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Features of the Application of Artificial Intelligence in the Formation of Creativity in the Professional Training of Teachers

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***Abstract*— Artificial intelligence (AI) is rapidly changing the educational landscape, opening up new horizons for the development of creativity and professional competence in the training of future teachers in the specialty A5.39 (formerly 015.39 "Vocational Education (Digital Technologies)"). Given the dynamic development of information and communication technologies (ICTs) in the modern world, it is important to study the impact of these changes on the educational process. Modern informatization of education has changed the role of the teacher as a knowledge carrier to a facilitator of learning. A modern teacher should not only be a translator of knowledge, but also an innovator, communicator, scriber, creator, tutor, coach, methodologist, and researcher. Students have access to a lot of information resources, and their role in the educational process is becoming more active. At the same time, new challenges arise due to data security and privacy. Innovative technologies, traditional, distance, online and hybrid learning models, digital platforms, interactive tools and adaptive systems contribute to a more individualized approach to the organization of the educational process. The authors of the article discuss tools and technologies that, with the support of AI (ChatGPT, Gemini, Claude, Leonardo, LearningApps, Tinkercad, etc.), including Python and Arduino robotics kits, contribute to the development of creativity and professional competence of future teachers. The use of such technologies in the educational process stimulates innovative forms of thinking, creativity, and teamwork among students majoring in A5.39. AI libraries (TensorFlow, PyTorch, etc.) are allow future teachers to dive into the world of AI without requiring deep programming knowledge. Integrating AI, Python, and Arduino into teacher education stimulates creativity, develops professional competencies, and prepares future teachers for the challenges of modern education. Hybrid learning models, where technological tools are combined with pedagogical innovations, form competent, creative and self-confident professionals capable of working in the digital age.**

Keywords*— *artificial intelligence; innovative tools and technologies; creativity; professional training; hybrid learning; pedagogical technologies.

I. Introduction

In the modern world, information (digital) technologies and education are closely intertwined. The rapid development of information and communication technologies (ICT) has significantly influenced the organization of the educational process in higher education institutions (HEIs). Informatization of education has led to the transformation of traditional educational processes, which requires rethinking the roles of teachers and students. Teachers, who used to be the main source of knowledge, are now becoming learning facilitators who promote critical thinking, independent information search and self-education. We can note that students, having access to unlimited information resources, are becoming active participants in the educational process, which requires a high level of digital literacy [1].

Digital technologies can help in learning, but they cannot replace important social aspects of a person's need for live communication, emotional coloring, and non-verbal content of the educational process. On the other hand, the presence of digital tools in education creates challenges related to data security and privacy. As more and more data is collected and stored digitally, the risk of misuse of information is becoming increasingly high. An educational institution must ensure data protection and

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teach students how to use digital resources safely. Higher education institutions in Ukraine are required to implement and use complex information security systems (IPS) in their activities. In accordance with the Laws of Ukraine "On Information", "On Protection of Information in Information and Telecommunication Systems", "On Protection of Personal Data", comprehensive information protection systems in the information and telecommunication system are to be created in accordance with ND TZI 3.7-003-05, approved by the order of the Department of Special Telecommunication Systems and Information Protection of the Security Service of Ukraine. In May 2024, the Ministry of Digital Transformation of Ukraine published draft recommendations on the use of artificial intelligence in school education, which all schools should familiarize themselves with within a year.[2] Academician R. Gurevych and co-authors note in their research that AI in education is of great importance, especially in creating "individualized learning plans, automating task checking, adaptive testing, and even supporting teachers in assessing and analyzing student performance. AI provides powerful tools for analyzing educational data" [3]. The authors believe: "Artificial intelligence can become an important tool in the field of education, and using its capabilities, it is possible to adapt curricula to the individual needs of students by analyzing their progress, performance, and learning styles." We would like to note that informatization in education allows automating routine processes, which not only facilitates the work of teachers but also makes the educational process more interesting for students and teachers themselves. However, successful implementation of the latest technologies and innovations requires educational institutions to be ready for rapid change and adaptation. It is in the context of the rapid integration of digital technologies, artificial intelligence, and innovative approaches to the organization of the learning process that the issue of developing creativity arises, which would help all participants in the educational process to adapt to these challenges. We believe that a modern creative teacher will be able to find original solutions in teaching, develop interactive and exciting classes that will stimulate students' interest and promote cognitive activity and their active involvement in the educational process. In our opinion, developing creativity in future teachers helps to develop critical thinking skills, self-expression, and innovative problem-solving, which are important for a successful career in the professional future. Therefore, educational and professional programs should contain elements that promote creativity: project activities, interdisciplinary approaches, use of modern technologies, etc. To describe the impact of artificial intelligence and digital technologies on the formation of creativity and professional training of teachers, to give examples of the effective use of such technologies in the process of training future teachers. The innovation and information society, the digital society require the formation of a creative personality prepared to work in the era of innovation, mastering the necessary skills and competencies, ready to constantly update professional knowledge and skills. Today, creative education is being formed in the world, which contributes to the achievement of more effective global indices of creativity, innovation, human development, freedom of economic development, etc. Sunil Gupta, a professor at Harvard Business School, analyzed Fortune 500 companies and studied Ukraine's indices, which are shown in Table 1.

