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Research on Generative Artificial Intelligence Technologies in Education: Opportunities, Challenges, and Ethical Aspects

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Abstract: The article investigates that in Ukraine there are a number of regulatory documents aimed at supporting the use of artificial intelligence (hereinafter referred to as AI) in education and in various industries, starting from October 2019. The advantages and risks of using generative AI technologies are substantiated. The advantages and risks of using AI technologies in the educational process of professional training of higher education students and the education system are characterised. Using the example of practical work and generation tasks in Adobe Firefly with AI, it was found that the task program with abstract concepts (on the example of the Ukrainian fairy tale 'About Truth and Wrong') failed to generate images. At the same time, the author's fairy tale with real literary characters 'The Princess on the Pea' by Hans Christian Andersen was generated. The article also discusses the challenges that were identified when the programme performed the task of generating images for the query 'Artificial intelligence and humans: good or evil? A series of images', which, in the authors' opinion, require a thorough study by professional annotators. The authors have analysed the JourneyDB program and the Midjourney AI program, which runs on the JourneyDB platform. The results of a survey of pedagogical and scientific workers concerning the ethical aspects of AI in education are analysed. The paper contains an analysis of opportunities and new challenges in the field of AI application in education and other industries. The authors conclude that the existing models of developed AI generative programs require more comprehensive testing before they can be launched for mass use. If inaccuracies are found in the results of generations, they recommend changing the data on which they operate (changing the DataSet). We believe that generative AI technologies in education have a promising and rapid future. Generative AI technologies require research into their broader capabilities and challenges.

Keywords: artificial intelligence; generative technologies; ethical use of AI; query generation in Adobe Firefly; JourneyDB; Midjourney - AI; AI capabilities; ethical aspects of AI; survey analysis.

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1. Introduction

Generative artificial intelligence (AI) technologies are being integrated into education more and more rapidly by the day. As students and teachers learn about neural networks, they discover new opportunities or ideas about the applications and possible challenges of different types of AI.

Our research aims to explore the opportunities, challenges, and ethical aspects of generative AI technologies.

The objectives of the research are:

1. to describe the legislative documents that govern the use of AI in education and other industries in Ukraine;
2. to investigate the possibilities of new generative programs and their applications with generative AI technologies, including Adobe Firefly with AI, the JourneyDB platform, and the Midjourney AI program running on the JourneyDB platform;
3. to analyse the results of surveys on ethical aspects of AI in education (own development of questions).

Research methods: to achieve the goal, the following scientific methods were used: content analysis method: study of theoretical research in the form of scientific articles, conference papers, direct participation in conferences; method of statistical data processing - anonymous online survey of research and teaching staff of higher education institutions and pedagogical staff on the Google Form platform; method of practical study of working with generative AI programs, including the example of Adobe Firefly with AI.

2. Literature Review

Despite the Russian aggression and military actions aimed at our country, scientists in Ukraine do not stop their research activities and explore the possibilities of teaching students, including higher education, under martial law (Yuzyk et al., 2022; Nagay et al., 2023; Aliksieieva, 2023).

The importance of a special regime for restoring and stimulating the development of the territories affected by the armed aggression against Ukraine is substantiated at the scientific level (Martynovych, Boichenko, & Dielini, 2023). It is important to study the optimisation of production solutions with limited resources and community priorities in a difficult time for Ukraine (Nestorenko et al., 2022).

Ukrainian higher education institutions are organising conferences of various levels and seminars, and introducing new disciplines aimed at introducing and studying new digital technologies by students and researchers. Among these technologies, artificial intelligence (hereinafter referred to as AI) is gaining rapidly in popularity. In our opinion, scientists focus their attention on AI-related issues in the following areas: AI in various industries (education, medicine, healthcare, business, marketing, etc.) (Samoilenko, Stupak, & Yuzyk, 2023; Fishchenko, 2021; Potwora et al., 2024); generative AI (Banh & Strobel, 2023; Mao, Chen, & Liu, 2024); AI and modern technologies, including the synergy of human and artificial intelligence (Dotsenko & Sobchenko, 2024; Brailas, 2024), AI and automation, personalisation and forecasting (Potwora et al., 2024); ethical issues related to the use of AI (Cappelli & Di Marzo Serugendo, 2024; Ferrell et al., 2024).

Alekseeva's research in the field of AI application in dual education and preparation of students for the requirements of the modern labour market enhances the understanding of generative AI programs (Aliksieieva, 2024).

