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Araştırma Makalesi
Research Article

A literature review on artificial intelligence in art education and interactive learning in education

Sanat eğitiminde yapay zekâ ve eğitimde etkileşimli öğrenme üzerine bir literatür incelemesi

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Abstract: Artificial intelligence, defined by Max Tegmark as 'non-biological intelligence', stems from an understanding of human mental capacity and curiosity about this capacity. Artificial intelligence has found its place in many fields today, such as medicine, tourism, finance, and education. Art also adapts to the current conditions of the era in which it exists. In particular, artificial intelligence technology has transformed the art environment, its materials, and even its nature. This research aims to fill a gap in the literature on integrating artificial intelligence tools into art education. The scope of the research consists of domestic and international studies on the integration of artificial intelligence into education. The case study method from qualitative research methods was used for the study. Document analysis was used to examine the data. Based on the findings, domestic and international reports and applications were examined, and it was concluded that a separate curriculum is needed to integrate traditional education and AI-supported education. Although the integration of artificial intelligence into education offers many advantages, such as the ability to instantly transform any place into a workshop through a virtual environment and to provide feedback to students when the teacher cannot keep up, the disadvantages it brings should not be overlooked. For example, due to the lack of technological infrastructure in our country, educational inequality is an inevitable problem. Although artificial intelligence provides students with quick results, if the information it presents is not filtered through a certain sieve, it can lead to information pollution. In addition, a helpful guide is needed on the difficulties teachers and students will encounter during the implementation phase. In conclusion, it is impossible to ignore the technological developments of our age in education, and it is necessary for the Ministry of National Education and schools to collaborate, considering the adaptability of artificial intelligence technology to education.

Keywords: Art education, artificial intelligence, art education and AI, AI-supported education

Özet: Max Tegmark'ın 'biyolojik olmayan zekâ' olarak tanımladığı yapay zekâ, insanın zihinsel kapasitesini anlama ve bu kapasiteye duyulan meraktan doğmuştur. Yapay zekâ, günümüzde tıp, turizm, finans, eğitim vb. birçok alanda kendine yer edinmiştir. Sanat da içinde bulunduğu çağın mevcut koşullarına göre uyum sağlamaktadır. Özellikle yapay zekâ teknolojisiyle sanat ortamı, malzemesi hatta niteliğinde dahi değişimler meydana gelmiştir. Bu araştırmanın amacı yapay zekâ araçlarının sanat eğitiminde nasıl entegre edebileceğine yönelik literatürdeki eksikliği doldurmaktır. Araştırmanın kapsamı yapay zekânın eğitime entegre edilmesi adına yurtiçi ve yurt dışındaki çalışmalardan oluşmaktadır. Çalışma için nitel araştırma yöntemlerinden durum deseni kullanılmıştır. Verilerin incelenmesinde doküman analizi kullanılmıştır. Elde edilen bulgular doğrultusunda yurtiçi ve yurtdışındaki rapor ve uygulamalar incelenmiş, geleneksel eğitim ile yapay zekâ destekli eğitimin bir arada kullanılabilmesi için başlı başına bir müfredata ihtiyaç olduğu sonucuna varılmıştır. Yapay zekânın eğitime entegre edilmesinde sanal ortam sayesinde her yeri anında atölyeye dönüştürme imkânı, öğretmenin yetişemediği yerde öğrenciye geri dönüt verebilmesi gibi birçok avantajlar sağlasa da beraberinde getirdiği dezavantajlar da göz ardı edilmemelidir. Örneğin ülkemizdeki teknolojik altyapı yetersizliğinden dolayı eğitimde fırsat eşitsizliği kaçınılmaz bir problemdir. Yapay zekânın öğrenciye hızlı sonuçlar sunsa da karşısına çıkardığı bilgiler belli bir süzgeçten geçirilmezse bilgi kirliliğine maruz kalınabilir. Ayrıca öğretmen ve öğrencilerin kullanım aşamasında yaşayacağı zorluklar açısından da yardımcı bir kılavuz gerekmektedir. Sonuç olarak çağın teknolojik gelişmeleri göz ardı edilerek eğitim verme gibi bir durumdan söz edilemeyeceği gibi yapay zekâ teknolojisinin de eğitime uyarlanabilirliği düşünülerek Millî Eğitim Bakanlığı ve okullar arasında iş birliği çalışması yapılması gerektiği düşünülmektedir.

Anahtar Kelimeler: Sanat eğitimi, yapay zekâ, sanat eğitimi ve yapay zekâ, yapay zekâ destekli eğitim

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Extended Abstract

Although we use the concepts of art and technology as separate today, in ancient Greece, the same term was used for both: techne. Aristotle defined techne as 'the equipment to produce in accordance with the right rules' (Lenoir, 2002), revealing that art and technology are not distant concepts. This interplay continued through history, evident in how the camera became a tool for Impressionists to capture fleeting images after the Industrial Revolution. The modern concept of artificial intelligence (AI), which Max Tegmark defines as "non-biological intelligence," emerged from Alan Turing's foundational question, 'Can machines think?' and the human desire to understand our own mental capacity. From the 1950s to the present, AI has evolved from a theoretical field into a transformative force, securing a place in fields ranging from medicine and finance to tourism and education. Consequently, art, which constantly adapts to its era's conditions, is experiencing significant changes in its environment, materials, and quality due to AI technology. This research aims to fill a specific gap in literature by examining how AI tools can be integrated into art education and reviewing existing applications. As a qualitative study, it employs a case study design and a document analysis method, drawing on written and digital sources from national and international contexts. The study first traces AI's historical development, explaining its core components like algorithms, datasets, and neural networks. It then explores AI's manifestation in art through figures like Harold Cohen and his AARON program, and Simon Colton's Painting Fool, contextualizing them within philosophical debates on creativity (e.g., López de Mántaras & Boden). Examples of human-machine collaboration, from the first robot artist AIDA to contemporary creators like Memo Akten and Refik Anadol, are analyzed, highlighting how this partnership depends on a teacher-learner dynamic and requires the artist to develop AI literacy. In the section focused on education -the research's main topic- the review covers early AI applications like Pressey's teaching machine and Skinner's projects, leading to modern European reports and the integration of computer science into curricula. A key finding is that successfully integrating AI into classrooms places a significant burden on teachers, who must first achieve AI literacy themselves to guide students effectively. This underscores the need for comprehensive teacher guides and support systems, as highlighted in reports from UNESCO and Turkey's Ministry of National Education.