TABLE I. UKRAINE'S INDICES

No. p/n	**Name of the Transformation Index of Ukraine**	**Rating place in the index**
1.	Creativity	45
2.	Global Innovation Index	64
3.	Patent activity	27
4.	Human development	81
5.	Economic freedom	81

Gupta gives examples and analyzes them in detail, provides practical and effective advice on the path of inevitable digitalization, which allows us to take full advantage of all the opportunities offered by the modern world, as noted in Ukraine 2030. The Doctrine of Balanced Development [4]. In the context of the formation of the creative education model, new types of human-society interaction are emerging, which have led to the emergence of new forms of communication related to digitalization processes.

Creativity is an important competence for future teachers, as it allows them to implement innovative teaching methods that meet the needs of the modern world. According to O. Honcharenko (2019), creative teachers are able to create incentives for students, which leads to increased motivation and academic performance. The ability to use creative approaches also contributes to the development of students' critical thinking and independence. Creativity in teacher education is defined as the ability to generate new ideas and solutions, adapt to changing learning environments, and use resources effectively. According to T. Yakovyshyna (2019), creativity consists of several components: originality, flexibility, understanding of the context, and critical thinking ability (see Figure 1). The structure of creativity includes cognitive, emotional, and social aspects that form a holistic view of a teacher's personality.

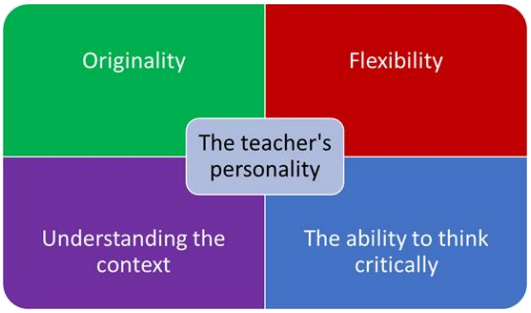

Fig. 1. Components of creativity.

Previous research has shown that students' creativity is influenced by individual traits Cheng (2019), educational environment Al-Kumaim (2021), and social support Laguía (2019) [5], [6].

The leadership of university teachers is student-centered, action-oriented, and has a positive impact on students Liu (2023). At this stage, students are experiencing a peak period of knowledge acquisition, while facing many new challenges and opportunities. Both external and internal factors influence students' creativity Zhang (2022). The internal factors that influence creativity include personality, psychological capital, self-esteem, cognitive style, emotions, creative motivation, education, work experience, experience and skills, and growth needs Wang (2016). Psychological capital is significantly positively correlated with the creativity of corporate employees Choi & Chang (2014), Ravaji & Golouzan (2016). Huang and Luthans (2015) found that software engineers' psychological capital mediates the relationship between learning goal orientation and creativity [6]. In addition, both empirical studies and meta-analyses have found a significant positive correlation between students' self-esteem and creativity; however, this correlation is influenced by creativity orientation Deng & Zhang (2011), Fan (2012). Researchers have shown that positive psychological capital and self-esteem influence creativity. Researchers believe that creativity can be developed and is influenced by a variety of factors. It is important how the spiritual leadership of teachers (external factor) and positive psychological capital and self-esteem of students (internal factors) jointly affect the creativity of students. This combination of internal and external factors can further deepen the study of the mechanism of influence on the creativity of future teachers. The concepts of spiritual leadership, positive psychological capital, and self-esteem have attracted considerable attention from scholars and are considered to be closely related to individual creativity Wang (2021), Yazdanshenas & Mirzaei (2022), Zeng (2022) [7].

Studying the creativity of our time, J. Xu considers it a key competence in modern society that is crucial for personal growth and future career development of students. There are many internal and external factors that influence students' creativity, but the researcher is exploring a new, more detailed theoretical framework that considers the mechanism of influence of teachers' spiritual leadership on students' creativity. Among the internal factors affecting students' creativity, J. Xu notes that psychological resources are particularly important, so he chose two variables - positive psychological capital and self-esteem - to study the dual mediating effect on the relationship between spiritual leadership and students' creativity [8].

