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Updating Art Education with Neuropedagogical Technologies and Artificial Intelligence

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Abstract: *This article emphasises the need to modernise art education by integrating neuropedagogical technologies and artificial intelligence (AI). Indeed, neuroscientific achievements (neurophysiological, neurobiological, neuropsychological, and neurosurgical) and AI have an enormous impact on people's everyday lives, especially in education. Neuropedagogy is a higher, current level of classical pedagogy. It recognises the achievements of education, pedagogy and psychology, as well as selects, refines and develops its most successful methods. Besides, this science proposes and implements new methods more effective and comprehensible for students. Importantly, the article shows how one can update art education by implementing design education and ensuring digitalisation. The main goal of art and design education is to prepare a qualified specialist. This specialist should be capable of gaining cultural experience and applying the latest technologies, including digital tools. This is made possible through the use of neuropedagogical technologies and AI, with attention to the effectiveness of their implementation. Using multimedia technologies and AI plays a key role in updating art education by integrating neuropedagogical technologies. This approach strengthens the visual perception of the learning process. It also brings transformative changes to art education by emphasising the core educational aspects. These changes are guided by the influence of neuropedagogical principles.*

Keywords: *neuropedagogy; education digitalisation; multimedia technologies; design education; intensified learning; artificial intelligence.*

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1. Introduction

Today, students spend a significant amount of time in the digital environment created by various technologies, including artificial intelligence and virtual and augmented reality. Consequently, these aspects should be considered when updating art education by introducing neuropedagogical technologies. The digitalisation of education is driven by the increased efficiency and accessibility of learning through the latest technological tools of today's education, including design education. It also affects and somewhat changes the educational environment and teaching styles.

The informational educational environment has shifted toward multimedia education. This shift influences the modernisation of arts education by introducing neuropedagogical technologies. Multimedia products in an educational environment act as an effective means of visualising educational information when updating artistic education.

Many Ukrainian and foreign scholars have studied the problem in question. Neuroscientific data on the characteristics of human cognitive processes help improve learning and self-learning in academic subjects for children and adults. Such information significantly facilitates knowledge acquisition and increases the number of students who benefit from such pedagogical influences (Abdullah et al., 2021; Lumsden et al., 2016; Sarancha et al., 2022; Sedivy, 2016).

At the same time, the rapid digitalisation of education in the context of modernising art education is prompting many learners to enrol in distance learning courses (Gurevych et al., 2011; Spirin, 2013; Vdovychyn & Iatsyshyn, 2013). As a result, there is a certain shift towards individualisation and popularisation of professional development courses among design teachers.

The digitalisation of the educational environment is rapidly transforming art education in the context of its renewal. The accessibility of distance learning programmes makes it possible to reach a wide and diverse audience of learners. At the same time, this transformation promotes a shift towards individualised learning trajectories. Such trajectories require students to engage in active independent learning and also necessitate continuing professional development, particularly for design educators.

The use of digital platforms, collaborative online projects, cloud services, and network-based forms of interaction creates favourable conditions for effective cooperation. These tools support collaboration both among participants in the educational process and between different educational institutions. They ensure openness in the exchange of experience and educational resources. Moreover, they contribute to improving the quality of learning and supporting the overall modernisation of the arts education system.

This article aims to explore the role of neuropedagogical technologies and AI in updating the education system. This article will scrutinise the modernisation of art education through the integration of design education and educational digitalisation. The article will also discuss how multimedia technologies can be applied to refresh art education using neuropedagogical methods. Additionally, it will explore the potential of incorporating AI into art education, highlighting the main benefits and challenges of this process. Finally, the article will analyse examples of the effective use of AI in creative learning.

2. Theoretical Framework

Today's evolving art education landscape increasingly integrates neuropedagogical approaches with AI tools. This integration provides a way to update educational content and improve teaching methods. Neuropedagogy, informed by advances in cognitive neuroscience, views learning as a process shaped by neuroplasticity, emotional regulation, and motivational reinforcement. These elements are essential for supporting creative activity.