Art education, which aims to support students' intellectual, emotional, and social development, is poised for a revolution driven by AI. The potential for personalized learning experiences can boost creativity, develop artistic skills, and foster new perspectives. The study examines specific AI applications, such as GauGAN, Midjourney, and DALL-E. It discusses Generative Adversarial Networks (GANs) as tools for students to explore different styles and break from traditional painting paradigms, ultimately fostering critical thinking and original work. The findings, based on an examination of domestic and international reports, conclude that a dedicated curriculum is necessary to blend traditional and AI-supported education harmoniously. Key advantages include the ability to create virtual workshops, provide instant feedback, make limited class time more productive, and offer portable, ergonomic tools that make learning experiential and lasting. However, significant disadvantages were also identified: technological infrastructure gaps can exacerbate educational inequality; unfiltered AI outputs risk misinformation; over-reliance on technology may lead to eye strain, reduced socialization, and diminished student self-confidence; and teacher resistance or poor adaptation pose further challenges. In conclusion, just as it is impossible to ignore technological advancements in education, this research affirms that collaboration with AI is essential. It is recommended that a cooperative framework be established between the Ministry of National Education and schools to integrate AI responsibly, leveraging its benefits while proactively addressing its risks, thereby creating a more adaptive and effective art education ecosystem.

Introduction

Although the concepts of art and technology are used with different meanings today, in Ancient Greece, the same term, techne, was used for both. Aristotle defines techne as "equipment for production in accordance with the correct rules" (Lenoir, 2002). From this, we can conclude that art and technology are not actually very distant concepts. For example,

following the Industrial Revolution, cameras were most useful to the Impressionists in capturing snapshots of nature. The concept of artificial intelligence emerged from Alan Turing's question, "Can machines think?" Artificial intelligence is a field of study that aims to understand and emulate human cognitive processes. Over the past few years, from the 1950s to the present, artificial intelligence has found its place in every area of our lives, particularly following the significant developments it underwent in 1990. One of the areas mentioned is education. As the first example of the integration of artificial intelligence in education, we can mention the inclusion of computer science courses in school curricula and the establishment of computer laboratories. Many applications and guidelines have been prepared abroad, and the Ministry of National Education has recently published a report in our country. However, it is still not possible to say that artificial intelligence has been fully integrated into lessons today. It offers many advantages for teachers and students in terms of lesson efficiency, especially in art education. In addition to personalized education plans, it teaches students to view things from different perspectives during the application process. Of course, it is necessary not to ignore the disadvantages as well as these advantages.

Research Objective

The purpose of the research is to fill a gap in the literature on integrating artificial intelligence tools into art education. Within the scope of the subject, it aims to analyze what applications and reports have been made domestically and internationally, which artificial intelligence programs can be used in the classroom environment, evaluate their advantages and disadvantages, analyze the problems that students and teachers may encounter in this process and discuss possible solutions, and address the ethical issues and violations that may arise during the use of artificial intelligence programs. Thus, it is intended to serve as a guide for researchers who wish to conduct future applications related to this topic.

Method

The case study method, a qualitative research method, was used in the research. A case study is a research method used when a current phenomenon is being studied within its own context, its boundaries are unclear, and there are multiple data sources (Yıldırım & Şimşek, 2008). According to Davey (1991), a case study involves the in-depth examination of a phenomenon, the gradual collection of data, and the explanation of the phenomenon's cause using the data obtained, along with an indication of what should be considered in future studies related to that phenomenon (Subaşı & Okumuş, 2017). The contributions and drawbacks of artificial intelligence programs to art education were investigated, and future steps were explored following an examination of domestic and international applications.

Data Collection Tools and Analysis

In this study, document analysis was used as a qualitative data collection tool. Document analysis is the systematic examination of written texts, such as books, articles, and reports, to obtain information about the research phenomenon. Furthermore, document analysis provides researchers with greater convenience in terms of time. Thus, data can be obtained through document analysis without the need for interviews and observations (Yıldırım & Şimşek, 2008; Karataş, 2015). The document analysis method was used to analyze the findings obtained within the scope of the research. Previously, document analysis was only used by librarians, historians, and disciplines such as anthropology. However, compared to costly analysis methods used in social sciences, such as surveys, interviews, and observations, document analysis is more economical. For this reason, document analysis has been frequently used in the social sciences in recent years. It involves collecting and examining existing printed or digital documents on the subject and then analyzing them through questioning. In addition to written documents, diagrams or graphs related to the subject are also used in document analysis (Sak et al., 2021).

Findings

Artificial Intelligence

According to Klaus Schwab and Richard Samans (2016), the Fourth Industrial Revolution, known as Industry 4.0, represents the most dynamic wave of change in human history. The Industrial Revolution has transformed from a period initially centered on steam power to an era led by information and communication technologies (Taluğ, 2023). Artificial intelligence, defined by Max Tegmark as "non-biological intelligence," was born out of an understanding of human mental capacity and a curiosity about it. Artificial intelligence is a system that can mimic human mental activities using mathematical and logical algorithms. The first studies on artificial intelligence began after World War II and have accelerated over the last 10-15 years. Studies in this field are being conducted in technologically advanced countries such as the United States and China. Artificial intelligence can be divided into three groups. The first, and the one we are currently experiencing, is limited artificial intelligence, which performs a defined task within its system. General artificial intelligence is a type of intelligence that can make new decisions based on what it has learned previously and has characteristics identical to human intelligence. The last type is artificial intelligence that reminds us of science fiction and is more advanced than human intelligence (Arslan, 2019). One of the main elements that constitute artificial intelligence is machine learning. Machine learning is a subset of artificial intelligence. Thanks to the mathematical and logical algorithms it contains, it can learn as it produces data and solve problems. Thanks to algorithms, machines can perform actions such as moving, finding directions, and making decisions. Machine learning algorithms encode texts numerically as 1 or 0 using a model called a word bag. Deep learning, a subfield of machine learning, involves a development process that progresses from simple to complex (Eser, 2024). In this process, artificial intelligence neural networks, inspired by the human nervous system, support deep learning. Thanks to artificial neural networks, it is possible to process, identify, and understand large amounts of data quickly and produce visual texts and videos (Sivri, 2024). For artificial intelligence to create a structure, whether visual or auditory, it needs a dataset and a database.

Figure 1. The chess match between chess grandmaster Gary Kasparov and the Deep Blue program developed by IBM

Alan Turing first introduced the concept of artificial intelligence in his 1950 paper "Computing Machinery and Intelligence," which explored whether machines could think. The concept was formally introduced in 1956 by John McCarthy at the Dortmund conference, where several scientists gathered. The first work on the concept was included

in the research of Warren S. McCulloch and Walter Pitts on the mathematical processing of neurons in the human brain. In the ongoing process, experts working at the Massachusetts Institute of Technology (MIT) laboratory officially implemented the concept of artificial intelligence. In this laboratory, Josep Weizenbaum developed a language-processing program called ELIZA in the mid-1960s. This program can mimic human speech using simple pattern matching and substitution methods. This program is the first example of today's intelligent assistants. Another important development was Deep Blue, the first artificial intelligence program capable of playing chess, produced by the renowned computer manufacturer International Business Machines (IBM). After each tournament Deep Blue participated in, its database was developed, and an upgraded version was produced. In its final version in 1996, it won its first significant victory over chess master Gary Kasparov (Figure 1).