II. MATERIALS AND METHODS

The rapid development of information (digital) and communication technologies has contributed to the development of the teacher's professional crisis S. Loboda (2023). A teacher today is perceived as a person with many roles, which requires adaptation to new conditions. Agreeing with the statements of S. Loboda, we note that in the dimensions of socio-pedagogical requirements for the advanced development of the innovation space in the modern educational sphere, the key factor remains the creative teacher [9].

Studying the impact of innovative technologies on the educational process, V. Fedorets proves that the use of digital platforms, interactive tools, adaptive systems, and hybrid learning models contribute to the effective organization of the educational process. When a person interacts with AI, the authors identify seven types of cognitive phenomena that arise: orientation- cognitive, subject-cognitive, communicative-cognitive, cognitive-analytical, cognitive- hermeneutical, cognitive-ontological, and cognitive-creative. Each of these types reflects different aspects of intellectual activity, including creativity. The cognitive-creative type of interaction is actualized through creative thinking, intuition, and the integration of various cognitive strategies. The authors emphasize that AI can stimulate creativity by providing new tools for generating ideas, interpreting data, and solving complex problems. The researcher emphasizes that AI can be a powerful tool for developing creativity, especially in the educational process. However, to fully utilize this potential, it is necessary to further integrate AI into curricula and actively engage students in using these technologies for creative tasks [10]. Creativity, as one of the key aspects of interaction with AI, can be an important factor in preparing future teachers to work in the digital era.

In 2023, a group of scientists K. Livingston, C. O'Sullivan, and K. Attard investigated the traits and conditions that foster teacher innovation in different international contexts. The study was conducted in different countries, where the main focus was on creativity as a key element of an innovative approach to education. Teachers presented various practices, new teaching methods that help develop creativity, as well as conditions for supporting a creative educational environment. how creativity in learning can positively influence the educational process, motivating students to actively participate and develop their own creative abilities [11].

The researcher H. Dewaard calls for a deliberate focus on media and digital literacy, as well as technological competencies in teacher education, based on her own experience as a teacher educator in Canada. As a teacher of pedagogical disciplines at the Faculty of Education, she argues that it is necessary to be fluent in media and digital skills in your educational practice. The researcher is convinced that practicing teachers should use technological resources to accomplish their tasks. It is becoming increasingly important to share the experience of practitioners, researchers and theorists in the field of education, making explicit what is often tacit and unexpressed, as well as sharing knowledge, reflections and actions [12]. By actively expressing their thoughts through blogs (Fig. 2), social media, and open scholarly publications, educators can publicly share details of what they do, how they do it, and why they do it.

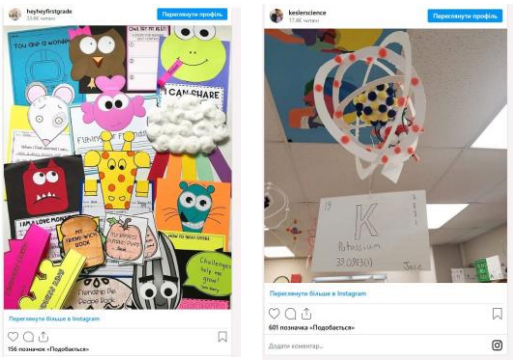

Fig. 2. A sample of Instagram educational blogs

We have studied the experience of K. Livingston, C. O'Sullivan, and K. Attard in their book "Characteristics and Conditions for Innovative Teachers: International Perspectives" where they describe the study of teachers' creativity through a comprehensive approach that included a variety of methods to obtain both quantitative and qualitative data [11]. One of the main tools was quantitative research, which included surveys and questionnaires of teachers. This made it possible to collect statistical data on their creative skills, preferences in choosing teaching methods, and readiness for innovation. Such studies allow us to assess the overall level of creativity among teachers, as well as to identify trends that characterize their approach to teaching.

However, qualitative research methods were used to gain a deeper understanding of how teachers perceive creativity and what conditions contribute to its development. In particular, interviews and focus groups with teachers allowed us to identify their personal practices, experiences and challenges they face in the process of integrating creative approaches into teaching. Such studies help to understand how teachers assess their own creativity, what strategies they use to develop it, and what factors are most important to them in this process.

Case studies have become another important tool for analyzing creativity. Researchers have looked at specific examples of successful innovative practices in different educational systems, which has helped to identify which methods and strategies are most effective in fostering creativity in both teachers and students. These cases demonstrate how certain approaches, such as project-based learning, cross-disciplinary integration, or the use of digital technologies, can become catalysts for the development of innovative thinking.

Classroom observation also played an important role in the study. The researchers were able to directly assess how teachers integrate creative methods into the learning process, what tools they use, and how this affects student engagement and interest. This approach allowed them to get an objective picture of how creativity manifests itself in a real learning environment.