AI technologies are not intended to replace artistic creativity. Instead, they function as cognitive and visual "amplifiers". They reduce cognitive load, stimulate associative thinking, and provide greater opportunities for experimenting with artistic forms. From this perspective, AI assists learners in developing their subjectivity, reflective thinking, and conscious control over the

creative process. This corresponds with the conception of learning as a neurocognitively based, emotionally significant, and personally relevant experience (Wang et al., 2024).

The effectiveness of digitalisation depends on the pedagogical strategies used alongside these technologies. Without attention to learners' cognitive, emotional, and motivational characteristics, digital tools may remain little more than technical additions to traditional instruction. Combining digitalisation with neuropedagogical methods is therefore essential. This method can significantly change the learning environment and improve the quality of the learning process as a whole (García-Peñalvo, 2024).

Ross (2021) establishes a connection between emotions and the limbic system, primarily located beneath the large hemispheres of the brain. The researcher focuses specifically on effects, characterising them as "the fury of the limbic system". Affects continue to be the focus of scientific research and act as a serious factor in behavioural disorganisation. This study makes it particularly important to modernise art education by introducing design education and advancing the digitalisation of the educational environment.

The mission of design education is to prepare a qualified specialist. This specialist should be capable of gaining cultural experience and applying the latest technologies, including digital ones. Design is a special type of activity in today's art education. It implies the wide use of innovative project solutions and the latest digital technologies. It follows that the current level of technological development and digitalisation significantly stimulates the advancement and promotion of design education. This impact is unprecedented.

Today's students spend much of their time in a digital environment formed by various technologies, including AI and virtual and augmented reality. Education digitalisation indeed helps increase the efficiency and accessibility of learning through advanced technological means. Nevertheless, digitalisation is not a solution to all the problems of today's education, including design education. While digitalisation can influence and even alter the educational environment and teaching styles, it is not a panacea (Shyshkina et al., 2012).

Digitalisation has changed the format, organisation, and accessibility of educational materials. Over the past few years, there has been a rapid development of interactive educational platforms, both standalone and based on educational organisations. Design education is increasingly using interactive media resources and digital technologies. The issue of educational digitalisation has become particularly acute during the COVID-19 pandemic and now Russia's war against Ukraine due to the widespread transition to distance learning. Traditional teaching methods turned out to not be "ready" for a sudden and complete transition to the media.

The rapid development of education digitalisation requires a global review and regulation of pedagogical practices. Distance learning programmes have become accessible to a large audience. The developments may also lead to a shift towards learning individualisation and encourage educators, especially design teachers, to engage in continuing professional development. These transformations strengthen the interaction among different educational institutions and ensure the openness of the educational process. Nowadays, students can choose any design specialist from foreign educational institutions as their mentor, working remotely. Thus, education digitalisation expands educational opportunities at different levels (Mykhailychenko, 2005).

Digital technologies contribute to developing innovations and generating new non-standard ideas in design and project activities. Currently, each design project is implemented with the help of digital technologies or is a media product. One can also observe the enormous impact of digitalisation and the integration of innovative technologies in design projects. This influence affects the quality and diversity of products and areas of design application. The "nano art" concept, which represents a synthesis of today's art and science, is actively developing. Most frequently, images from hypersensitive microscopes are taken as their basis, which are subsequently refined on a computer by an artist or designer.

Traditional design activities use computer combinatorics as an effective way to study the form creation process. Using the 3D modelling method, one can create various types of environmental and industrial designs.

New fields of design have emerged, such as motion graphic design, web design and UI/UX design. Today, more and more design projects are leveraging the possibilities of virtual and augmented reality. Recently, digital immersion has probably become the main trend in education and art. The COVID-19 pandemic, as well as Russia's ongoing war against Ukraine, has made the interaction between the culture and education sectors and digital technologies ever more relevant. World museums and art galleries are hosting virtual tours of their halls, storage rooms and studios. Owing to digital technologies, audiences for various discussion clubs and schools have significantly expanded. Such programmes are most often supported at the state level (Hotko & Chaikovska, 2015).

Thus, digitalisation expands access to educational content. It also supports museums, theatres, and other venues, which is particularly important under current circumstances.