The major leap in artificial intelligence occurred in the 1990s, followed by an increase in commercial applications in the 2000s. Generative Adversarial Networks (GAN), developed by Ian Goodfellow, are the first deep learning models capable of generating images. Google has made two significant contributions to artificial intelligence. The first is the development of a neural network program called DeepDream by a team at Google, using a dataset containing over 10,000 images. This program detects patterns in uploaded photos, exaggerates them, and produces hallucinatory-like images. The second contribution, DeepMind, can play computer games better than humans through its own moves, without external intervention, using deep learning. Today, OpenAI introduced a model called Generative Pre-trained Transformer (GPT-3) for developing text-generation technology. Unlike others, this model provides more consistent responses to natural language commands. OpenAI Following this new step, OpenAI released Contrastive Language-Image Pre-training (CLIP) (Radford et al., 2021). This model was trained on more than 400 million text-image pairs found on the internet. OpenAI released DALL-E, a model that generates high-resolution images from text descriptions, by developing a version that incorporates some of GPT-3's features. Text-to-image systems like DALL-E generate a series of images depicting the scene described in the text within a few seconds. The United States, which can be said to be an expert or specializing in the field of robotics, has created a robot with emotional intelligence almost close to that of a human being with its project named 'Atlas'. Following that, Russia's 'Ameca', announced to the world in 2021, has been called the robot closest to humans, with emotional intelligence, language skills, and physical abilities.

Artificial Intelligence and Art

In every era, innovations in many fields, including art, transform themselves to suit that era. Along with these innovations, art has changed form, material, and subject matter. The machine was first addressed as a subject in art by futurist artists. According to futurists, the machine itself creates the work of art. In addition to the new approaches artificial intelligence has brought to the production process in art, changes have also occurred in the consumption and interpretation of artworks. With advances in artificial intelligence, changes are taking place in the art environment, its materials, and even its nature. Not only the resulting product but also the viewer's perception of art is changing. Brushes and paints are now giving way to new forms of expression, such as artificial intelligence tools. Artists are embracing the possibilities offered by artificial intelligence and discovering innovative approaches in their work. These contributions, ranging from new color palettes and composition suggestions to inspiring and iterative formal processes, make artificial intelligence a turning point for the visual arts (Hutson & Cotroneo, 2023). In addition, machines and artificial intelligence offer practical opportunities for artists.

Contrary to popular belief, the machine is not in a creative position in the aforementioned creative process. In fact, the machine acts as an assistant partner in the artist's production process. The partnership between machine and human during production is based on a teaching-learning dyad, and the result is a digital manipulation. To achieve this collaborative balance, artists need to develop themselves and become literate in artificial intelligence.

Artificial intelligence saves artists time when brainstorming and is also ergonomically sound. Mark Coeckelbergh offers a conceptual framework for the philosophical debate on whether machines can create art and poses three critical questions: What is 'creation'? What is 'art'? Moreover, what does it mean for a machine to 'create art'? Coeckelbergh approaches creativity as an unstable and subjective phenomenon; he argues that the clear distinction between human and non-human art production is artificial. He argues that this duality should be replaced with a more collaborative understanding that positions technology as a partner in the creative process (Hutson & Cotroneo, 2023). Ramon Lopez de Mantaras (2017) argues that artificial intelligence should be seen not only as an auxiliary tool in the artistic process but also as an autonomous creative tool. According to Mantaras, this field, which he calls computational creativity, is the effort to develop software that can paint, compose music, write poetry, in short, exhibit human-like creativity. In fact, the fundamental goal here is still to understand human creativity, but also to create programs that actively contribute to the production process, going beyond mere tools for the user. However, although artificial intelligence can perform these functions to a certain extent, it is currently far from possessing the cultural context and depth of human intelligence. Unlike Mantaras, Margaret A. Boden (2004) classifies creativity into three different categories. The first of these, combinational creativity, is the production of a new and original result by combining two previously existing concepts or elements.

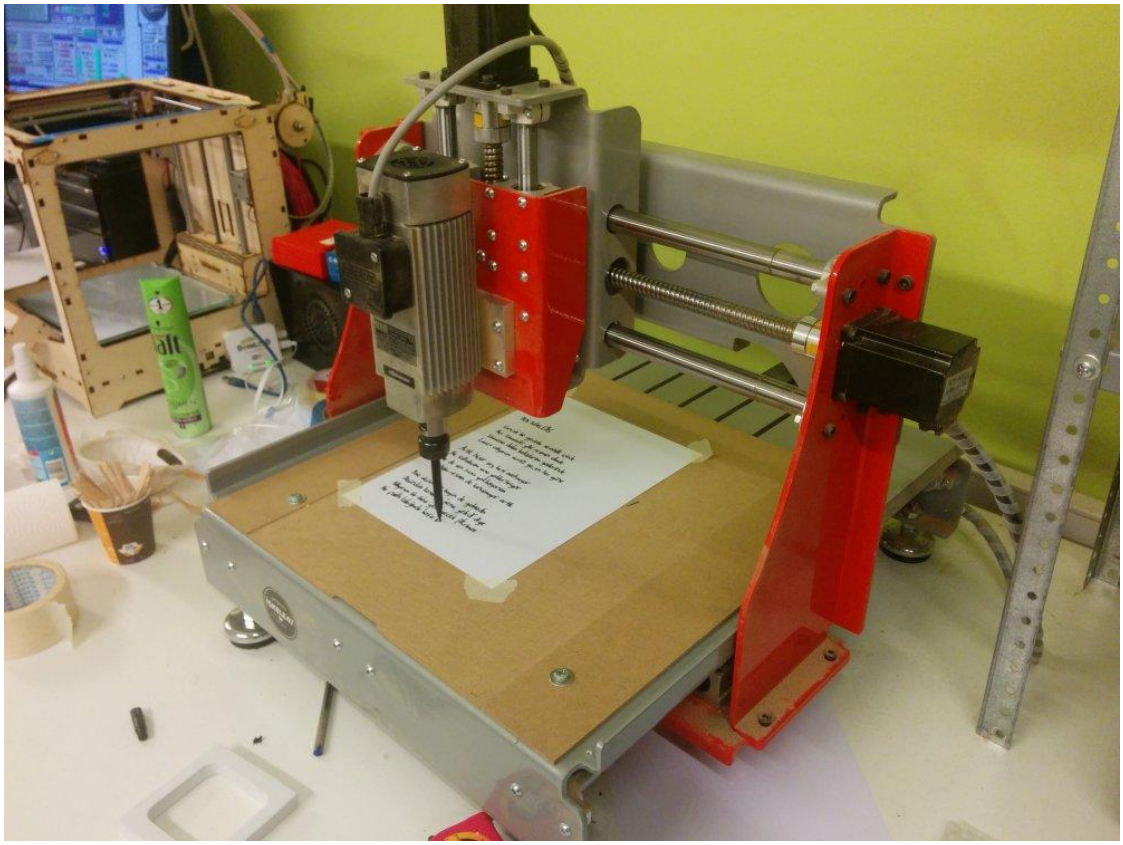

Figure 2. Deniz Yılmaz, the robot poet developed by Bager Akbay, 2015

In other words, this type of creativity synthesizes existing ideas in unusual ways to produce new combinations. Algorithms capable of writing poetry and prose frequently use this type of creativity in their systems. One of the best examples of this is the robot poet named Deniz Yılmaz, developed by Bager Akbay (Figure 2). This artificial intelligence produces its own poems based on 12,000 poems in its database and syllable count.