In addition, a comparative analysis of the educational systems of different countries has revealed common characteristics that foster creativity. This made it possible to understand which conditions, such as support from the administration, access to resources, and professional development opportunities, are most important for the formation of innovative teachers.

In general, research has confirmed that developing teachers' creativity requires systemic changes in education. This includes not only support from educational institutions, but also providing teachers with the necessary resources, access to modern teaching methods, and opportunities for continuous professional development. Only under these conditions can an environment be created that will foster innovative and creative teachers who are able to prepare creative future teachers for the challenges of the modern world.

In the future, we can predict a significant spread of innovative technologies in the educational process, which will facilitate more effective interaction between teachers and students and open up new opportunities for achieving high learning outcomes. In particular, the use of artificial intelligence in education can be a powerful tool for developing the creativity of students, especially in the context of professional training of future teachers. In our study, we propose to integrate AI into curricula, which will stimulate creative thinking and innovative approaches to solving pedagogical problems. This may include the use of AI to create individual learning paths, automate learning outcomes assessment, and develop interactive tasks that develop students' critical thinking and creativity.

We believe that an important factor in obtaining high-quality professional education and professional and personal development of students as future professionals for the sustainable development of the state is the effective interaction of professionals with society. An important factor in the development of professional skills and abilities, as well as personal qualities such as responsibility, initiative, creativity, etc. contribute to the effective interaction of a professional with society [13]. An equally important factor in shaping creativity in teacher training is the skillful and appropriate use of artificial intelligence (AI) and its products. AI plays an important role in encouraging students to think critically, analyze and evaluate information. It is with the help of artificial intelligence that it is possible to automate the solution of similar problems, make decisions and solve tasks in real or virtual situations, which contributes to the development of their critical and creative potential. One of the possibilities of using AI is individualized learning. This technology makes it possible to develop educational and professional programs that take into account the individual needs and level of training of each student, which allows them to study the material at their own pace, ensuring more efficient knowledge acquisition [14].

The quarantine of 2019-2022, global circumstances (which favored online learning), as well as the rapid development of information technology and the expanding

influence of AI on all spheres of life, directly affect the way we teach and learn. The educational environment is also changing dynamically, and it is clear to everyone that the classical model of university education and the lecture as one of its most important components can be significantly transformed or even changed beyond recognition. Students need more than just passive perception of information - a model that is much more effective is one where students become direct participants in the lecture, participating in discussions and having the opportunity to respond to what they hear. In situations of relative chaos, during the war, Ukraine is actively implementing a hybrid (blended) learning system. Hybrid and blended learning have a common feature. It is the use of modern computer and mobile technologies that facilitate the learning process for both children and adults. For each, the material is presented in an accessible form that meets individual needs. When conducting blended or hybrid learning, different curricula are used to facilitate the receipt and transfer of information [12]. The most common platforms for organizing blended (hybrid) learning are Blackboard and Moodle. Students have the opportunity to communicate with teachers remotely, solve test tasks, work on materials independently, and have access to video lectures. In our opinion, this combination of technological tools and pedagogical innovations can help to develop competent, creative and self-confident professionals capable of working in the digital era. We would like to note that blended and hybrid learning not only meets modern challenges, but also opens up new horizons for creativity in education. The integration of traditional and new teaching methods contributes to the formation of an innovative educational process, which is critical in the face of rapid change.

Hybrid learning has a number of advantages that make it attractive to many students and teachers. The main advantages are flexibility, which allows students to choose a time and place for studying that is convenient for them. Individualization of learning, the ability to tailor the process to one's own needs and pace, significantly increases the efficiency of learning. The use of various teaching methods, such as videos, interactive tasks and forums, makes the learning process interesting and rich. In addition, saving time and resources by not having to attend classes physically saves travel time and transportation costs. Finally, the ability to review lectures and materials repeatedly allows students to better absorb the information.

However, hybrid learning also has its drawbacks. The lack of direct contact with the teacher and fellow students can negatively affect motivation and the quality of learning. Dependence on technical means and an Internet connection can create obstacles in the learning process, in particular when technical problems arise. Students need a high level of self-discipline and self-organization to succeed in their studies, which is not always easy to achieve. Some subjects requiring practical skills are difficult to study effectively in an online format. Also, ensuring fair and objective student assessment can be challenging in an online environment.

One of the hybrid learning technologies is the use of the project method, which involves working on real-world problems and tasks. This method allows both teachers and students to go beyond traditional learning by developing the ability to analyze, synthesize, and creatively solve problems. Project-based learning not only increases the motivation of students but also prepares them for life challenges where they need to apply knowledge in practice.

