies such as the learning factory, virtual laboratories, project teams, and online learning enable students to develop practical skills and critical thinking. Interdisciplinary projects and collaborative learning foster complex thinking and collaborative skills that prepare students to take on complex professional challenges.

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Bolatkhan N.,[1] *Balagazova S.,*[1] *Kosherbayev Zh.* [1]*

[1]*Abai Kazakh national pedagogical university, Almaty, Kazakhstan*

A COMPONENT MODEL OF POP VOCAL PERFORMANCE COMPETENCE OF FUTURE MUSIC TEACHERS

Abstract

Pop and vocal performance plays an important role in the training of future music teachers, as it is one of the key areas of their professional activity in a modern school. For the successful implementation of this activity, it is necessary to possess a set of knowledge and skills that consider its specific features. The genre-style authenticity of vocal performance, artistic presentation, interpretation, and stage dramaturgy require well-developed pop and vocal performance competence (PVPC). In the course of the study, a specific goal was formulated, which served as the basis for modeling the component structure of the PVPC. In the course of the research, the TEL (Technology-Enhanced Learning) methodology was applied, which, in the process of studying such constructs as competence, involves conducting research in an interdisciplinary context in several projections: personal, cognitive, affective, as well as projections of social interaction. This approach has contributed to the formation of a four-component model, including emotional-motivational, cognitive-epistemological, empathic-communicative and assertive-self-regulatory components. The analysis of the obtained structure confirmed the main hypothesis of the study, which is that the components of the PVPC are functionally interconnected, while the emotional aspects are permeated and involved in the entire component structure. The article defines the prospect of further research, which consists in empirical verification of the results obtained by purposefully evaluating each component for compliance with reasonable criteria.

Keywords: future music teachers, competence, component model, pop vocal performance, assertiveness.