The second is exploratory creativity. This type of creativity involves pushing the boundaries of conceptual fields to create new works. What Boden defines as the conceptual field is one of the important factors in the formation of creativity: rules, styles, and thought patterns. For

creativity to develop, these conceptual fields need to be explored and transformed. In other words, it involves generating new ideas by looking at a familiar way of thinking from a previously unexplored angle. AARON, a program developed by Harold Cohen in 1970 that can create abstract works using real paint and brushes, is an example of exploratory creativity (Figure 3). Initially, AARON could only produce complex black-and-white abstract drawings, but later, more images were added, enabling it to draw humans and animals. In its 1990 version, a realistic drawing infrastructure for color and interior spaces was developed. In its latest version, the ability to produce more colorful drawings than in the first version has increased the impact of abstract works.

Figure 3. Aaron software developed by Harold Cohen, 1970

The Painting Fool, developed by Simon Colton, uses an emotion-recognition program to detect emotions on human faces and generate abstract paintings (Figure 4). For example, if the person in the photo is happy, it uses more vibrant colors, while if the person is sad, it uses more muted and pastel tones.

Boden's final type of creativity, transformational creativity, involves the artist completely changing the conceptual space in their mind, i.e., their way of thinking, to produce a new form of expression. In artificial intelligence, this involves changing previously used techniques to produce unusual images. An example of this is Google's Deep Dream program. Deep Dream uses algorithmic pareidolia to detect patterns in photos uploaded to the system, exaggerates them, and produces hallucination-like images. Several of these applications are also found in text-based applications such as Midjourney and Dall-E. One of the most significant developments in art and digital technology in 2019 was the robot artist Aida, who created paintings and sculptures from real materials and became the first robot artist to open a solo exhibition.

Artificial intelligence learns the rules of the works it analyzes as it generates images. Therefore, its ability to reflect human-like emotional depth or metaphorical thinking in the intended image is weak. However, the view that artificial intelligence will eliminate certain professions due to its ability to perform and replicate given tasks quickly persists. Regarding this issue, some artists view artificial intelligence applications negatively because they diminish art's sublime value and increase its accessibility to the masses. Other artists,

however, see this situation as a new quest, an experience, and a tool that will help them during this period (Bastaban, 2024). One example of this helpful tool is Paul Tresset, who produces through human-machine collaboration. Tresset is a drawing program called PAUL that mimics hand-eye coordination like humans (Figure 5). According to Tresset, PAUL's work is good because it can well characterize human drawing (Romic, 2021). An example from our country is Refik Anadol. Refik Anadol produces his work using Generative Adversarial Network (GAN) technology. A Generative Adversarial Network (GAN) consists of two networks: a generator (a data-producing component) that aims to create realistic images, and a discriminator that distinguishes between authentic and generated images. The task of the Generative Adversarial Network (GAN) is to produce realistic data at a level that can fool the discriminator.

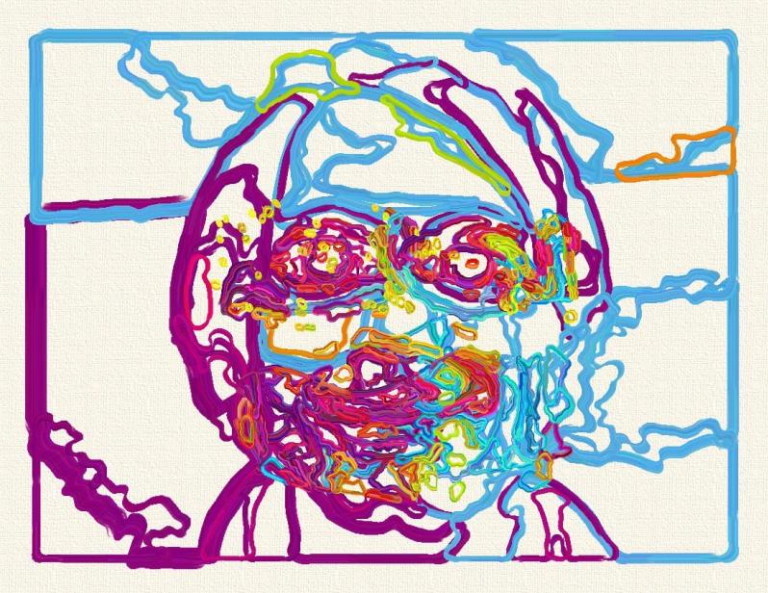

Figure 4. Simon Colton, The Painting Fool-Emotionally Aware Portraiture, 2007

Figure 5. Paul Tresset, Six Robots Named Paul, 2012

Artist Mario Klingemann uses neural networks and machine learning techniques to create both visual and conceptual works. In her project titled 'Eunoia', Lisa Park uses brain waves generated by her own emotional state, recorded via an EEG device (a device used to record electrical activity in the brain), to produce artistic Works (Figure 6).

Figure 6. Mario Klingemann, Neural Glitch / Mistaken Identity, 2018

The unexpected impact of artificial intelligence on the field of art and the debates surrounding whether it constitutes art actually occurred when photography first emerged. However, despite this similarity, artificial intelligence brings different concerns to the production side of art compared to photography. One concern is whether production enabled by artificial intelligence applications is ethical. Since designs created with artificial intelligence are highly likely to resemble the work of any artist, this raises the risk of copyright infringement. Furthermore, this issue affects not only the artist but also the art market. Artworks become popular, accelerating consumption and breaking the art world's monopoly. To prevent this, in 2018, Montreal University and the European Commission worked on transparent, accountable, and responsible artificial intelligence. In our country, the Ministry of Industry and Technology has a study titled Artificial Intelligence Strategy (Bastaban, 2024). However, when considering the functioning of artificial intelligence in general, it is known that algorithms produce specific outputs by feeding on data, which is similar to the artist's production process. Throughout the production process, artists unconsciously collect many images during the day and create their work inspired by them. Although this situation may standardize painting, throughout art history, each standardization has resulted in something more different and newer. For example, when the classical understanding of painting became commonplace, Cubism emerged (Eser, 2024).