According to scientific data, "over the next three years, more than 47% of learning management tools will be available through artificial intelligence capabilities" (Dotsenko & Sobchenko, 2024; Prohrama velykoi transformatsii «Osvita 4.0: ukrainskyi svitanok», 2022).

The various aspects of AI consideration indicate the growing relevance of its study and application.

3. Methodology

The methodological aspect of our study is based on the theoretical analysis of the scientific results of AI researchers, including the JourneyDB platform and the Midjourney - AI program running on the JourneyDB platform; analysis of the results of research on generative AI technologies; practical work in the Adobe Firefly AI program; analysis of the results of surveys of scientists and educators on their use of AI programs.

4. Results

Based on the analysis of the legislative and regulatory framework in Ukraine, we found that the following regulatory documents are applied in Ukraine when working with and using AI: 1) recommendations of the Organisation for Economic Co-operation and Development on artificial intelligence (Organisation for Economic Co-operation and Development, Recommendation of the Council on Artificial Intelligence, OECD/ LEGAL/0449) (October 2019); 2) the Cabinet of Ministers of Ukraine approved the Concept for the Development of Artificial Intelligence in Ukraine as one of the priority areas in the field of scientific and technological research (No. 1556-p of 2 December 2020) (Pro skhvalennia Kontseptsii rozvytku shtuchnoho intelektu v Ukraini, 2020). The Concept for the Development of Artificial Intelligence in Ukraine, in the section "Purpose, Principles and Timing of the Concept Implementation, states that the main task of education in the development of AI is to provide the relevant field with qualified personnel. The demand on the labour market shows that the modern education system should train competitive specialists in the field of AI to a much higher quality" (Pro skhvalennia Kontseptsii rozvytku shtuchnoho intelektu v Ukraini, 2020); 3) On approval of the action plan for the implementation of the Concept of Artificial Intelligence Development in Ukraine for 2021-2024: Order of the Cabinet of Ministers of Ukraine of 12 May 2021 No. 438-p, Program of the Great Transformation "Education 4.0: Ukrainian Dawn" (On the Approval of the Action Plan for Implementing the Concept of Artificial Intelligence Development in Ukraine for 2021–2024; Cappelli & Di Marzo Serugendo, 2024). It is worth noting that the challenges and opportunities in education (world level) of the transformation program "Education 4.0: Ukrainian Dawn" indicate the following opportunities related to technology: first, the coming of IR 4; second, "new learning technologies." "New learning technologies do not replace but complement the teacher" (taken from World Economic Forum 2020), (The Grand Transformation Program "Education 4.0: The Ukrainian Dawn", 2022), and others.

We should familiarise ourselves with the European Union Artificial Intelligence Act, 2024, especially with Art. 5 KI-VOVerbotene Praktiken im KI-Bereich (European Union Artificial Intelligence Act, 2024).

Users of AI generative programs can use a website that contains a catalogue of free AI tools on Aixploria. It contains more than 5000 different tools that use AI. Link to the catalogue: <https://www.aixploria.com/en/> (see Figure 1).

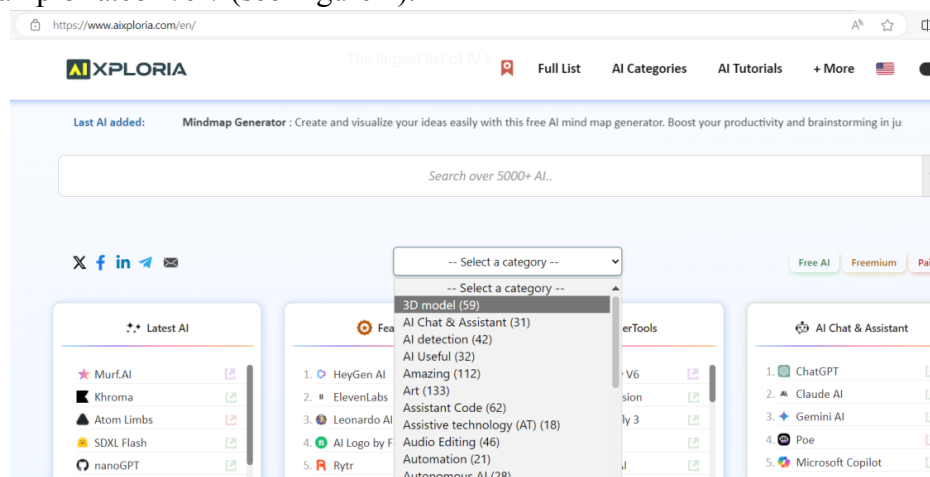


Figure 1. Catalogue of free AI tools on Aixploria

AI generative programs can be used to perform the following technologies: natural language processing, speech recognition, face recognition and processing, handwriting recognition, and image manipulation, such as the use of AI in computer game avatars, malware bots, virtual researchers, smart robots, and autonomous weapons; analysis of human behaviour; the use of AI to analyse human behaviour, facial expressions, etc.; intelligent data analysis for forecasting; machine creativity; the use of AI in systems that create new photographs, works of music, art or literature (Dotsenko & Sobchenko, 2024).