An important element of modern education is cross-disciplinary learning, which integrates knowledge from different subjects into a single learning context. This approach helps teachers create a more connected and engaging learning environment where students can apply their knowledge in new, non-standard situations. For example, combining science, technology, arts, and humanities allows future teachers to see interdisciplinary connections and develop a deeper understanding of the world around them. It also promotes systems thinking, which is essential for success in modern society. In addition to cross-disciplinary learning, interactive methods such as games, simulations, and other innovative technologies can be used to play a key role in engaging students in the learning process. They not only make learning more exciting, but also stimulate creativity, activity, and independence of students. For example, the use of simulations allows students to "live through" complex situations, developing decision-making and critical thinking skills. Games, on the other hand, promote team spirit and the ability to respond quickly to change. Games require cooperation and teamwork, which is another important aspect of modern education. Working in groups allows future teachers to exchange ideas, learn from each other, and develop collective creativity. This not only increases the effectiveness of learning, but also prepares students for future professional activities where teamwork is one of the key skills. Teachers who encourage collaboration create a learning environment where each participant in the educational process can feel part of the team and contribute to the overall result.

III. Results and discussion

The integration of digital technologies into the educational process opens up new opportunities for students' creative expression. The use of multimedia tools such as video, audio, graphics, and interactive platforms allows students to create their own projects, presentations, and other works that demonstrate their knowledge and skills. Digital technologies also allow teachers to individualize the learning process, taking into account the needs and abilities of each student.

The digitalization of modern life and education in particular is forcing more and more attention to be paid to the integration of innovative technologies that promote the development of creative thinking, team spirit, and practical skills. In our study, we have reviewed such tools as ChatGPT, Gemini, Claude, Leonardo, LearningApps, Tinkercad, as well as robotics kits based on Python and Arduino. These tools not only help in teacher training, but also encourage teachers to use the latest teaching methods.

These tools open up new opportunities to develop creativity, teamwork, and practical skills for both teachers and future teachers.

Artificial intelligence, represented by ChatGPT, Gemini, and Claude, is becoming an indispensable assistant in the work of teachers. It allows you to work efficiently with large amounts of information, automate routine processes, such as the creation of training materials, and develop individual approaches to learning. For example, ChatGPT can be used to create interactive dialogues that simulate real-life teaching situations, which helps to better prepare for working with students. In addition, this tool can generate ideas for projects, which stimulates creative thinking and an innovative approach to learning. Artificial intelligence allows you to create adaptive educational platforms that analyze the level of knowledge of students, recognize their needs, and provide personalized recommendations. For example, machine learning algorithms can be used to identify weaknesses in understanding the material and automatically suggest additional learning resources or exercises. This not only improves the quality of education, but also allows teachers to allocate their time more efficiently, focusing on individual student support. Integration of AI into the educational process also allows automated assessment, which significantly reduces the workload of teachers. Text analysis algorithms can check written works for compliance with predefined criteria, and image processing systems can be used to evaluate drawings or handwritten assignments. Gemini and Claude, in turn, help with data analysis, which allows educators to better understand the needs and abilities of each student [3]. This makes it possible to adapt the educational process by creating personalized lesson plans, tests, and exercises that develop critical thinking of students.

An important element of modern learning is the visualization of complex concepts, and this is where the Leonardo tool comes in. It allows you to create high-quality visuals such as charts, infographics, and presentations that make it easier for students to understand information. Teachers can use Leonardo to illustrate complex topics, making learning more accessible and interesting. For example, when studying scientific concepts or historical events, visuals help students to better understand the material and visualize key aspects of the topic.

Interactive platforms such as LearningApps, Kahoot, Mentimeter play an important role in creating an engaging learning environment. These platforms allow you to develop interactive exercises, tests, and games that engage students in active learning. For example, you can create individualized tasks that take into account the level of knowledge and interests of each student. This not only increases motivation to learn, but also promotes independence and responsibility.

Tinkercad is an indispensable tool for developing spatial thinking and design skills. This 3D modeling platform allows future educators to create their own models that can be used in robotics projects. Teachers can integrate Tinkercad into the educational process by offering students tasks related to the development of prototypes of devices or architectural objects. This not only develops technical skills but also stimulates creativity in problem solving.

We would like to elaborate on a practical lesson using 3-D modeling with future teachers. In the classes at Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, modern approaches are being actively implemented as part of the curriculum of the mandatory discipline "Technology Workshop" for future technology teachers. One of the key elements of training is the use of computer graphics and 3D programs for product design, which significantly increases the efficiency of the educational process and develops students' creative and technical skills. Previously, the design process involved manual drawing on paper, calculations, and the creation of working models, which took a lot of time and effort. Now, thanks to modern computer programs, students can immediately see the project in three projections (see Figure 3), in volume, and make adjustments quickly, which significantly saves time and improves the quality of work.