The important point here is that artificial intelligence is a learning model, meaning humans are still in the teaching position. Whatever data we input, it will produce solutions within that framework. In fact, artificial intelligence encourages the artist to use their thinking ability more than just form. Of course, form and pattern form the basis of this work, but there may still be shortcomings in terms of the thinking and the idea behind the work. Here, we can also say that we are experiencing a return to conceptual art because, whether it is traditional or produced with artificial intelligence technology, the fundamental question is not which tool is used, but what is planned to be done with it, what the purpose and discourse of doing it is (Erdurmuş, 2024).

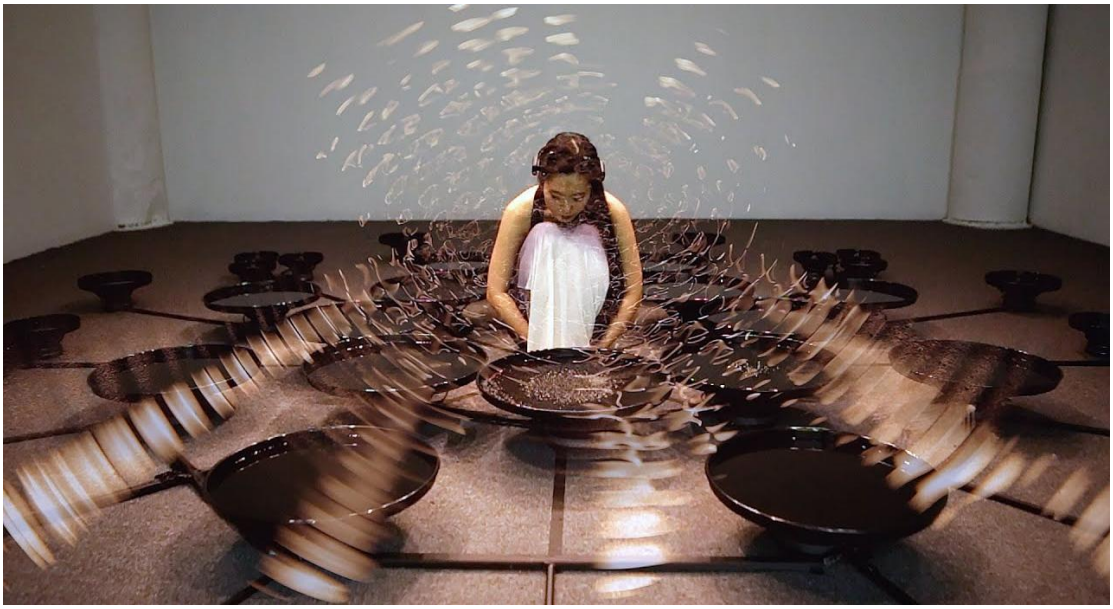

Figure 7. Lisa Park, Eunoia, 2013, 5 Aluminum plates, 5 Speakers, Water, Speaker wires, 1 Audio Interface, Neurosky brainwave headset

Artificial Intelligence and Education

In the context of art education, the impact of artificial intelligence is also evident in general education systems. Contrary to popular belief, the first applications of artificial intelligence in education date back to the 1920s-50s. Sidney L. Pressey, who worked at Ohio University, proposed a machine that could display students' test results and provide feedback on correct answers. However, he did not have the opportunity to implement it at the time. Supporting Pressey, Edward Thorndike stated in his law of effect that feedback should be immediate in tests used to evaluate learning. The "personalized learning" system used in today's educational technology was called the "Pigeon Project" by Burrhus Frederic Skinner in 1958. The project can also be used on humans, where students can look at the questions through one eye of a two-eyed board and write their answers on paper through the other eye, then see the correct answer when they turn the paper over (Arslan, 2020). Efforts to integrate information technology education into primary education have gained momentum in Europe. For example, the Royal Society in the UK stated in a report that providing digital education to students would both facilitate their adaptation to this new digital age and contribute to the country's prosperity. A similar report was also published in France. The published report emphasized the necessity of technology education at an early age. Subsequently, computer courses were added to the curriculum, first in primary and middle schools, then in high schools (MEB, 2022).

The expected point of arrival for artificial intelligence today, especially in education, is an approach that provides students and teachers with a new perspective rather than a

teacherless classroom environment. In other words, the expectation in this process is not the complete elimination of human skills but rather the use of artificial intelligence as a tool. Teachers bear a significant share of the workload in integrating artificial intelligence models into the classroom. This is because they must first acquire artificial intelligence literacy themselves in order to guide students in this area. In addition, there should be a guide to assist teachers in this process. In 2019, UNESCO prepared guidelines to assist teachers in their lessons regarding this very issue. These guidelines cover topics such as the development-oriented use of artificial intelligence in education, personalized learning plans, how teachers can integrate artificial intelligence into their lessons, and the comprehensive use of artificial intelligence (Mayo, 2024). In Turkey, Kürşat Arslan's study titled "Artificial Intelligence and Its Applications in Education" argues that a contemporary education model can be implemented by placing the student at the center of the educational process. The use of AI-based platforms in classrooms offers advantages, such as preparing lesson materials tailored to students' learning methods and identifying gaps in the curriculum. Looking at the artificial intelligence modules commonly used in education, the first expert systems in this field primarily focus on problems that can be solved by specialists in a particular field.

Expert systems are generally based on experience rather than on artificial intelligence and are more commonly used in distance learning. In this process, expert systems provide individual feedback to students, constantly updating their own database through problems. They are computer-assisted learning systems that preceded the evolution of intelligent tutoring systems. The software called PLATO is one of the intelligent teaching systems, ensuring effective learning on the desired subject by assuming that all students have the same level of readiness. As this situation brought disadvantages, Jamie Cabonell later developed a superior model, SCHOLAR, and established a dialogue-based system. It presents material based on the students' needs and skills and provides individual feedback on their responses. The last of the dialogue-based instructional systems, CIRCISM, is a superior system that can detect students' errors during learning activities and provide explanations to correct them.

In 2023, the Ministry of National Education introduced elective courses such as artificial intelligence, digital arts, and robotics into the 6th and 7th-grade middle school curriculum. The main reason for this change is the desire to help students develop not only knowledge but also critical thinking, problem-solving, and communication skills in the digital age they live in. In 2024, the Ministry of National Education published the "International Forum on Artificial Intelligence Applications Report" on this subject. The report covers the areas of application and sub-dimensions of artificial intelligence, as well as pilot studies on integrating artificial intelligence and ethics into education. For example, the General Directorate of Special Education and Guidance Services utilizes artificial intelligence technology in its education programs for students with special needs and gifted students. The "Science and Art Centers Artificial Intelligence Applications Workshop Program" was created to equip gifted students with the computational skills that have become a necessity in the digital age. The activity-based program includes nearly 35 activities covering the fundamentals of artificial intelligence, project creation, problem solving, and ethics.