Yuzyk and Lahoyko in their thesis “The use of artificial intelligence in education and the issue of intellectual property for it: the results of research and own analytics” investigated and described the results of surveys of pedagogical and scientific and pedagogical workers (210 respondents in total) on the most used “smart” services. The responses showed that ChatGPT is the most used service - 80.5% of respondents, Canva - 66.5%, «To the lesson» - 40.5% (Yuzyk & Lahoyko, 2024). Another study on the current use of AI in Ukrainian general secondary education institutions, conducted by Projector Creative & Tech Institute and the Minor Academy of Sciences of Ukraine with the support of the research company Factum Group Ukraine, involved 3,000 Ukrainian respondents, including 1,747 teachers and 1,443 students (8- 11th graders). The results showed that “almost all of the surveyed teachers have heard of AI services. At the same time, 7 out of 10 have used at least one of them in the last six months. In total, 76% of surveyed teachers have used AI at least once - half of them had a positive experience of interaction. The most popular AI service, which both audiences are familiar with, is ChatGPT, as expected. The second most popular among respondents is the AI tool from the Na Urokon project. This service is known to 49% of teachers and 35% of students. Both teachers and students are much less familiar with the following well-known international AI services: Grammarly, Google Bard, Midjourney, Notion AI, and Stable Diffusion” (Yuzyk & Lahoyko, 2024).

To find out whether there are any guidelines for the use of AI in educational institutions, we developed a Google form with a survey “AI and generative AI technologies” (AI and generative AI technologies - Google Forms) and sent it to the participants of the All-Ukrainian Conference “Preparing Teachers for Professional Activity in Blended Learning” (Rivne, Ukraine) on 29 May 2024. Voluntary and anonymous responses were required. A total of 17 respondents took part in the survey. To the question “Does your university/educational institution have instructional and methodological recommendations on the use of AI by students?”, the respondents' answers were as follows: “Yes” was answered by 4 people (23.5%), “No” by 13 people or 76.5%. This indicates that the vast majority of higher education institutions do not discuss the use of AI, its benefits, and its possible risks.

Researchers Dotsenko and Sobchenko believe that AI “is one of the most effective tools that educators and scientists can have at their disposal, and it often relieves them of administrative burdens. These technologies will never replace academic staff, but rather allow them to spend more time on research and teaching students.” (Dotsenko & Sobchenko, 2024). In their study on the possibilities of using AI technologies in the educational process of professional training of designers, Shevchenko, Umanets, & Rozputnia (2024) describe the following advantages of AI: creation of interactive training courses in design, 3D modelling, and visualisation using neural networks. Such courses will be adapted to the individual characteristics of each student, his or her previous knowledge and skills, and the pace of learning. This will allow for more effective learning of practical skills. Development of computer-based testing systems and automatic assessment of the quality of drawing, colouring, composition, etc., skills based on machine learning. Neural networks are able to analyse quickly a large number of creative works and provide objective assessments. Application of Data Science technologies to obtain insights from big data on the educational process in order to further optimise and improve its quality. Neural networks will be able to identify hidden dependencies between different factors.

Creating AI-based virtual 3D laboratories - imitations of designers' work environments - to reproduce and simulate complex design processes, such as interior design, etc. Building platforms

for communication, discussion of creative works, and receiving feedback and recommendations from AI, which will help students in their growth as designers. AI technologies can significantly improve the learning of 3D modelling and visualisation as important competencies for future designers. Specific neural network services, such as Vector to 3D and Masterpiece X, developed by Anthropic and Dreamatter, respectively, allow for the automatic conversion of 2D art into spatial 3D objects. This creates unique opportunities for hands-on learning of the basic principles of 3D design based on specific examples. In addition, the integration of convolutional neural networks into modelling software such as Maya, 3ds Max, Blender, and others will help analyse the quality of the models created and optimise individual learning paths for each student. This will ensure a deep mastery of the necessary competences and training of specialists of the appropriate level (Shevchenko, Umanets, & Rozputnia, 2024).