Digital technologies significantly contribute to design art, as one can observe the rapid development of this field today. This development culminates in the creation of artistic works in digital formats, particularly through software art, fractal and photorealistic rendering, and VR/AR technologies. At the same time, a visualisation using digital technologies allows the designer to construct a virtual space. It also enables the creation of media products, models, and other syntheses of forms and formats that change parameters. Essentially, this process has no limitations for creative exploration. In this regard, digital technologies are perceived as more of a tool for visualising designer content.

The designer's role in project activities, as well as in the creative process as a whole, is being reconsidered. VR/AR designers and artists today work at the intersection of the material and virtual worlds. Augmented reality becomes more accessible for designers and users. In turn, traditional printed products are not as popular and innovative as they used to be.

However, interactive printed products are much more attractive for designers. The QR code can contain a tremendous amount of information, and when the camera is pointed at it, a virtual gallery can open, bringing exhibits to life and more. Multimedia guides have become the most common element of museum exhibitions. With the help of an application and a smartphone, visitors can receive information about an object or an audio lecture. Thus, designers can arrange the exhibition space differently, making it more accessible and convenient for educational or informational purposes.

It follows that the advantages of digital technologies are the following: a) the possibility of providing more information using minimal space; b) a non-standard method of presenting textual and visual information; c) high user engagement and better memorability of information; and d) the lack of content limitations.

However, these technologies have certain disadvantages: a) the high cost of technology and limited mass adoption; b) technical limitations and the time required to prepare necessary materials, which include creating space for visualisation as well as the work of designers and other experts in developing augmented or virtual reality and providing support during its use; and c) the requirement for users to download special applications and acquire additional equipment (Bazeliuk, 2013).

Innovations have also impacted the educational process. Much emphasis is placed on pedagogical design, which belongs to instructional design or learning experience design. Educational environment designers should demonstrate, first and foremost, design thinking. They should also be able to visualise information, as they deal with the methodology and the development of educational courses and programmes. Such activity requires skills in integrating design and pedagogy, creative and systematic thinking, and the ability to analyse information and convey it to the user.

Pedagogical design is one of the ways to develop educational resources aimed at enhancing learning quality. The digital development of multimedia integrative educational tools will help one

adapt to technological changes and transformations in the labour market. At the same time, it preserves and improves the educational space. This method of optimising educational programmes is extremely useful for design education, as it promotes the rapid updating of learning materials and stimulates spatial thinking among students.

Global digitalisation inevitably affects all areas of human activity. Design education includes science, technology, art and culture. The peculiarities of design thinking enable successful adaptation of educational programmes to new realities through the promotion of pedagogical design. Digital technologies have occupied a significant niche as tools for creating educational resources, visualising learning materials and implementing distance or blended learning.

The development of these technologies and their integration into the educational environment enhance the quality of the educational process. They broaden its possibilities, particularly in the area of design projects. At the same time, the use of multimedia technologies to modernise art education through neuropedagogical approaches not only improves the visualisation and intensification of learning but also fundamentally transforms it by emphasising the main areas of the educational environment. These aspects might include imagining the constructive elements of an object during art lessons, showing it from a different perspective, or using a different colour scheme. Multimedia technologies are indispensable in cases when one cannot demonstrate numerous physical processes in real conditions, illustrate sequential actions during experiments, or visually show imperceptible processes. Such activities result in forming cognitive ways of mastering educational material, as well as understanding its associative and semantic connections, interactions, and processes (Bykov, 2011).

Multimedia is increasingly becoming a trend in the information educational environment. However, multimedia products are more than just an effective means of visualising educational information. They constitute a technology with the following features: a) multimedia didactics, which includes pedagogical design and integrative and interactive processes; b) visualisation of the most essential and complex learning material; c) a harmonious colour scheme, composition, and design for the illustrative part; d) high-quality sound recording; and e) synchronisation of video and sound.

These features make multimedia technologies rather effective. Furthermore, multimedia technologies demonstrate flexibility, interactivity and integration with various types of information.