Work on this topic has continued unabated since 2020, and there are currently 78 artificial intelligence workshops in our country. Another important development is that the Ministry of National Education and Turkcell have come together to provide 814 high school students and 173 teachers with 10 weeks of artificial intelligence training through the 'Intelligence Power Artificial Intelligence Marathon'. Artificial intelligence, which is expected to increase learning diversity in education, can create individualized learning programs for each student in the classroom. The report plans to incorporate artificial intelligence into the education program by reducing it to the primary and middle school levels for classroom use and to have the Ministry of National Education reorganize textbooks on the subject. This will enable students to acquire a certain level of knowledge about artificial intelligence and technology from an early age. It is stated that not only students but also teachers, who perhaps bear the most significant responsibility in this process, will have the opportunity to raise their knowledge

and skills to a certain level through seminars and guidance materials on the usability, ethical, and social dimensions of artificial intelligence in education. Teachers who complete the adaptation process will thus be able to guide their students better. Addressing teachers' concerns in this regard depends on increasing artificial intelligence literacy and developing the proper solution methods. However, to achieve this, attention must also be paid to issues such as the cultural structure of society where artificial intelligence literacy is to be increased, data privacy, and ethics. Another issue is that technological capabilities and conditions vary across regions of the country. To ensure equal educational opportunities, the technological infrastructure in disadvantaged regions must first be strengthened. Once these negative situations are resolved, it will be possible to integrate artificial intelligence into education. In this regard, the quality and success of education will also increase. The most important thing in this process is to create content tailored to students' and teachers' needs and to use artificial intelligence as a tool rather than a goal in education.

Artificial Intelligence, Art Education, and Applications

The primary goal of art education is to cultivate individuals who can think critically, take responsibility, possess observational skills, visualize their ideas, and have self-confidence. Given that education must constantly renew itself in the age of the information society, art education is also affected by this. Gude (2007) states the following in this regard: a good art curriculum not only explains works of art but also displays a cultural stance in how it conveys the content, independent of the content itself. Students need to be able to discover and analyze the ideas and themes underlying the curriculum (Gude, 2007). Based on this statement, the needs of our era can only be met by creating a curriculum suitable for all levels of education using artificial intelligence. For the functional use of artificial intelligence on smart boards and computers currently available in most schools, software must be installed and of high quality, meeting students' classroom needs. It should not be forgotten that most educational tools activate visual perception. For this reason, technology can be used in art education to understand current shifts in how visual arts are understood. Moreover, computer-assisted learning is increasingly being used in visual arts education (Cancan, 2020). The National Art Education Association in the United States has outlined the benefits of artificial intelligence in education in four separate points. The first is that artificial intelligence software enhances students' creative thinking skills. Here, artificial intelligence, used as an aid in the creative process, broadens the student's horizons and allows them to push their boundaries through extensive trial and error. The second point is that it fosters critical thinking skills as a platform for creativity. Instead of simply saying something is good or bad, the students will also reinforce their ability to think critically and examine what they see. Thirdly, it can assist teachers in preparing the curriculum. Due to large class sizes, teachers cannot provide education tailored to each student's learning style. Using artificial intelligence as an educational aid enables tailored learning for each student, potentially eliminating the problem of learning inequality in crowded classrooms. Finally, it can assist students of all skill levels. Not every student has the same capacity to perform a task; some students may need more attention. At this point, artificial intelligence can provide learning appropriate to each student's level and development. In addition to all this, the National Art Education Association has listed the disadvantages of artificial intelligence as follows: loss of originality and subsequent anxiety; loss of uniqueness; and neglect of the artistic dimension of the work due to the desire for quick results in images created with artificial intelligence (NAEA, 2024).

The National Coalition for Core Arts Standards (NCCAS) has created 12 digital media arts courses for secondary education, emphasizing the importance of digital technology since 2012, when artificial intelligence was not as widespread as it is today. The courses cover topics such as media arts, website design, and game design. Although it may seem like a subject for digital artists, it fundamentally involves visual arts skills, so that visual arts teachers can teach this course with guidance. Following this process, James Hutson and Peter Cotroneo (2023) taught an AI-based art course to 15 students enrolled in the Digital Art II-III course at the College of Arts and Humanities. Students in Digital Art II design images

using AI-powered visual generators and then reproduce them in Adobe Photoshop using these images as references. Advanced students in Digital Art III were asked to design plants for space use and then transfer their designs to an artificial intelligence tool to produce more realistic versions. Throughout the process, students in both courses used OpenAI's DALL-E2 image generator (Hutson & Cotroneo, 2023).

Figure 8. Per Gulbranson, Alien Plant Design, Original Artwork, 2023 (Hutson & Cotroneo, 2023)

Figure 9. Cassidy Krewson, A toxic, red/purple plant made of round bulbs with rings connecting them, spikes, and a yellow stem, in a desert; photorealistic, after Gulbrandson, Dalle-2, 2023 (Hutson & Cotroneo, 2023)

Art serves as a form of documentation in the transmission and preservation of cultural heritage due to its visual and auditory diversity. In this context, the styles artists employ in their work carry the socio-cultural traces of the society in which they are embedded. In this context, Bastaban and Sarıhan's (2024) study on the impact of artificial intelligence on the transmission of cultural heritage through miniature and ukiyo-e art can be cited as an example. Miniature art features a unique, small-scale painting technique, primarily found in handwritten books. Miniature also has a wide-ranging history and cultural heritage. Turkish miniature artists such as Nusret Çolpan and Sina Bey frequently featured cultural clothing, symbols, color diversity, and landscapes in their works. Ukiyo-e is an art form created through a unique woodblock-printing method native to Japan. In ukiyo-e art, created using a high relief carving technique, the raised areas are inked and then printed onto paper. The prints are used in many areas, such as books and advertisements. Leading ukiyo-e artists such as Suzuki Harunobu and Utagawa Hiroshige incorporated nature scenes, local dress, and the contemporary lifestyle into their works. The project was carried out with 10 students studying at the Visual Communication Design Department of Haliç University in 2023-2024. Students were permitted to use artificial intelligence programs such as Midjourney, Recraft, Canva AI, Adobe Firefly, and Leonardo AI, and were given one month to create their desired designs. As a first step, students created their sketches using programs such as Photoshop and Illustrator. Following an informative lecture on miniature ukiyo-e art, the students created their final works using the artificial intelligence programs mentioned. The resulting designs, which combine miniature and ukiyo-e art related to Turkish and Japanese culture through the use of artificial intelligence, are rich not only artistically but also culturally. The creative process was shortened in terms of time by combining traditional art with

technology, and students gained the ability to establish cross-cultural relationships (Bastaban & Sarıhan, 2024).