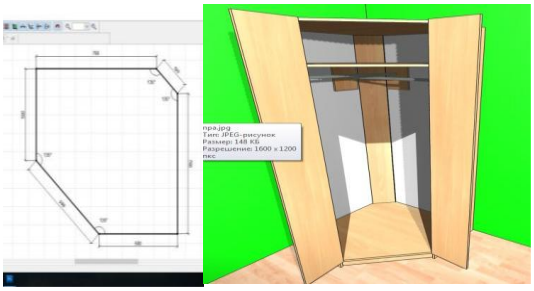

Fig. 3. 3-D design of a wardrobe for clothes corner closed two-door (student development)

Among the variety of programs for computer-aided furniture design, we have chosen the most effective and convenient program for use in the educational process - PRO100. It allows you to quickly and efficiently develop designs, estimate the cost of materials, obtain detailed drawings, and visualize projects. The PRO100 program consists of subprograms such as PRO100 Professional, PRO100 Show Room, and New Cut, which provide ample opportunities for creating complex projects. For example, through the Structure window, you can analyze any element of the project in detail, quickly edit or replace parts using ready-made libraries, and get detailed drawings and specifications. PRO100 automates many processes, such as marking holes, marking parts, taking into account the technological nuances of connecting elements, placing fittings, and generating optimal cut maps. This makes it an ideal tool for teaching future technology teachers who can quickly master design skills and achieve high results in furniture design.

During the technological workshop, students perform laboratory and practical work where they apply their knowledge in practice. For example, one of these works is "Development of a project for a corner wardrobe for clothes using the PRO100 computer-aided design (CAD) system." The purpose of this work is to teach students how to design

custom furniture using modern computer-aided design tools. According to the instructions, , future technology teachers work through theoretical issues, prepare sketches, approve them with the teacher, and then proceed to create a project in the PRO100 program. They group the parts, give them texture, save the project in the library, and prepare a report with the results of their work.

This approach allows students not only to master the technical skills of working with the program, but also to develop creative thinking and the ability to innovate in solving problems. The use of PRO100 in the educational process has proven to be effective, as future technology teachers demonstrate a high level of learning and the ability to create complex projects on their own. This indicates that the integration of modern technologies into the training of technology teachers is an important step in the development of education, which allows training specialists who can work effectively in the context of modern technological progress.

Robotics and programming is an important area in modern education. The use of robotics kits based on Python and Arduino allows students to develop programming, logical thinking, and teamwork skills. Python, as one of the most popular programming languages, is used to develop algorithms and control robots. Arduino, in turn, allows you to create simple and complex electronic devices that stimulate creative thinking and engineering skills. Teachers can use these kits to conduct hands-on activities where students can create their own projects, such as automated systems or robotic devices. This not only develops technical literacy, but also builds the ability of future teachers to think innovatively and solve complex problems. This analysis visualizes the possibilities of using the Arduino platform and Python libraries to create robots that can be implemented in education and everyday life. The authors have presented a working model of a robot built and programmed on the basis of Arduino components to measure humidity in computer laboratories and develop automatic plant irrigation systems to maintain appropriate conditions in classrooms. They also provide an example of integrating the learning of the Python programming language with the use of Arduino robotics kits. This method aims to enhance the quality of training for future computer science teachers, broaden their methodological toolkit, and equip them with the ability to teach students using innovative methods. The study's results and the developed teaching materials aim to increase students' interest in STEM education and prepare a new generation of computer science teachers for the challenges of the modern technological world. This will expand their methodological arsenal and develop their ability to use integrated technical, engineering, and mathematical solutions to solve theoretical and practical problems [15].

```python
# Налаштуйте порт і швидкість передачі даних
arduino = serial.Serial(port='COM3', baudrate=9600, timeout=1)
time.sleep(2)  # Зачекайте, поки Arduino ініціалізується

def send_command(command):
    """Відправка команди на Arduino"""
    arduino.write(command.encode() + b'\n')
    time.sleep(0.1)
    response = arduino.readline().decode().strip()
    return response

# Приклад використання
if __name__ == "__main__":
    while True:
        cmd = input("Введіть команду для Arduino: ")
        if cmd.lower() == "exit":
            break
        response = send_command(cmd)
        print(f"Arduino відповів: {response}")

    arduino.close()
```

Fig. 4. Python code for Arduino generated by AI

Creativity is an integral part of teacher training, as it allows for innovative teaching methods and adaptation of teaching to different learning styles. With Python and Arduino, you can create unique educational projects that combine programming, robotics, and artificial intelligence. For example, you can develop educational robots that respond to voice commands or emotion recognition systems that help analyze students' moods during classes. With the help of Arduino, you can create smart classrooms that analyze the conditions of the learning environment, adjusting the level of lighting or ventilation according to the needs of students, which helps to increase their concentration and productivity. This opens up new possibilities for interactive learning, making it fun and effective.