Compared to traditional educational tools, multimedia technologies are characterised by a) colour graphics and various types of computer graphics; b) animation and compositing (both individual elements and the entire product); c) sound accompaniment (speech, music, individual sound effects); d) hypertext and hyperlinks; e) a continuous updating of information; f) interactivity (quizzes); and g) non-linearity in learning materials (hyperlinks).

A package of integrated components and animated image management ensures the effective acquisition of educational material. It also includes support for a unified working mode, the import of files with multimedia objects, and the broadcasting of slides in online mode (Voronkin, 2015).

Graphic editors assist teachers in creating animated products with simple tools or templates and in overlaying them with sound effects. Simple animations and interactive content are created using tools such as PowerPoint, Photoshop, Adobe After Effects, and Animate CC. Additionally, the visual presentation of information through multimedia is becoming a standard for computer systems. Software tools have shifted from a text-based standard (DOS for IBM PC-type machines) towards a visual one (Windows for IBM PCs). Multimedia technologies significantly contribute to self-learning. Outside classroom hours, students can access a multimedia product on a computer or portable device to acquire additional educational information and independently identify answers to questions in a test mode. It follows that the online environment offers numerous opportunities to enrol in free courses or watch individual webinars on relevant topics (Vdovychyn & Iatsyshyn, 2013).

Multimedia resources help students concentrate, understand, interpret and remember educational information better. Consequently, students gradually develop visual-spatial and abstract

thinking skills, as well as the ability to self-assess when solving tasks. Most importantly, they acquire skills in working with multimedia technologies. However, there are also some negative aspects for those learning to use these technologies for educational purposes. Despite being accessible, visually appealing, and diverse in their presentation of educational material, students sometimes neglect to use this technology for their learning.

Students most frequently use portable gadgets and computers for entertainment, not for educational purposes. The developers of these resources should consider components of students' cognitive activity, such as their ability to concentrate. In this regard, resources should contain an optimal amount of educational material. Also, it is important to nurture interactivity in the interaction between the teacher and the student, creating an active virtual educational environment for obtaining new knowledge. Multimedia resources should be concise, with optimal colour solutions that contribute to perception by forming a colourful and voluminous image of the object under study. Theoretical information should be divided into small blocks of video or animation and provided in a clip format, not exceeding 4-5 minutes in length. Subsequently, it is recommended to offer students to take an interactive test or perform a task to maintain their attention. As an entertainment effect, one can use an animated character as a guide to the stages of mastering the material. Alternatively, a small gaming element can be introduced, to which the student can return after viewing new material or completing a task (Mihara & Higuchi, 2017).

When creating multi-layered content using various multimedia options, it is crucial to follow the style of the product. This style should inform all types of graphics, video materials, and animated elements.

Visual material should account for approximately 60% of the entire video content. About 30% is allocated to animated segments, while 10% is allocated to text content, which can also be presented dynamically without losing functionality and readability. At the same time, the colour scheme should be harmonious but dependent on the style and concept of the multimedia product. Regarding the sound, it is recommended that one focuses on its synchronisation with the video content. Following these requirements, the multimedia product, as a means of visualising educational information, is expected to boost students' motivation to learn. It will also increase their cognitive interest in the topic under study and develop their logical thinking and creativity skills.

The conclusions obtained from theoretical research and practical work prove that the knowledge acquired through multimedia technologies improves students' general cultural and educational skills in working with various types of visual educational information. Using multimedia as a way of visualising educational information allows for the diversification of the educational process, which makes it more flexible and effective.

For example, such platforms as DALL·E, Runway ML, and Adobe Firefly allow students to create images, animations, or videos from text descriptions. These tools spark creativity and enable students to explore visual styles, composition techniques, and colour theory in an interactive format. As suggested by Holmes et al. (2019), this approach encourages students to experiment and obtain instant feedback.

Many AI tools are designed to generate compositions of various styles. These include AIVA, Amper Music, and Google Magenta. From an educational perspective, they enable students to study different genres of music, create their own tracks, and further understand the essence of compositional logic.

Emphasis should also be placed on text generation systems, such as ChatGPT, which can be effectively used to develop music projects, analyse artwork, and even write scripts. These tools can engage in dialogue, correct writing styles, and offer creative solutions, significantly enhancing learning in theatre and literary studies (Luckin et al., 2016).