Figure 10. (Left) P. Sude Gültegin, Digital Design, 2024 (Bastaban ve Sarıhan, 2024)

Figure 11. (Right) Bedirhan Vıcıl, Digital Design, 2024 (Bastaban ve Sarıhan, 2024)

Meriç states that, based on an analysis of each student's learning method, pace, and needs, artificial intelligence-supported augmented reality provides students with personalized teaching materials (Meriç, 2024). Augmented reality, he says, makes learning more permanent through visuality and interaction, as the material is shaped to the students' needs. Artificial intelligence-generated works allow users to evaluate artworks from a different perspective. For example, Yujia Huang and colleagues conducted research using augmented reality technology at a kindergarten in Hong Kong. The augmented reality (AR)-based learning program, planned for three weeks, used the 'colAR mix' application developed by Puketo Limited (2013). The two-dimensional work created using traditional methods is presented in three dimensions when photographed with the application. Thirty-two copies of the application's website were printed for the students to color.

Once the coloring part is complete, students can reflect on their work in three dimensions through the application and show it to their friends. While this is fun for students, it also has some disadvantages. For example, the 32 different copies listed on the application's website may dull children's imaginations, impair motor development, and make students more introverted in communication. In the research conducted by Shih-Yeh Chen and colleagues, augmented reality technology was used in conjunction with STEAM education to help students learn colors. The study aimed to investigate whether students could learn basic color knowledge and color mixing through smart glasses. With these smart glasses, students can use two coloring methods: guided and unguided. Unguided coloring uses an algorithm to create the contour color, while guided coloring matches the areas outside the contour according to the color distribution. Initially, these two methods are not visible on the screen, allowing students to discover colors through their own experience first. Whenever the student feels stuck, they can view sample color mixtures based on the three primary colors using the control button. At the end of the exercise, it was observed that students remembered the three primary colors and the colors obtained from their mixtures better and had less difficulty finding the colors for a new exercise given to them.

Another example of artificial intelligence that can be used in art education is Tilt Brush. Tilt Brush, which lets users paint with a digital brush and palette, also offers a sculpting experience. It allows others to watch the user working in the virtual environment via a computer or connected screen. When the user finishes their work, they can print it out from a 3D or 2D printer or save it to continue working on it later if they wish. There are some potential drawbacks to using the Tilt Brush application in a classroom setting. For example,

prolonged use can cause eye strain and headaches, limited movement in the classroom due to short cables, financial strain due to large class sizes, and difficulties with equipment use, which can lead to prejudice and a lack of motivation among students.

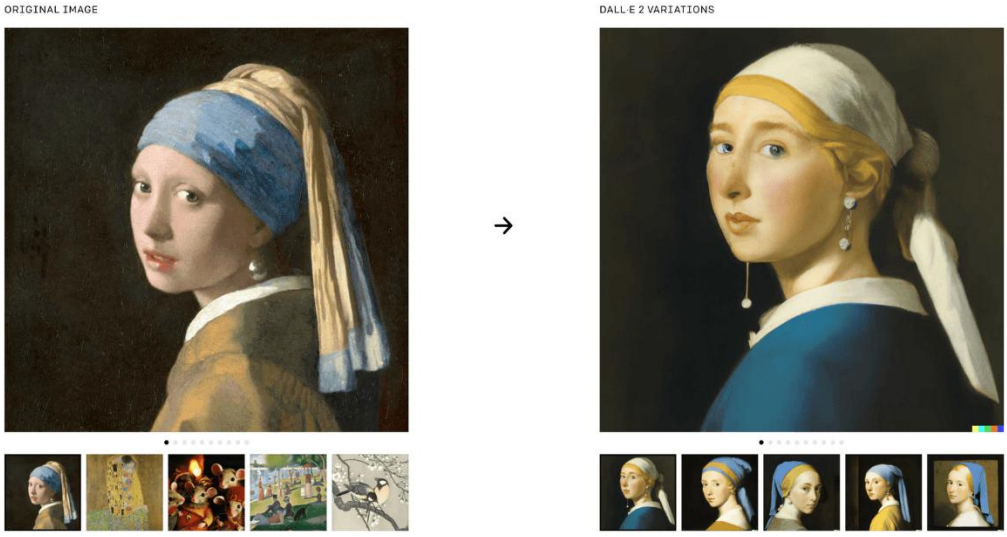

Figure 12. The Girl with the Pearl Earring painting recreated with DALL-E

Nvidia is an artificial intelligence program that teachers can use in visual arts classes. It is software developed using a deep learning model. Thanks to the Generative Adversarial Networks (GAN), it can convert simple inputs into photorealistic images. This model, which has two panels on its interface, can generate images by considering not only the information about the entered concept (shape, etc.), but also its connection to its environment, thanks to its machine learning feature (Erdurmuş, 2024).

Artificial Intelligence Creative Competitive Network (AICAN) is an artificial intelligence model developed by Dr. Ahmed Elgammal and his team at Rutgers University that operates across different styles, including Baroque, Rococo, and Abstract Expressionism. In addition, it can discover and produce styles that are not defined in its system. In short, it learns and analyzes styles from art history and creates new styles by discovering them.