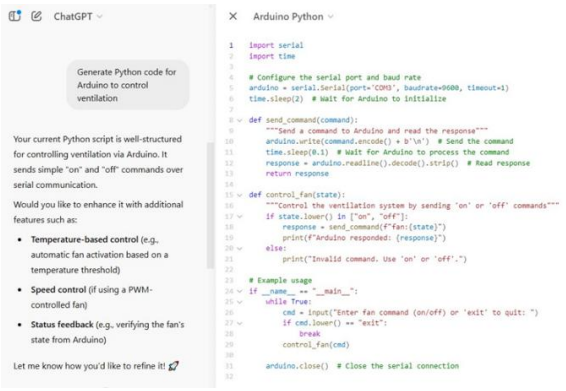

Fig. 5. Code generated by AI according to the promo

We conducted a survey in the "Questionnaire: AI Pros and Cons" in Google form among students of two higher education institutions: Mykhailo Kotsiubynskyi Vinnytsia State Pedagogical University and Pavlo Tychyna Uman State Pedagogical University.

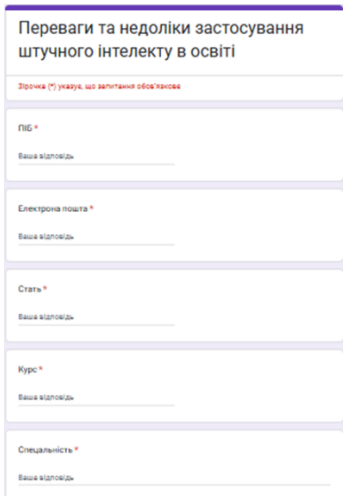

Fig. 6. Registration form "Questionnaire: AI pros and cons"

This survey revealed a number of challenges related to the use of AI in the educational process. In particular, it was found that most students demonstrate an initial level of interest in using artificial intelligence, but the creative potential of this technology remains underutilized. Only a small part of students actively use AI to perform creative tasks, which indicates the need to further improve the methods of integrating technology into the educational process.

Along with numerous advantages, the use of AI and other innovative technologies in education has certain limitations. One of the main challenges is the decrease in personal interaction between teachers and students, which can negatively affect the latter's motivation. This underscores the need for a creative approach to organizing the educational process that would combine the benefits of technology with the support of personal communication. For example, the use of hybrid learning formats, where online resources are supplemented by regular meetings and discussions, can be an effective solution to overcome this limitation.

IV. Conclusions

Creativity is a critical component of the professional activity of educators, which directly affects the quality of education and the development of students. Its formation requires the creation of a favorable environment in educational institutions, opportunities for professional development of teachers and active cooperation between them and students. Modern teachers must demonstrate high adaptability and flexibility, the ability to change their teaching approaches in accordance with the needs of students and the current challenges of society [16].

The integration of modern technologies, including artificial intelligence, into the educational process plays an important role in stimulating the creativity of future teachers. The use of AI tools allows educators to introduce new teaching methods, create individual learning paths, and automate routine processes, which, in turn, contributes to the development of innovative, creative thinking in both teachers and students. In addition, cross-disciplinary approaches and cooperation between teachers and students of different educational and professional programs ensure the comprehensive development of the educational process, which is important for the formation of creative skills.

The use of various media materials, such as videos, audio recordings, and graphic elements, makes educational material more accessible and understandable. Visualization of information makes it easier to perceive and memorize, which is especially important in the process of forming future teachers' professional development. Interactive elements such as online tests, polls, and discussions on hybrid (blended, distance) learning platforms encourage students to actively participate in the educational process, creating a dynamic environment for sharing opinions and receiving instant feedback.

Experimentation with different forms of learning, including blended and hybrid learning, allows students and their teachers to choose the most convenient format for them, which promotes independence and creativity. The availability of learning resources anytime and anywhere allows students to plan their learning independently, increasing their motivation and engagement. In addition, the implementation of practical tasks, for example: 3-D modeling, programming Arduino in Python, using ChatGPT, Gemini, Claude, Leonardo broadens students' horizons and develops their professional competencies.

We believe that further research should focus on the impact of AI on the development of creativity in different educational contexts, including inclusive education, and the impact of AI on the psychological and cognitive state of future teachers in the process of professional training. It is also important to study the effectiveness of using various AI tools, such as content generators, data analysis systems, and interactive platforms, in developing students' creative and professional skills. The development of new methods of integrating AI into the educational process that combine technological innovations with support for personal interaction may be an important area for future research [17].

Thus, the use of AI will create an environment where teachers and students can effectively interact, develop their skills, and reach new heights in their professional activities.