Furthermore, students can study the history of art within VR and AR environments, such as Artivive or Tilt Brush platforms. When combined with specific AI components, these environments can recreate the atmosphere of famous museums and art galleries or create digital design displays.

In the context of art education, AI tools expand and reinforce the potential of traditional teaching methods, rather than replace them. Therefore, it is crucial to implement the positive aspects of such experiences in educational programmes. In doing so, one can effectively develop students' artistic thinking and prepare them for the innovations of the digital world.

3. Research Methodology for Examining how AI Tools Affect the Development of Students' Creative Abilities

The research aims to examine the impact of artificial intelligence (AI) tools, such as ChatGPT, DALL·E, Copilot, and Canva AI, on the development of students' creative abilities in the learning process. It is also important to gather students' opinions on the integration of AI tools into the creative process.

The framework of mixed methods, specifically quantitative and qualitative ones, guides this research. The quantitative stage lies in an online survey using Google Forms. At the same time, the qualitative stage involves semi-structured interviews, which allow a more profound understanding of the obtained results and facilitate the validation of generalisations. This design allows measuring overall trends while also analysing individual student experiences.

Sampling Strategy

Sampling type: purposive sampling

Number of respondents: 120

Target group: students in years 2-4 of humanities programmes

Age range: 18-25 years

Geographical coverage: Ukraine (Kyiv, Lviv, Kharkiv, and Dnipro)

Voluntary participation: all participants took part voluntarily, in accordance with principles of anonymity and research ethics.

For quantitative data collection, an online questionnaire was created, containing 20 questions of three types: 12 Likert-scale statements (from 1–"strongly disagree" to 5–"strongly agree"), 5 open-ended questions about personal experiences with AI, and 3 socio-demographic questions (age, programme, and frequency of AI use).

Examples of Likert-scale statements are as follows:

- Using AI helped me generate creative ideas more quickly.
- AI tools enhanced the quality of my assignments.
- AI increased my confidence in my own creative abilities.
- Using AI encouraged me to combine knowledge from different disciplines.
- AI does not replace human creativity but helps to develop it.

Examples of open-ended questions are as follows:

- To what extent have AI tools changed your approach to creating projects?
- Can you specify moments when AI restricted your artistic expression?
- Could you describe the advantages of problems you faced when implementing AI tools into learning?

For the qualitative stage, 10 semi-structured interviews were conducted with students who actively used AI tools in their studies.

Examples of interview questions are as follows:

- How would you describe your experience interacting with AI in creative tasks?
- Which AI tools were most effective for you?

- Has using AI affected your independence in learning?
- How would you describe the balance between AI assistance and your creativity?
- What recommendations would you offer to educators regarding the use of AI in the learning process?

Analysis Method

The interview's data was converted to text and thematically analysed. The main themes included the following: 1) a boost in learning efficacy, 2) the development of new inspirational channels, 3) the possibility of students becoming unmotivated, and 4) the need to cultivate critical thinking skills when interacting with AI tools.

Over the course of one month, students completed creative learning tasks using AI, including creating texts, illustrations, and presentations. Once the course concluded, respondents completed an online survey to assess the effectiveness of AI tools. After the quantitative analysis, 10 students were selected for interviews to elucidate the findings.

Finally, the research complied with ethical standards, such as voluntary involvement, the non-disclosure of identities, the confidentiality of feedback, and the exclusive use of information for academic inquiry.

4. Discussion

Figure 1 shows that 92% of respondents (n = 120) reported using at least one AI tool, such as ChatGPT, DALL·E, Copilot, or Canva AI, when completing creative learning tasks.

Seventy-eight per cent of respondents indicated that AI had enhanced the quality of their creative work. They also noted that AI tools encouraged interdisciplinary thinking, combining text and images, while critical thinking remained fully intact.

In addition, 67% of students emphasised that AI did not replace their ideas. Instead, it serves as a tool that helps them organise and structure their thoughts more effectively.