Marienko and Kovalenko (2023) highlight the following advantages in the application of generative technologies with AI in the education system:

1. AI systems adapt to the learning needs of each student and goals according to their strengths and weaknesses.
2. AI systems analyse and observe a learner's current learning style and abilities and provide a customised template of content and support.
3. AI systems evaluate not only closed-ended answers in a test format but also descriptive answers.
4. Thanks to AI, learners feel free to make mistakes, which is an integral part of learning, and then receive real-time feedback to make the necessary corrections.
5. Adaptive learning is used to teach students at the initial level and then gradually move on to the next stage, completing the previous one.
6. AI can provide students with access to education according to their needs, for example, by reading content to a visually impaired student.
Developing the necessary competences and training specialists at the appropriate level.
7. AI can also be used in preschool education in a dosed manner to present interactive games that teach and develop children's basic skills.
8. It can be used to create educational content: for example, there are AI programs that convert voice to text and others (Marienko & Kovalenko, 2023).

However, using generative AI programs may also pose certain risks. We fully agree with Shevchenko, Umanets, & Rozputnia, (2024), who systematised the risks as follows:

1. Non-independence of students in performing work. Some students are already actively using AI to write essays and papers, which makes it difficult for the teacher to understand whether the student wrote the paper or the AI. This can lead to a decrease in the quality of students' knowledge, as they may not master the material independently.
2. Impact on social interaction. The use of AI can change the way teachers and students communicate. This may affect the development of communication and social interaction skills, as students may interact more with technology than with people. Social skills are important for a successful career, and personal life may remain undeveloped.
3. Breaching the privacy of students' data without their consent or adequate protection of this data. This raises serious ethical and legal issues related to the confidentiality and security of personal information.
4. Dependence on technology. Intensive use of AI can lead to dependence on technology, which can have a negative impact on useful skills in real life.
5. Incorrect answers. AI models, such as GPT, may provide correct or incorrect answers. This can mislead students and affect the quality of their learning. Teachers need to carefully verify the information provided by AI to avoid spreading false data (Shevchenko, Umanets, & Rozputnia, 2024).

We have analysed the work of Adobe Firefly (a free AI generative software). When asked a series of questions to generate images by this program, we found out that when using it, you need to look very carefully at the images it generates, because they may contain errors. At the author's request to generate the image “Four of us are going to the forest in the evening”, the following images were generated by the program (see Figure 2).



Figure 2. Generated by Adobe Firefly for the query “Four of us are walking into the woods in the evening”

If we look closely at the first person and the legs behind him, we can see his hands on his legs. In the middle of the man's right hand, where the fingers are, it is blurred in the form of pixels. This image should not be used for classroom demonstrations.

Next query “A story about an insect fighting a wolf. Five pictures”. The following result was generated by the program (see Figure 3).