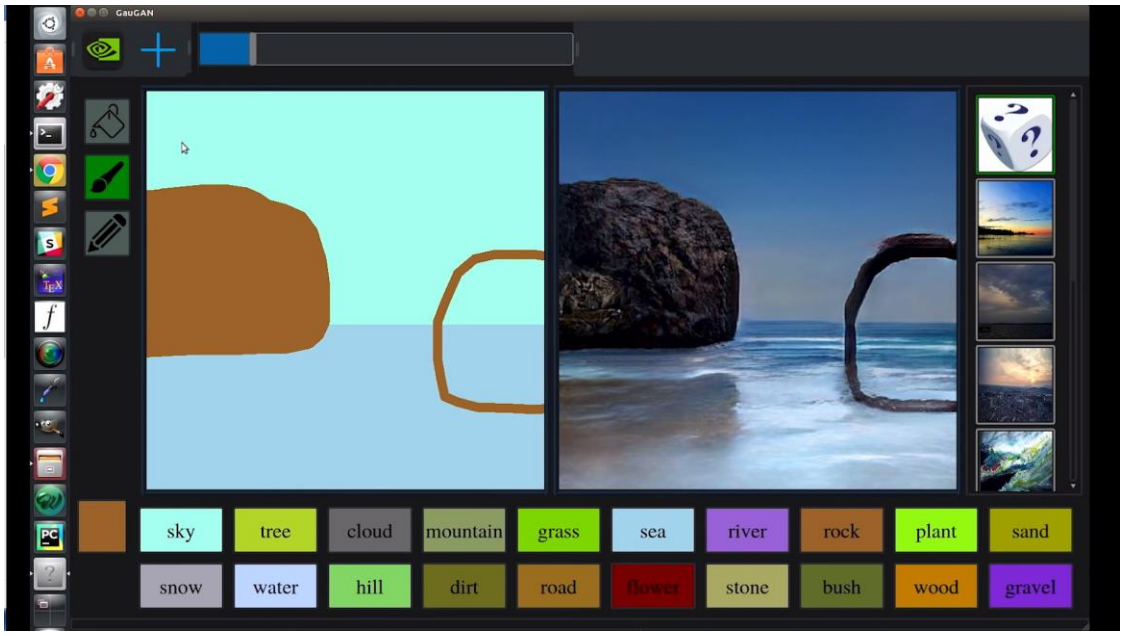

Figure 13. NVIDIA's GauGAN application's simple drawings

Stable Diffusion is a model that generates images from text using its deep learning infrastructure and can apply different styles. Thanks to its diffusion-based algorithm, it can produce high-resolution and natural images compared to other models (Erdurmuş, 2024). Regarding DALL-E and Midjourney, Öcal (2024) lists the advantages and disadvantages of using these tools in visual arts education for students as follows: By concretizing abstract concepts, students can achieve the desired result through trial and error. However, due to the ready-made visual content and conveniences offered by the programs, students may become accustomed to ready-made solutions and lose their critical thinking skills. The text used to create visuals is important for the depth of the sentence's meaning and for establishing the connection between language and visuals. Inadequate language skills can make it challenging to create the intended visual. Visuals created for presentations and projects may become superficial over time, leading to a decline in students' critical thinking skills.

While digital skills acquired at an early age help students cope with new situations in the future, they may sometimes behave prejudicially due to difficulties they encounter or become entirely dependent on quick results. Generative Adversarial Networks (GANs) are another alternative AI tool for developing students' creativity. Through the products generated by Generative Adversarial Networks, students can explore different styles and break away from their traditional understanding of painting, producing their own original work. It contributes to their development by instilling critical and divergent thinking in students. By offering personalized learning and incorporating materials that make the student's learning process effective and lasting, artificial intelligence actually contributes to the much-advocated student-centered education. Generative Adversarial Networks also challenge the limits of students' thinking power in art education and push them to think critically by finding what is different. As an example, the artificial intelligence program GauGAN, developed by NVIDIA in 2019 using a deep learning model, was presented to users as a program that transforms simple Paint drawings into realistic images in real time. The program uses Generative Adversarial Networks (GANs) to convert simple drawings into realistic visuals. These deep learning models consist of two artificial neural networks: a generator and a discriminator. While the generator creates images, the discriminator, trained on real images, provides feedback to the generator on how to make the images more realistic (Salian, 2022). Erdurmuş used the artificial intelligence tool called GauGAN in his master's thesis, which he conducted with middle school students. In his study investigating the effects of artificial intelligence on art education, he introduced the model to the computer lab. He conducted application tests to assess students' knowledge and skills. As a result, students improved their visual perception, technique, and creativity through artificial intelligence, particularly in aspects such as perspective in their pictures (Erdurmuş, 2024).

Orhak and Çağıltay (2024), in their study on virtual reality in education and teacher opinions, state that many teachers believe VR technology should be incorporated into education and try to collaborate with their colleagues for implementation, but that the overall rate of this is low. At the end of the study, it was found that some teachers had sufficient knowledge and skills in VR technology. It was concluded that the remaining teachers needed guidelines to integrate VR technology into their lessons. Perhaps at this point, UNESCO’s Guide to Education and Research on Generative Artificial Intelligence and the Ministry of National Education's 'International Forum Report on Artificial Intelligence Applications in Education' could be examined.

Conclusion

The use of artificial intelligence, which continues to grow in popularity today, spans many fields, from medicine and health sciences to banking, cybersecurity, tourism, advertising, education, and design. All artificial intelligence models used in the aforementioned fields are semi-autonomous rather than fully autonomous. While fully autonomous software can make decisions on its own, semi-autonomous software can be said to make decisions with

initiative (Eser, 2024). Unlike traditional education, the innovations enabled by artificial intelligence applications can create a compelling, engaging learning environment. Although there are concerns about the use of artificial intelligence in art, it generally provides artists and art educators with greater convenience. While the use of artificial intelligence teaches individuals to view things from different perspectives and develops visual perception, ethical issues such as protecting the rights of the owners of the visuals used as references in the system, and the direct use of references may also arise. According to Negara and Yunita, one of the contributions of artificial intelligence to art education is encouraging student participation in class. Transforming imagination into three dimensions with multimodal generative models allows teachers and students to share their own experiences. Of course, artificial intelligence provides users with many conveniences in terms of time. However, artificial intelligence applications are often insufficient at the design stage. Especially if the student has limited time for design, it is important to correctly direct the inputs (prompts) written into the application at this point. This allows for many different results to be obtained. However, at this stage, problems such as plagiarism, mentioned earlier, also arise. This is because artificial intelligence processes information, we teach it as data and uses this to offer new products. In other words, when imitating an artist's style and colors in the desired direction, the resulting image may be identical to that artist's work. From the user's perspective, this situation can lead to copyright issues. To completely eliminate the aforementioned inadequacy and prevent copyright issues, the student can retouch and rearrange the result using programs such as Photoshop or Illustrator.

Although AI-supported education has many advantages, it also creates situations that could lead to educational inequality. In our country, technological infrastructure and literacy may vary from region to region. A separate curriculum is needed to combine traditional education with AI-supported personalized education. AI, which offers the ability to transform any environment into a workshop through virtual environments instantly, is beneficial due to its efficiency in limited class time, portability, and ease of use. Applications such as Tilt Brush, GauGAN, DALL-E, and Midjourney allow students to learn through experience, challenging their imaginations to acquire lasting, practical knowledge. Moreover, it offers opportunities such as avoiding problems like material shortages, increasing the students' problem-solving ability, obtaining three-dimensional and two-dimensional printer outputs of completed work, and saving work so that it can be continued in the next class if it is left unfinished.

Along with the contributions of artificial intelligence to art education, there are also disadvantages. Although artificial intelligence provides students with quick results, if the information it presents is not filtered through a particular lens, students may be exposed to information pollution. Spending too much time in front of a screen can lead to problems such as eye strain and reduced socialization. Students who believe that success can only be achieved with artificial intelligence tools may eventually lose confidence in themselves and feel unsuccessful. Depending on the use of artificial intelligence programs, teachers may struggle to adapt, or socioeconomic inequality may lead to disadvantages. However, it should not be forgotten that these programs can make students dependent, limit their imagination, and cause some psychological issues. When the tool becomes the goal, learning from it may be reduced to mere input-output scenarios. In short, just as it is impossible to ignore technological developments in any era when providing education, collaboration must be pursued by considering the adaptability of artificial intelligence technology to education.

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