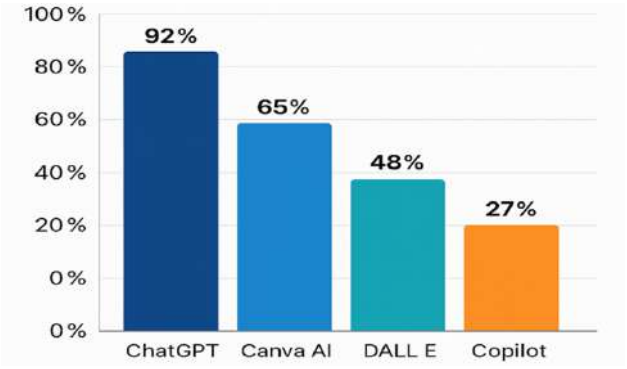

Figure 1. The effectiveness of using artificial intelligence in creative learning
Source: the authors' own conception

The obtained results reflect students' subjective perceptions of their creative abilities when using AI tools. Most respondents reported that AI seemed to enhance their capacity to generate creative ideas. They also experienced a quicker transition from concept to implementation and greater confidence in their own creative potential. In this context, the integration of AI into the learning process should not be considered a direct driver of creativity. Rather, it serves as a stimulant for the students' creative process. This approach positively influences their motivation, self-reflection, and interdisciplinary thinking.

These findings align with international research (García-Peñalvo, 2024; Wang et al., 2024). Previous studies highlight that generative AI in education primarily encourages students to rethink their role in creative activity, rather than automatically improving the quality of their work.

However, the use of AI in art education involves several risks. One of these is the mismatch that can occur between the prompt and the generated result. Often, AI cannot produce genuinely new ideas and lacks a distinctive creative style because it relies on generalising existing illustrative information. Additionally, the images it generates usually require further correction and refinement. Copyright is another significant concern. AI-generated images are created from publicly available image databases, and an inadequately formulated text prompt can result in unintended or unexpected outcomes. These challenges highlight the importance of pedagogical guidance. Students need to be taught how to integrate AI technologies into the creative process in a way that is both effective and responsible.

5. Conclusions

Neuropaedagogy fundamentally affects the application of artificial intelligence (AI) in educational settings. Unlike traditional technical methods, neuropaedagogy considers students' cognitive characteristics, particularly the dominance of cognitive strategies in either the left or right hemisphere of the brain. This method makes it possible to adjust AI-driven methods of teaching to one's particular learning style.

At the same time, one can observe neuropedagogical links between the human brain and technologies that do not allow AI tools to be used only mechanically. They, however, ensure their effective integration into the cognitive process and cultivate creativity. Based on experimental data and neuropsychological principles, a three-component model has been proposed: 1) *the cognitive-neural component* (it adapts learning tasks to students' thinking patterns using AI prompts tailored to their information-processing style (analytical or visual)); 2) *the emotional-creative component* (it employs AI tools to visualise the emotional aspects of ideas through images, colours, and music, fostering empathy, aesthetic sensitivity, and associative thinking); and 3) *the metacognitive component* (it develops students' skills for conscious interaction with AI, enabling them to analyse, verify, and ethically evaluate the results produced by the technology).

The findings indicate that digitalisation informed by neuroscience in technical education enhances personalised learning by accounting for cognitive individualisation. It also cultivates new mechanisms of technical thinking, including synthesis, integration, and image analysis, and transforms AI from a simple automation tool into an instrument of cognitive augmentation. In this regard, critical thinking is fostered, and new formats of digital art (e.g., nano-art) emerge. Thus, AI tools serve as direct agents in the creative process.

AI becomes a true tool for innovation in art education only when integrated into a neuropedagogical model that accounts for individual lateralised thinking, stimulates emotional and sensory perception, and fosters a conscious symbiosis between humans and technology. This interaction, namely, "AI + human intelligence + emotional creativity", offers a new model for technical education in the 21st century.

Statement on the Use of Artificial Intelligence

The authors confirm that artificial intelligence (ChatGPT, OpenAI) was used to enhance language clarity and readability, as well as to assist with online research. The final interpretation of the results, formulation of conclusions, and scientific generalisations were performed entirely by the authors.

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