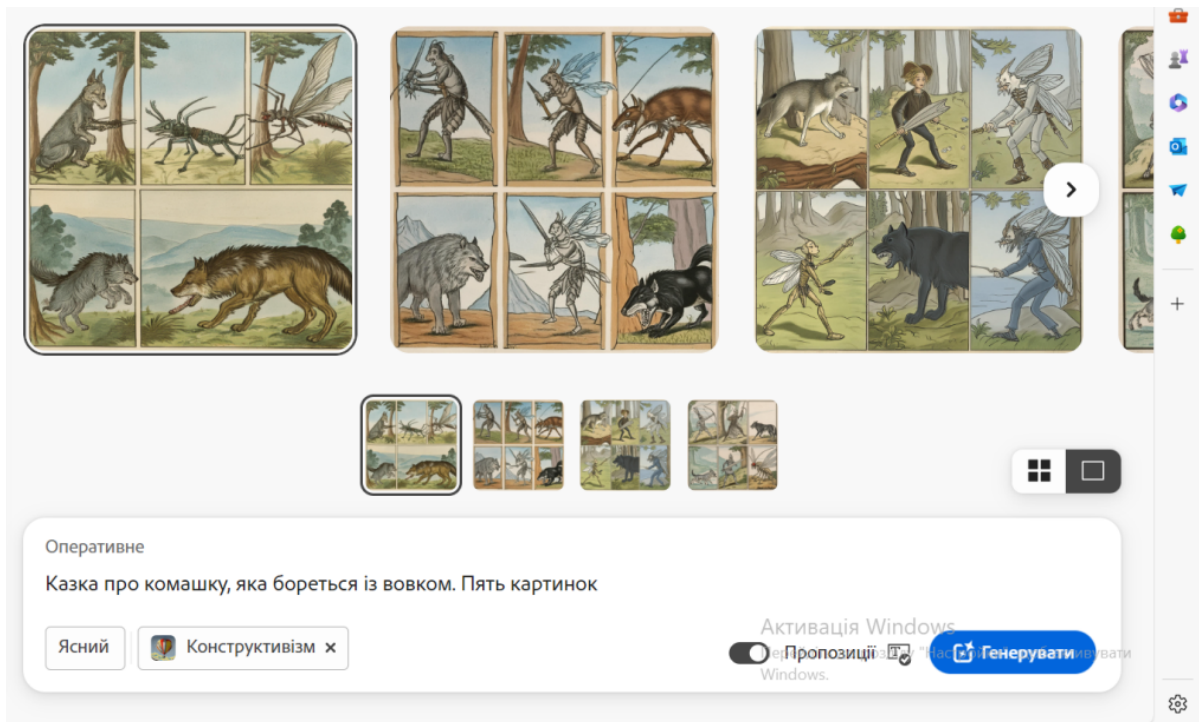


Figure 3. The result of the query “A story about an insect fighting a wolf. Five pictures”

It was also found that it is difficult for the program to generate abstract concepts. For example, the task was to generate pictures for the fairy tale “About Truth and Falsehood” (a Ukrainian folk tale). Unfortunately, the result was as follows: “Unable to upload. We cannot process this request. You can edit and try again or mark it for review. Please note that request data is collected if it is marked for review” (see Figure 4).

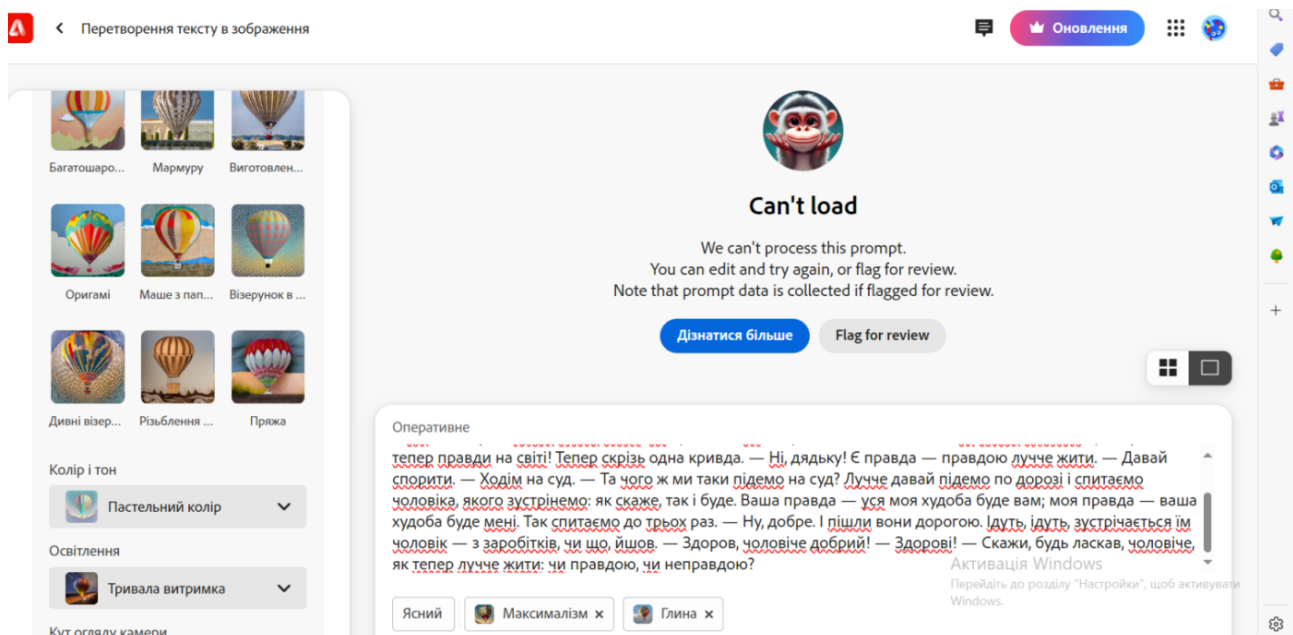


Figure 4. The result of the Adobe Firefly program's request to generate pictures for the fairy tale “About Truth and Falsehood” (Ukrainian folk tale)

When a fairy tale is written, a series of pictures is generated. For example, the task was to generate pictures for the fairy tale “The Princess on the Pea” by Hans Christian Andersen. The result was as follows (see Figure 5).