REFERENCES

[1] U. Shostak, V. Yablochnikova, та Y. Yasenchuk, "Змішане та гібридне навчання у закладах вищої освіти," Collection of scientific papers «ΛΌГОΣ», с. 277–283, травень 2023.

[2] Ministry of Digital Transformation of Ukraine, "How to use artificial intelligence in school education: a draft of recommendations presented," Government Portal. [Online]. Available: https://thedigital.gov.ua/news/yak-vikoristovuvati-shtuchniy-intelekt-u-shkilniy-osviti-prezentuemo-proekt-rekomendatsiy . [Accessed: Sep. 27, 2024].

[3] R. Gurevych, O. Konoshevskyi, A. Voievoda, and S. Liulchak, "Integration of artificial intelligence in education: problems, challenges, threats, and prospects," Modern Information Technologies and Innovative Methodologies of Education in

Professional Training, vol. 72, pp. 170–186, 2024. https://doi.org/10.31652/2412-1142-2024-72-170-186.

[4] S. Gupta, Digital Strategy: A Guide to Business Transformation. Kyiv: KM-BUKS Publishing, 2020.

[5] B. Shermukhammadov, "Creativity of a Teacher in an Innovative Educational Environment," J. High. Educ. Theory Pract., т. 22, № 12, 2022. https://doi.org/10.33423/jhetp.v22i12.5468 .

[6] A. S. Auzani, L. Leonido, A. Pereira, and E. Morgado, "Innovation and creativity in extension projects: The role of art in UTFPR engineering courses," in Smart Learning Solutions for Sustainable Societies, pp. 203–217, May 2024. doi: 10.1007/978-981-97-0661-7_15.

[7] O. Komenda, B. Kysliak, and O. Marach, "The structural and activity method of studying the universal creative personality (on the example of musical culture) | O método estrutural e de atividade do estudo da personalidade criativa universal (a partir do exemplo da cultura musical)," Convergencias: Revista de Investigacao e Ensino das Artes, 2024.

[8] J. Xu, "Enhancing student creativity in Chinese universities: The role of teachers' spiritual leadership and the mediating effects of positive psychological capital and sense of self-esteem," Think. Skills Creat., т. 53, ст. 101567, 2024. https://doi.org/10.1016/j.tsc.2024.101567 .

[9] S. Loboda, Y. Plyska, та M. Dobrzyniak, "Creative self-actualization of the future teacher in the professional training process," Youth Voice J., т. 1, № Special Issue, с. 60–71, 2023.

[10] V. M. Fedorets, O. V. Klochko, I. A. Tverdokhlib, and O. A. Sharyhin, "Cognitive aspects of interaction in the 'Human — Artificial Intelligence' system," Journal of Physics: Conference Series, vol. 2871, no. 1, p. 012023, Oct. 2024. doi: 10.1088/1742-6596/2871/1/012023.

[11] K. Livingston, C. O'Sullivan, and K. Attard, Eds., Characteristics and Conditions for Innovative Teachers: International Perspectives, 1st ed. London, UK: Routledge, 2023. doi: 10.4324/9781003216902 .

[12] H. J. Dewaard, "Into the Open: Shared Stories of Open Educational Practices in Teacher Education | À découvert: des histoires partagées de pratiques éducatives libres dans la formation des enseignants," Can. J. Learn. Technol., т. 50, № 4 Special Issue, 2024. https://doi.org/10.21432/cjlt28603 .

[13] E. M. Zorina, A. Yu. Ivanova, and E. I. Chirkova, "Professional and Personal Development of a Student as a Key to Sustainable Development of the State," in Springer Proceedings in Business and Economics, pp. 323–335, 2024. doi: 10.1007/978-3-031-56380-5_29.

[14] L. Liubarska, "Artificial intelligence as a means of developing creativity in future technology teachers," Artif. Intell., № 3, с. 58–64, 2024.

[15] V. Kyslitsyn, L. Shevchenko, V. Umanets, L. Sikoraka, and Y. Angelov, "Applying the Python programming language and Arduino robotics kits in the process of training future teachers of computer science," ETR, vol. 2, pp. 162–167, Jun. 2024. doi: 10.17770/etr2024vol2.8026.

[16] L. Tleubekova, K. Atemova, K. Turebayeva, and R. Kenzhebekova, "Development of students' creativity: Results of practical testing of the learning model during the pandemic," European Journal of Contemporary Education, vol. 2, p. 655, 2023. doi: 10.13187/ejced.2023.2.655

[17] V. Umanets, V. Solovei, L. Lyubarska, та B. Rozputnia, "Methodology for the application of artificial intelligence technologies for the development of the creativity of future designers in the professional education," у Art in Contemporary Culture: Theory and Practice of Teaching, 2024. https://doi.org/10.31652/3041-1017-2024(3)-07 .