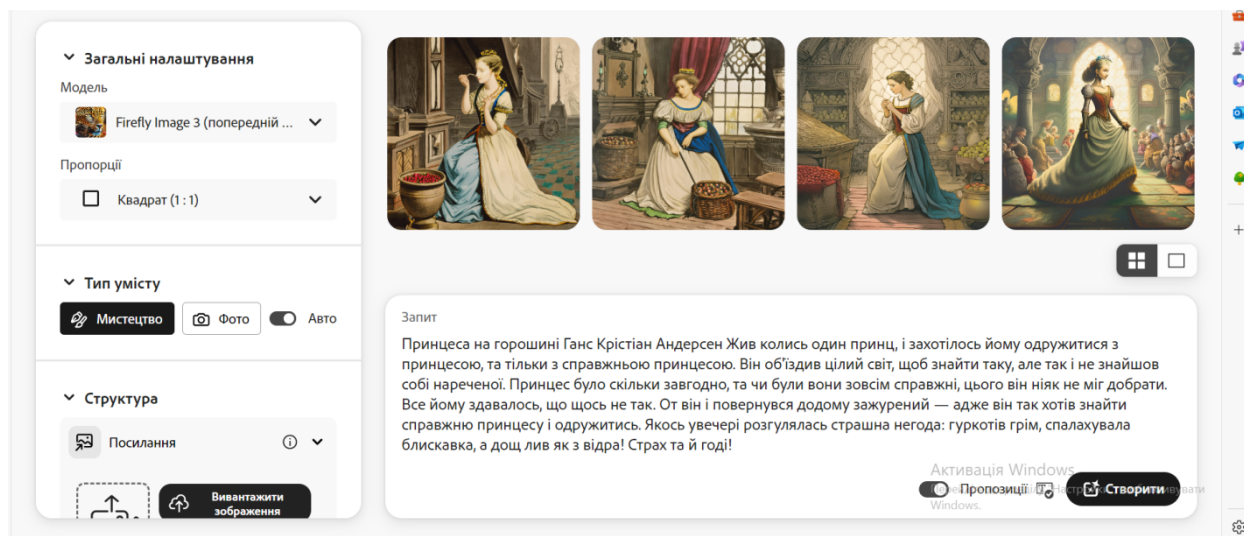


Figure 5. Generating a series of pictures for the fairy tale “The Princess on the Pea” by Hans Christian Andersen

For the query “Artificial intelligence and humans: good or evil? A series of images”, the program generated a series of images of the following content (see Figure 6a and see Figure 6b). Note that the same request was submitted twice.

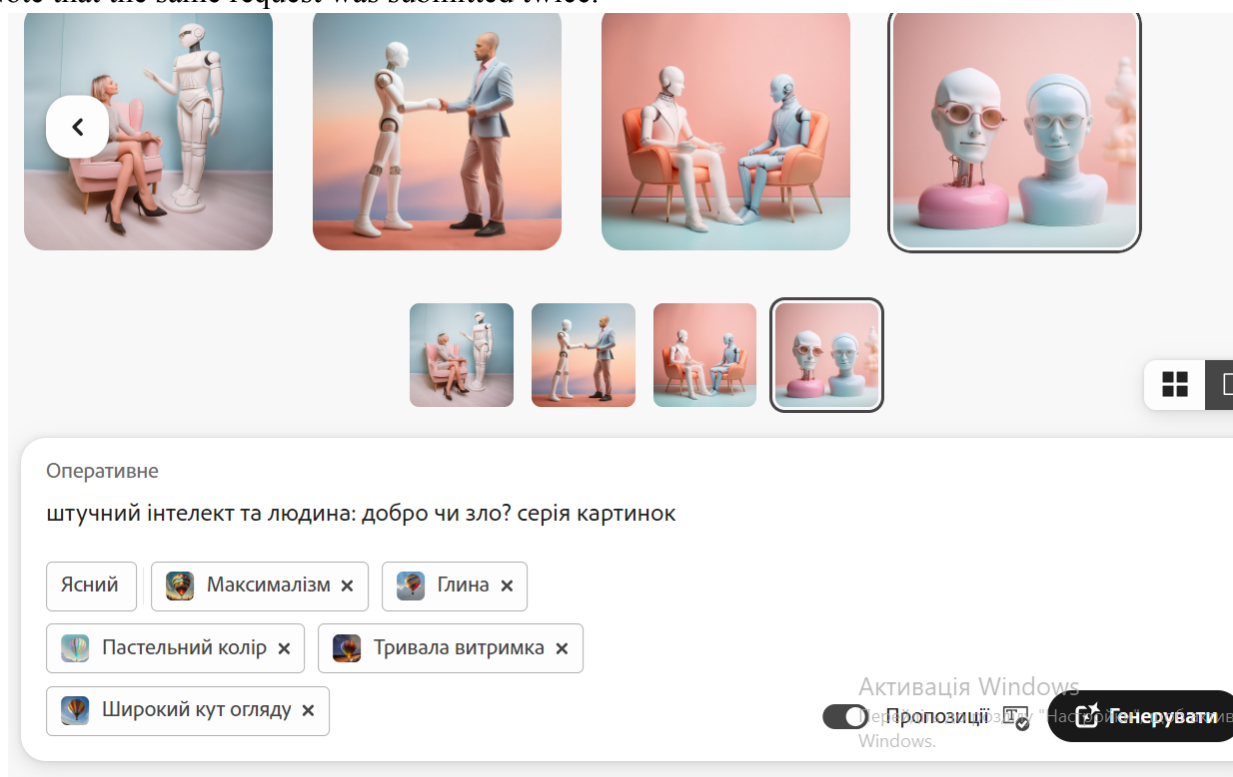


Figure 6a. Generating a series of images for the query “Artificial intelligence and humans: good or evil? A series of images” for the first time

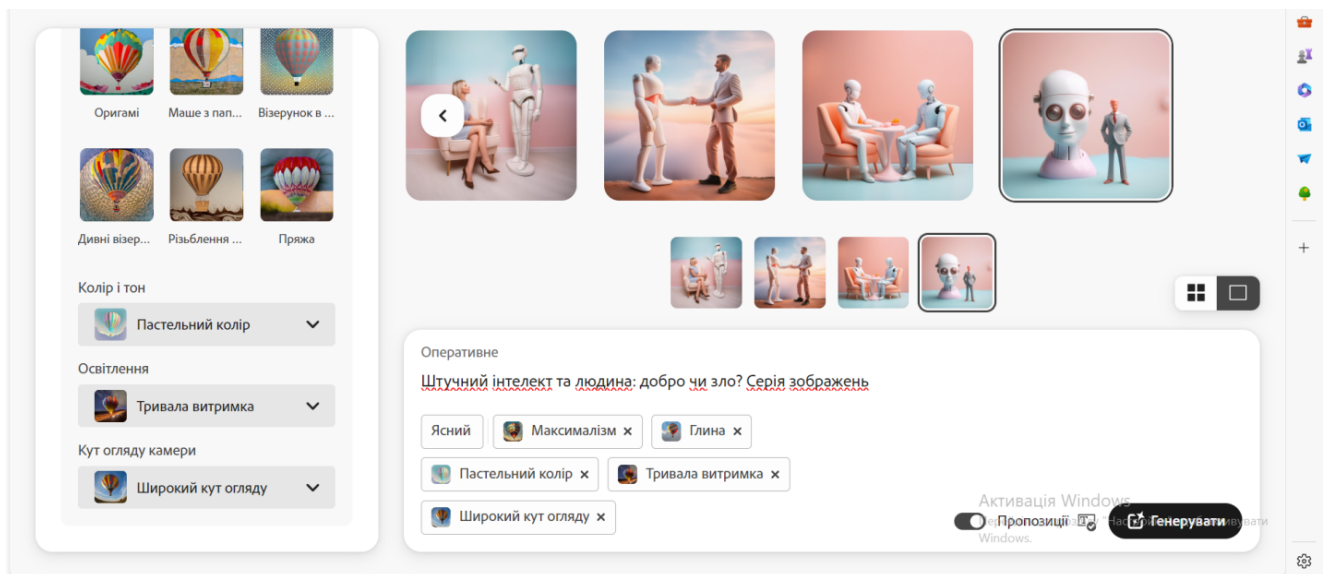


Figure 6b. Generating a series of images for the query “Artificial intelligence and humans: good or evil? A series of images” for the second time

A close look at the two series of image generations in Figure 6a and Figure 6b for our query, in our opinion, requires a thorough study by professional annotators.

Sun et al. (2023), at the 37th Conference on Neural Information Processing Systems (NeurIPS, 2023) Track on Datasets and Benchmarks, present interesting research related to COCO Capilot and JourneyDB. Their JourneyDB program, which serves the field of generative images in the context of multimodal visual understanding, contains a carefully selected dataset of over 4 million clear and high-quality generated images, each of which is paired with relevant textual cues, JourneyDB covers both detailed descriptions and high-level summaries of images, thus assessing the model's skill in fine-grained recognition and holistic understanding. JourneyDB is also backed by 40 professional annotators who mark the words of the tooltip that do not match the image. This way, only relevant and correct information remains. In Table 4, the authors of the article show the errors that are also made in generative programs. “The results are presented in Table 4, indicating the challenges faced by multi-modal models trained on natural images in providing accurate descriptions for AI-generated content The quantitative performance is notably poorer (significantly worse than COCO Caption results) due to two primary factors: GPT-3.5 tends to generate verbose descriptions for the images in JourneyDB, resulting in lengthy ground-truth captions. This discrepancy between lengthy ground-truth captions and shorter predicted captions undermines the quantitative performance. When describing AI-generated images, the focus may differ in terms of concepts such as emotions, human/object attributes, etc., compared to natural images” (Sun et al., 2023). JourneyDB: A Benchmark for Generative Image Understanding. 37th Conference on Neural Information Processing Systems (NeurIPS, 2023).

Midjourney - This AI image-generation software is based on a database of images contained in the JourneyDB platform. JourneyDB is a large-scale generated image understanding dataset containing 4,429,295 high-resolution Midjourney images annotated with corresponding text prompts, image captions, and visual question answering (GitHub - JourneyDB/JourneyDB) as of 2023. The Midjourney - AI software allows you to generate 25 images for free and indicates when signing the user agreement that the free version for the user allows the user to use the generated images and the software to take the results of the work in this program into its database. Other paid versions of this program are more protective of the user's authorship, like Pro Plan. The tariff cost

of \$60 per month guarantees the highest form of privacy in image creation (Midjourney — AI for image generation. How to use it?, 2023).

5. Discussion of the Research Topic

We would like to suggest that it is appropriate to use AI in synergy with a human user in developments with generative technologies. The question of authorship of the result of work with generative AI technology remains open.

6. Conclusions

AI has huge potential to improve the educational process, but its implementation as a tool in the education system at all levels requires a careful approach and a number of problems to be solved. Educational institutions and teachers must be ready for these challenges and actively implement new technologies and teaching methods while ensuring a high level of education quality and protection of students' rights.

When working with generative AI technologies, it is important to thoroughly analyse the result of the query by the program for further use. We also believe that developers of generative AI programs should carefully check their developments if they launch them for mass use in the following way: the model should undergo more test trials. If inaccuracies are found in the results of the generations described in the article above, they should try to change the data on which it operates (change the DataSet).

The use of AI in computer science classes at educational institutions, including vocational and higher education, is a good solution to improve the formation of competitive specialists. Thanks to AI, the educational sector will be able to develop more intensively by introducing new tools and technologies that make learning more interesting and better. Thus, improving the quality and capabilities of current education and increasing the flow of applicants for admission to higher education institutions that use these tools.

Scientists, educators, and students should be introduced to new generative technologies that include AI. Therefore, we believe that it is better to use newer and proven AI generative technologies (including paid versions) that are thoroughly tested before launch by professional annotators and have large databases of proven models, images, sounds, etc.

We see prospects for further research in the study of generative AI technologies in various fields, analysing the impact of generative AI technologies on the cognitive sphere of the individual. Detailed research on the ethical considerations of human authorship when creating queries for generative AI programs will also be valuable. Transferring analogies in the study and classification of digital technology tools, such as Trello as a tool for developing lifelong learning skills (Shchetynina et al., 2022), and based on this, it is promising to describe digital tools used in generative technologies in the future.

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Contributions of the authors:

Author 1 defined the theoretical and methodological aspects of AI in education through research areas and branches, as well as the methodological aspect of the study, the aim, and the objectives. Author 2 classified the research methods. Author 3 proposed discussion topics on the research topic and systematised the research findings. Author 4 created queries to be generated in AI programs. Author 5 systematised the benefits of using generative AI technologies in the education system. Author 6 studied in detail the Aixploria website, which contains a variety of AI-powered tools, and described the types of technology. Author 7 described the Midjourney-AI program. Author 8 described the results of regenerations in Adobe Firefly on the query of the fairy tale "About Truth and Falsehood" (Ukrainian folk tale) and concluded. Author 9 described the

results of surveys of teachers and researchers on different resources and compared them, performing statistical processing of the calculations. Author 10 put forward ideas and worked on the design of the research results. Author 11 analysed the errors made by Adobe Firefly in user tasks and the reasons for their occurrence. Author 12 analysed scientific research related to AI and the legal framework in Ukraine for AI use.

Conflict of Interest:

The authors declare no conflict of interest.

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